ATTACHMENT 2

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

Eastern San Joaquin Groundwater Subbasin

GROUNDWATER SUSTAINABILITY PLAN

AMENDED
November 2024

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Eastern San Joaquin Groundwater Subbasin

Groundwater Sustainability Plan

Prepared by:

GWA EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

REGISTERED PROFESSIONAL ENGINEER
LESLIE SCOTT DUMAS
No. 43897
EXP. 06-30-25
CIVIL
STATE OF CALIFORNIA

November 2024

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Appendices

Tables

Figures

Acronyms

µg/L	micrograms per liter
1,2,3-TCP	1,2,3-Trichloropropane
AB	Assembly Bill
ACS	American Community Survey
AEM	Airborne Electromagnetic
AEM	airborne electromagnetic survey
AF	acre-feet
AF/day	acre-feet per day
AF/year	acre-feet per year
AMI	Advanced Metering Infrastructure
AMI	automated metering infrastructure
ASR	aquifer storage and recovery
AWMP	Agricultural Water Management Plan
B.P.	before present
Bay-Delta Plan	Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary
bgs	below ground surface
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylenes
C&E Plan	Communication and Engagement Plan
C2VSim-FG	California Central Valley Simulation Model – Fine Grid
Cal Water	California Water Service Company Stockton District
California State Parks	California Department of Parks and Recreation
CALSIMETAW	California Simulation of Evapotranspiration of Applied Water
CalTrans	California Department of Transportation
CASGEM	California Statewide Groundwater Elevation Monitoring
CC	climate change
CCR	California Code of Regulations
CCR	Consumer Confidence Report
CCWD	Calaveras County Water District
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CDP	census designated place
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CDWA	Central Delta Water Agency
CEDEN	California Environmental Data Exchange Network
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGPF	CalSim II Generated Perturbation Factors
CGPS	continuous global positioning system
CNRA	California Natural Resources Agency
CSJWCD	Central San Joaquin Water Conservation District

CVFPB	Central Valley Flood Protection Board
CVRWQCB	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWC	California Water Code
CWSRF	Clean Water State Revolving Fund
DAC	Disadvantaged Community
DBCP	1,2-dibromo-3-chloropropane
DDW	Division of Drinking Water
Delta	Sacramento-San Joaquin River Delta
DER	Department of Environmental Resources
DFW	Department of Fish and Wildlife
DMS	data management system
DOGGR	Division of Oil, Gas, and Geothermal Resources
DPC	Delta Protection Commission
DPR	Department of Pesticide Regulation
DPW	San Joaquin County Department of Public Works
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
Eastside GSA	Eastside San Joaquin GSA
EBMUD	East Bay Municipal Utility District
EC	electrical conductivity
EDB	ethylene dibromide
EO	Executive Order
EPA	Environmental Protection Agency
ERTs	Encoder Receiver Transmitters
ESJ	Eastern San Joaquin
ESJGWA	Eastern San Joaquin Groundwater Authority
ESJGWA Board	Eastern San Joaquin Groundwater Authority Board of Directors
ESJWRM	Eastern San Joaquin Water Resources Model
ETo	evapotranspiration
EWMPs	efficient water management practices
ft. bgs	feet below ground surface
ft/mi	feet per mile
GAMA	Groundwater Ambient Monitoring and Assessment
GBA	Groundwater Basin Authority
GCM	global climate model
GDE	groundwater dependent ecosystem
GICIMA	Groundwater Information Center Interactive Mapping Application
GIS	Geographic Information System
GMP	Groundwater Management Plan
gpd	gallons per day
gpm	gallons per minute
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWL	groundwater level

HCM	Hydrogeologic Conceptual Model
ICU Program	Integrated Conjunctive Use Program
IDW	inverse distance weighted
ILRP	Irrigated Lands Regulatory Program
InSAR	interferometric synthetic aperture radar
IRWM	Integrated Regional Water Management
IRWMP	Integrated Regional Water Management Plan
ISW	interconnected surface water
IWFM	Integrated Water Flow Model
JPA	Joint Powers Agreement
JPL	Jet Propulsion Laboratory
LCSD	Lockeford Community Services District
LCWD	Linden County Water District
LLNL	Lawrence Livermore National Laboratory
LOCA	local analogs
MAC	Mokelumne-Amador-Calaveras
MAF	million acre-feet
MAR	managed aquifer recharge
MCL	maximum contaminant level
mg/L	milligrams per liter
MGD	million gallons per day
MHI	median household income
MICUP	Mokelumne River Integrated Conjunctive Use Program
µmhos/cm	micromhos per centimeter
MO	measurable objective
MOA	memorandum of agreement
MokeWISE	Mokelumne Watershed Interregional Sustainability Evaluation
MSL	mean sea level
MT	minimum threshold
MtBE	methyl tertiary-butyl ether
MUD	Municipal Utilities Department
MWH	Montgomery Watson Harza
NAD 83	North American Datum of 1983
NASA	National Aeronautics and Space Administration
NAVD 88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NDWA	North Delta Water Agency
NEPA	National Environmental Policy Act
NGS	National Geodetic Survey
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NSJWCD	North San Joaquin Water Conservation District
NWIS	National Water Information System
O&M	operations and maintenance

OES	San Joaquin County Office of Emergency Services
OID	Oakdale Irrigation District
OSWCR	Online System for Well Completion Reports
PCBL	Projected Conditions Baseline
PCE	perchloroethylene
PDA	Protest Dismissal Agreement
pdf	portable document format
PFOA	perfluorooctantoic acid
PFOS	perfluorooctanesulfonic acid
PG&E	Pacific Gas and Electric Company
PMA	Projects and Management Actions
PMC	Project Management Committee
PRISM	Precipitation-Elevation Regressions on Independent Slopes Model
PS	persistent scatter
RCA	recommended corrective action
RCD	Resource Conservation District
RCP	representative climate pathways
RD	Reclamation District
RFP	request for proposal
RL	Reporting Limit
RMN	representative monitoring network
RMW	representative monitoring well
RWQCB	Regional Water Quality Control Board
SAGBI	Soil Agricultural Groundwater Banking Index
SAW	Stakeholder Advisory Workgroup
SB	Senate Bill
SCADA	supervisory control and data acquisition
SCWSP	South County Water Supply Program
SDACs	Severely Disadvantaged Communities
SDWA	South Delta Water Agency
SEWD	Stockton East Water District
SGM	Sustainable Groundwater Management
SGMA	Sustainable Groundwater Management Act
SJC	San Joaquin County
SJC POC	San Joaquin Valley Point of Contacts
SJCFCWCD	San Joaquin County Flood Control and Water Conservation District
SJV	San Joaquin Valley
SMC	sustainable management criteria
SMCL	secondary maximum contaminant levels
SNMP	Salt and Nutrient Management Plan
SOPAC	Scripps Orbit and Permanent Array Center
SRA	State Recreation Area
SS	specific storage
SSJ	South San Joaquin
SSJ GSA	South San Joaquin GSA

SSJID	South San Joaquin Irrigation District
SVRA	State Vehicular Recreation Area
SWRCB	State Water Resources Control Board
SWTF	Surface Water Treatment Facility
SY	specific yield
TAC	Technical Advisory Committee
TAFY	thousand acre-feet per year
TCE	trichloroethene
TDS	total dissolved solids
TNC	The Nature Conservancy
TSS	Technical Support Services
UNAVCO	University Navstar Consortium
UNGL	University of Nevada Geodetic Laboratory
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	United States Fish & Wildlife Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
UWMP	Urban Water Management Plan
UWMPs	Urban Water Management Plans
VFD	variable frequency drive
VIC	Variable Infiltration Capacity
VOC	volatile organic compound
Water Code	California Water Code
WDL	Water Data Library
WDR	Waste Discharge Requirement
WID	Woodbridge Irrigation District
WIIN	Water Infrastructure Improvements for the Nation
Workgroup	Groundwater Sustainability Workgroup
WPCF	Water Pollution Control Facility
WRFP	Water Recycling Funding Program
WRIMS	Water Resource Integrated Modeling System
WY	water year

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ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Executive Summary

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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Acronyms

AF	acre-feet
AF/year	acre-feet per year
Cal Water	California Water Service Company Stockton District
CASGEM	California Statewide Groundwater Elevation Monitoring
CCWD	Calaveras County Water District
CDWA	Central Delta Water Agency
CGPS	continuous global positioning system
CSJWCD	Central San Joaquin Water Conservation District
Delta	Sacramento-San Joaquin River Delta
DMS	data management system
DWR	Department of Water Resources
Eastside GSA	Eastside San Joaquin GSA
ESJGWA	Eastern San Joaquin Groundwater Authority
ESJGWA Board	Eastern San Joaquin Groundwater Authority Board of Directors
ESJWRM	Eastern San Joaquin Water Resources Model
GAMA	Groundwater Ambient Monitoring and Assessment
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
InSAR	Interferometric Synthetic Aperture Radar
LCWD	Linden County Water District
LCSD	Lockeford Community Services District
Letter	Consultation Initiation Letter
MAF	million acre-feet
mg/L	milligrams per liter
NSJWCD	North San Joaquin Water Conservation District
OID	Oakdale Irrigation District
PMAs	projects and management actions
PMC	Project Management Committee
RWQCB	Regional Water Quality Control Board
SDWA	South Delta Water Agency
SEWD	Stockton East Water District
SGMA	Sustainable Groundwater Management Act
SMCL	secondary maximum contaminant levels
SSJID	South San Joaquin Irrigation District
TDS	total dissolved solids
TSS	Technical Support Services
USACE	United States Corps of Engineers
USGS	United States Geological Survey
WID	Woodbridge Irrigation District
Workgroup	Groundwater Sustainability Workgroup

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EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

ATTACHMENT 2

EXECUTIVE SUMMARY

ES-1. INTRODUCTION

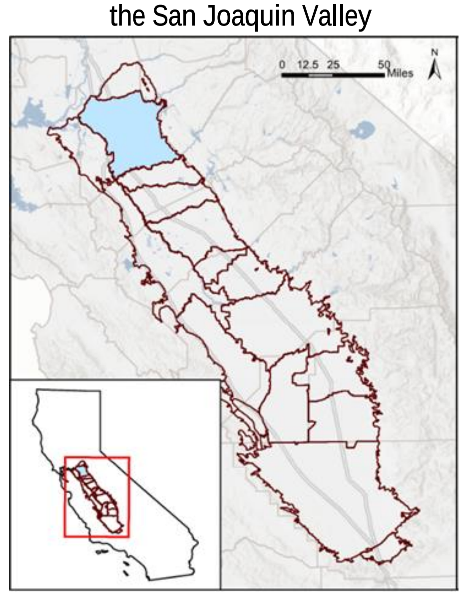
In 2014, the California legislature enacted the Sustainable Groundwater Management Act (SGMA) in response to continued overdraft of California's groundwater resources. The Eastern San Joaquin Groundwater Subbasin (Eastern San Joaquin Subbasin, or Subbasin) is one of 21 basins and subbasins identified by the California Department of Water Resources (DWR) as being in a state of critical overdraft. SGMA requires preparation of a Groundwater Sustainability Plan (GSP) to address measures necessary to attain sustainable conditions in the Subbasin. Within the framework of SGMA, sustainability is generally defined as long-term reliability of the groundwater supply and the absence of undesirable results.

> Critical Dates for the Eastern San Joaquin Subbasin
>
> ☒ 2020 By January 31: Submit GSP to DWR
> ☒ 2025 Evaluate GSP and update if warranted
> ☐ 2030 Evaluate GSP and update if warranted
> ☐ 2035 Evaluate GSP and update if warranted
> ☐ 2040 Achieve sustainability for the Subbasin

The Eastern San Joaquin Groundwater Authority (ESJGWA) was formed in 2017 in response to SGMA. A Joint Exercise of Powers Agreement establishes the ESJGWA, which is composed of 16 Groundwater Sustainability Agencies (GSAs): Central Delta Water Agency (CDWA), Central San Joaquin Water Conservation District (CSJWCD), City of Lodi, City of Manteca, City of Stockton, Eastside San Joaquin GSA (Eastside GSA) (composed of Calaveras County Water District [CCWD], Calaveras County, Stanislaus County, and Rock Creek Water District), Linden County Water District (LCWD), Lockeford Community Services District (LCSD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), San Joaquin County No. 1, San Joaquin County No. 2 (with participation from California Water Service Company Stockton District [Cal Water]), South Delta Water Agency (SDWA), South San Joaquin GSA (composed of South San Joaquin Irrigation District [SSJID] including Woodward Reservoir, City of Ripon, and City of Escalon), Stockton East Water District (SEWD), and Woodbridge Irrigation District (WID). The ESJGWA is governed by a 16-member Board of Directors (ESJGWA Board), with one representative from each GSA. The Board is guided by a Steering Committee, also with one representative from each GSA, that is tasked with making recommendations to the ESJGWA Board on technical and substantive matters.

SGMA requires development of a GSP that achieves groundwater sustainability in the Subbasin by 2040. The GSP outlines the need to reduce overdraft conditions and has identified 43 projects for potential development that either replace groundwater use (offset) or supplement groundwater supplies (recharge) to meet current and future water demands. Although current analysis indicates that groundwater pumping offsets and/or recharge on the order of 95,000 acre-feet per year (AF/year) may be required to achieve sustainability, additional efforts are needed to confirm the level of pumping offsets and/or recharge required to achieve sustainability. These efforts include collecting additional data and a review of the Subbasin groundwater model, along with other efforts as outlined in the GSP.

Figure ES-1: GSP Plan Area within the San Joaquin Valley



To address the requirements prescribed in SGMA and outlined in the GSP Emergency Regulations (2016), the Subbasin GSAs prepard and submitted a Final GSP by the initial January 31, 2020 deadline. On January 28. 2022, the ESJGWA received a Determiniation Letter from DWR. The Letter identified two deficiencies in the Subbasin GSPs which precluded DWR's approval, as well as potential corrective actions to address each potential deficiency. The Letter initiated consultation between DWR, the Plan Manager, the ESJGWA, and the Subbasin's GSAs. On July 27, 2022, the GSAs submitted the 2022 Revised GSP to DWR. In a July 6, 2023 Determination Letter, DWR concluded that the GSAs has taken sufficient actions to correct the deficienes identified by DWR and approved the 2022 Revised Plan. This 2023 Determiniation Letter also outlined eight recommended corrective actions that the GSAs could consider addressing during preparation of the first Periodic Evaluation. The ESJGWA determined that a Plan Amendment was required to adequately address the recommended corrective actions.

A Public Draft of the 2024 GSP Amendment was prepared and made available for public review and comment on October 1, 2024 for a period of 31 days ending on October 31, 2024. The ESJGWA received numerous comments from the public, reviewed and prepared responses to comments, and revised the Draft 2024 GSP Amendment. This Final 2024 GSP Amendment includes those edits and revisions, as well as edits to address the eight recommended corrective actions in DWR's 2023 Determination Letter.

ES-2. PLAN AREA

The ESJGWA's jurisdictional area is defined by the boundaries of the Eastern San Joaquin Subbasin in DWR's 2003 Bulletin 118 as updated in 2016 and 2018. The Subbasin underlies the San Joaquin Valley, as shown in Figure ES-1.

ES-3. OUTREACH EFFORTS

A stakeholder engagement strategy was developed to enable the interests of beneficial users of groundwater in the Subbasin to be considered. The strategy incorporated bi-monthly Project Management Committee (PMC) meetings, Steering Committee meetings, ESJGWA Board meetings, public meetings, an informational open house event, and information distribution to property owners and residents in the Subbasin.

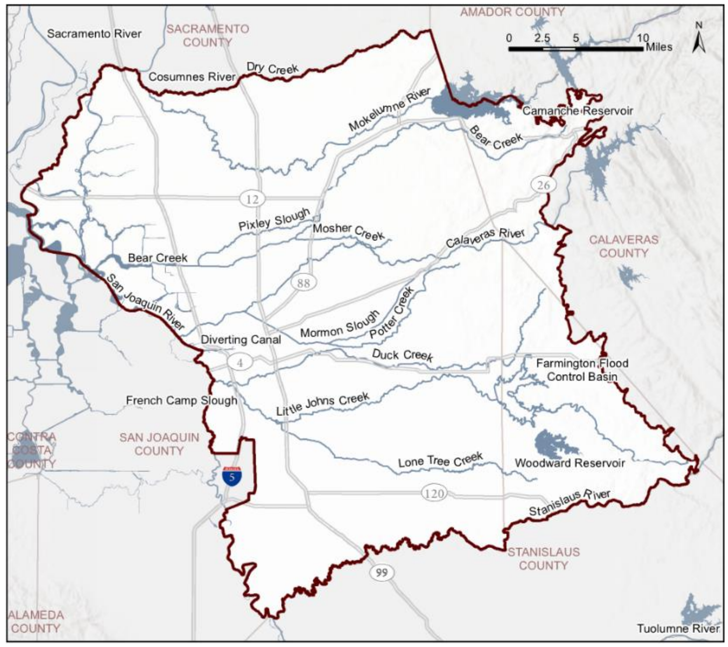
Public Meeting Type	Number of Meetings
ESJGWA Board Meetings	5
Steering Committee Meetings	5
Project Management Committee Meetings	20
Public Events (Meetings & Informational Open House Events)	3

To support the 5-year Periodic Evaluation of the GSP and development the 2024 GSP Amendment, the Steering Committee recommended that the chair of the ESJGWA form an Ad Hoc Project Management Committee (PMC). Approved by the Steering Committee in December 2023, the PMC was comprised of six GSA volunteers representing the varied interests in the Subbasin and covering both urban and agricultural areas. The PMC met bi-monthly during the GSP Periodic Evaluation and GSP Amendment process, and was tasked with driving the review and update process and coordinating other SGMA implementation efforts, including development of a Domestic Well Mitigation Program, coordination of stakeholder outreach and engagement, and annual and long-term budgeting. PMC members reviewed draft work products and other meeting materials to provide input and direction as needed at the bi-monthly meetings. The PMC was also responsible for recognizing and flagging items requiring discussion and direction from stakeholders, the Steering Committee, and the ESJGWA.

ES-4. BASIN SETTING

The Subbasin is located to the west of the Sacramento-San Joaquin River Delta (Delta) and is bounded by the Sierra Nevada foothills to the east, the San Joaquin River to the west, Dry Creek to the north, and Stanislaus River to the south. In the eastern portion of the Subbasin, groundwater flows from east to west and generally mirrors the westward sloping topography of the geologic formations. In the western portion of the Subbasin, groundwater flows eastward toward areas with relatively lower groundwater elevation. Surface water generally flows from east to west, with the major river systems traversing the Subbasin being the Calaveras, Mokelumne, and Stanislaus rivers. Multiple smaller streams flow into the San Joaquin River, which flows from south to north. The location of the Subbasin is shown in Figure ES-3.

Figure ES-3: Basin Setting

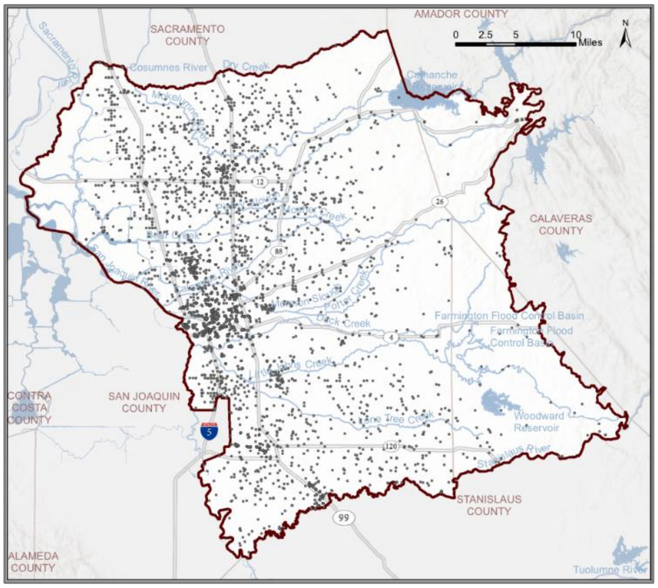


ES-5. EXISTING GROUNDWATER CONDITIONS

Groundwater levels in some portions of the Subbasin have been declining for many years, while groundwater levels in other areas of the Subbasin have remained stable or increased in recent years. The change in groundwater levels varies across the Subbasin, with the greatest declines occurring in the central portion of the Subbasin. The western and southern portions of the Subbasin have experienced less change in groundwater levels, in part due to the minimal groundwater pumping in the Delta area to the west and the import of surface water for agricultural and urban uses. In the most recent years, groundwater levels show a general trend of increasing as a result of two signficantly wet water years following two critically dry water years. It has also been established through isotope analysis that the implementation of the Tecklenberg project has added to groundwater levels in the project area.

Groundwater quality in the Subbasin varies by location. Areas along the western margin have historically had higher levels of salinity. Salinity may be naturally occurring or the result of human activity. Sources of salinity in the Subbasin include Delta sediments, deep saline groundwater, and irrigation return water. Total dissolved solids (TDS), which is a measure of all inorganic and organic substances present in a liquid in molecular, ionized, or colloidal suspended form, and chloride are commonly used to measure salinity. The Groundwater Ambient Monitoring and Assessment (GAMA) Program includes numerous water quality monitoring sites in the Subbasin compiled from different sources, shown in Figure ES-4. Maximum TDS concentrations across the Subbasin have been reported as high as 2,500 milligrams per liter (mg/L) along portions of the Subbasin's western boundary. Maximum chloride concentrations have been reported at concentrations greater than 2,000 mg/L, with higher concentrations measured in the central and western regions of the Subbasin. For drinking water, California has three secondary maximum contaminant level (SMCL) standards for TDS, all based on aesthetic considerations such as taste and odor, not public health concerns. These are 500 mg/L (recommended limit), 1,000 mg/L (upper limit), and 1,500 mg/L (short-term limit). TDS concentrations decrease significantly to the east, to typically less than 500 mg/L (the recommended limit for aesthetic considerations). The SMCL for chloride is 250 mg/L. Chloride concentrations are typically low across the Subbasin with the majority of measurements falling within the 0-250 mg/L range. Elevated concentrations of other constituents, such as nitrate, arsenic, and point-source contaminants, are generally localized and not widespread and are

Figure ES-4: GAMA Water Quality Sampling Locations



generally related to natural sources or land use activities. The GSP establishes ongoing monitoring of salinity (as TDS and chloride) and uses publicly available groundwater quality data to assess groundwater quality relative to arsenic, nitrate, and a number of other common water quality constituents to fill data gaps and identify potential trends of concern.

While the total volume of groundwater in storage in the Subbasin has declined over time, groundwater storage reduction has not historically been an area of concern in the Subbasin, as there are large volumes of fresh water stored in the aquifer. The total fresh groundwater in storage was estimated at over 50 million-acre-feet (MAF) in 2015. The amount of groundwater in storage has decreased by approximately 0.01 percent per year (or -0.34 MAF per year) between 1995 and 2023. As such, it is highly unlikely the Subbasin will experience conditions under which the volume of stored groundwater poses a concern, although the depth to access that groundwater does pose a concern.

Land subsidence has not historically been an area of concern in the Subbasin, and there are no records of land subsidence caused by groundwater pumping in the Subbasin.

Seawater intrusion is not considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin as the adjoining Sacramento-San Joaquin River Delta (Delta) is managed as a freshwater body, there is minimal pumping near the Delta, and there are relatively low chloride concentrations in the Subbasin.

Surface waters can be hydraulically interconnected with the groundwater system, where the stream baseflow is either derived from the aquifer (gaining stream) or recharged to the aquifer (losing stream). If the water table beneath the stream substantially lowers as a result of groundwater pumping, the stream may disconnect entirely from the underlying aquifer. Major river systems in the Subbasin are highly managed to meet instream flow requirements for fisheries, water quality standards, and water rights of users downstream. The Eastern San Joaquin Water Resources Model (ESJWRM) Version 3.0 was used to identify interconnected reaches of rivers and streams contained within or bounding the Subbasin by comparing monthly groundwater elevations from the historical calibration of the ESJWRM to streambed elevations along the streams represented. The Mokelumne, Stanislaus, and lower San Joaquin Rivers were found to be connected at least 80 percent of the time over the model simulation period, and the Calaveras River less than 20 percent of the time. ESJWRM Version 3.0 was also used to evaluate current conditions to those simulated for Water Year 2015 (representing dry conditions with low groundwater levels after a multi-year drought). The resultant trends were very similar to historical gains and losses, with the exception of the Stanislaus River, which has a high number of stream nodes in the center portion of the river that are losing under current conditions. ESJWRM Version 3.0, while the best available tool at the time of analysis, contains uncertainty preventing the GSAs from having sufficient data to determine if or when streams or reaches are connected to the groundwater table with this level of granularity. The GSAs will be collecting more data with the new ISW monitoring wells to help inform this analysis going forward.

ES-6. SUSTAINABLE MANAGEMENT CRITERIA

SGMA introduces several terms to measure sustainability, including:

Sustainability Indicators – Sustainability indicators refer to any of the effects caused by groundwater conditions occurring throughout the Subbasin that, when significant and unreasonable, cause undesirable results. The six sustainability indicators identified by DWR are the following:

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

Sustainability Goal – This goal is the culmination of conditions resulting in a sustainable condition (absence of undesirable results) within 20 years.

Undesirable Results – Undesirable results are the significant and unreasonable occurrence of conditions that adversely affect groundwater use in the Subbasin, including reduction in the long-term viability of domestic, agricultural, municipal, or environmental uses of the Subbasin's groundwater. Categories of undesirable results are defined through the sustainability indicators.

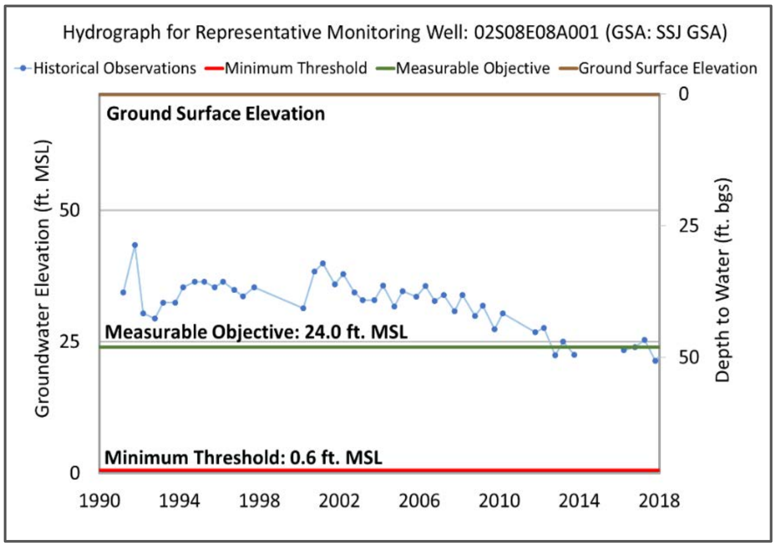
Minimum Thresholds – Minimum thresholds are numeric values for each sustainability indicator and are used to define when undesirable results occur. Undesirable results occur if minimum thresholds are exceeded in an established percentage of sites in the Subbasin's representative monitoring network.

Measurable Objectives – Measurable objectives are a specific set of quantifiable goals for the maintenance or improvement of groundwater conditions.

The method prescribed by SGMA to measure undesirable results involves setting minimum thresholds and measurable objectives for a series of representative monitoring wells or sites for each sustainability indicator. Representative monitoring wells are identified to provide a basis for measuring groundwater conditions (levels and quality) throughout a basin or subbasin without having to measure each well, which would be cost prohibitive. In the Eastern San Joaquin Subbasin, representative wells were selected based on history of recorded groundwater level and/or quality data and potential to effectively represent the groundwater conditions. For the sustainability indicator relating to inelastic land subsidence, representative montioring locations measure ground surface elevations. Similar to the monitoring networks for groundwater levels and quality, monitoring sites were selected based on the history of recorded data and the potential to effectively represent conditions across the Subbasin. As determined following further evaluation, the sustainability indicator relating to significant and unreasonable seawater intrusion was deemed not applicable to the Eastern San Joaquin Subbasin as the Subbasin is not on the coast, and saltwater intrusion through the Delta is managed by upstream reservoir releases to maintain salinity concentrations around 2 parts per thousand.

A total of 23 representative wells were identified for measurement of groundwater levels in the Subbasin, 21 representative wells were identified for groundwater quality monitoring, and 12 representive wells were identified for monitoring related to interconnected surface water. For measurements related to inelastic land subsidence, four CGPS stations and six survey benchmarks were selected to form the monitoring network for this sustainability indicator. The GSP uses groundwater level data as the basis for evaluating conditions for groundwater storage.

Figure ES-5: Sample Relationship Between Minimum Threshold and Measurable Objective



Minimum thresholds and measurable objectives were developed for each of the representative monitoring sites. Figure ES-5 shows a typical relationship of the minimum thresholds, measurable objectives, and historical groundwater level data for a sample groundwater level representative monitoring well. Similar analyses can be made for groundwater quality and land subsidence.

Minimum thresholds for groundwater levels were developed with reference to historical drought low conditions and domestic well depths. Specifically, minimum thresholds were established based on the historical (2015) drought low plus a buffer of the historical fluctuation *or* the 10th percentile domestic well depth, whichever is shallower – establishing levels that are protective of 90 percent of domestic wells and wells that community water systems may rely on. In municipalities with ordinances requiring the use of City water (water provided by the City's municipal wells), the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.

Measurable objectives for groundwater levels were established based on the historical (2015) drought low and provide a buffer above the minimum threshold. A table summarizing minimum thresholds and measurable objectives is included in Chapter 3 of this Amended GSP. Graphs showing the minimum threshold and measurable objective for each of the representative wells are contained in an appendix to the GSP.

The minimum thresholds and measurable objectives for groundwater levels are used for the groundwater storage sustainability indicator, as this sustainability indicator is strongly linked to groundwater levels. The groundwater levels minimum thresholds are found to be protective of groundwater storage

Minimum thresholds for groundwater quality were defined by considering two primary beneficial uses at risk of undesirable results related to salinity: drinking water and agriculture uses. Minimum thresholds are 1,000 mg/L total dissolved solids (TDS), 250 mg/L chloride, or the groundwater concentration of those constituents as measured in 2015 at the representative monitoring location, whichever is greater. These values reflect the Secondary Maximum Contaminant Limit (SMCL) for the two constituents of concern (TDS and chloride), plus ackowledges groundwater quality degradation that was already occurring in 2015. Furthermore, these values reflect the agricultural nature of the Subbasin.

Measurable objectives for groundwater quality were set at 600 mg/L for TDS, and the maximum maximum recent historical measurement (as measured between 2015 and 2023) for chloride. The TDS measurable objective of 600 mg/L was developed based on the TDS recommended SMCL for drinking water of 500 mg/L with an added 100 mg/L buffer. A measurable objective of 600 mg/L TDS is close to the recommended SMCL of 500 mg/L and significantly below the upper limit SMCL of 1,000 mg/L, and is considered adequate for drinking water and agricultural uses. The chloride measurable objective was set equal to the maximum measured chloride concentration as measured during recent historical conditions (between 2015 and 2023), accounting for fluctuations in constituent concentrations with hydrologic conditions.

The minimum threshold for inelastic land subsidence in the Subbasin was set at no more than 0.2 foot/year [2.4 inches/year] in any five-year period between 2020 and 2040, resulting in no more than a total additional 2 feet (24 inches) of land subsidence by 2040. This is set within the same magnitude of estimated error of the InSAR data (+/- 0.1 foot [0.03 m]), which is currently the most comprehensive tool available for measuring subbasin-wide land subsidence consistently each year, based on historical subsidence rates. Additionally, the minimum threshold of 24 inches of additional subsidence by 2040 reflects the historical subsidence level with an added buffer, and is in line (both by method and magnitude) with the minimum thresholds established by other nearby basins overlying the Corcoran Clay.

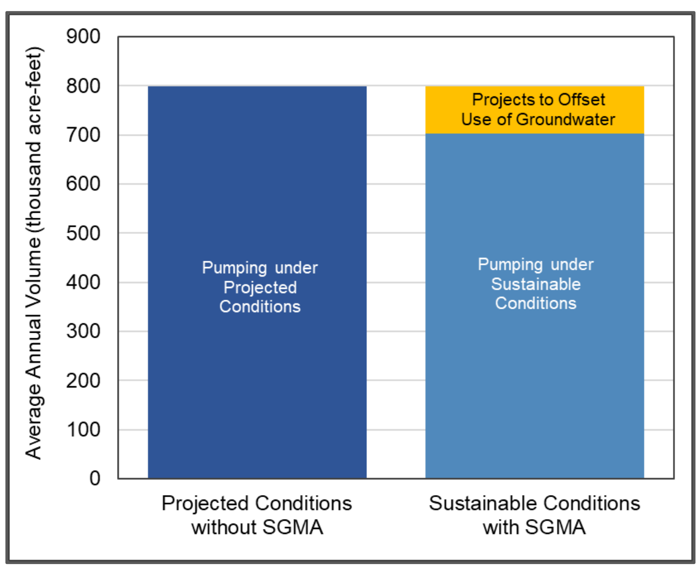
The measurable objective for inelastic subsidence is based on the long-term avoidance of land subsidence: 0 ft/year, on a long-term average. This measurable objective is set recognizing the interconnectedness of the Subbasin with surrounding subbasins, and the ability to meet this objective is dependent on the successful management of all nearby subbasins

Finally, the minimum thresholds and measurable objectives established for interconnected surface water representative monitoring wells both use groundwater levels as a metric. Groundwater level data are used to calculate water table gradients and, therefore, the volume of water gained and lost. The interconnected surface water minimum thresholds and measurable objectives for wells with historical groundwater level observations are the same as for the chronic lowering of groundwater levels minimum thresholds. Analyses were conducted to demonstrate that the groundwater level minimum thresholds are protective of stream depletions and stream-aquifer interactions (stream connectivity, stream gains and losses, and stream gains and losses as a percentage of streamflow), and therefore the use of these minimum thresholds is justified. For new representative montiroing wells without historic data sets, minimum thresholds and measurable objectives will be established after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period, utilizing the methodologies outlined in Chapter 3 of this GSP.

ES-7. WATER BUDGETS

The Eastern San Joaquin Subbasin has been in an overdraft condition for many years. Overdraft occurs when the amount of groundwater extracted exceeds the long-term average groundwater recharged.

Figure ES-6: Subbasin-Wide Total Groundwater Pumping and Offsets Required to Achieve Sustainability



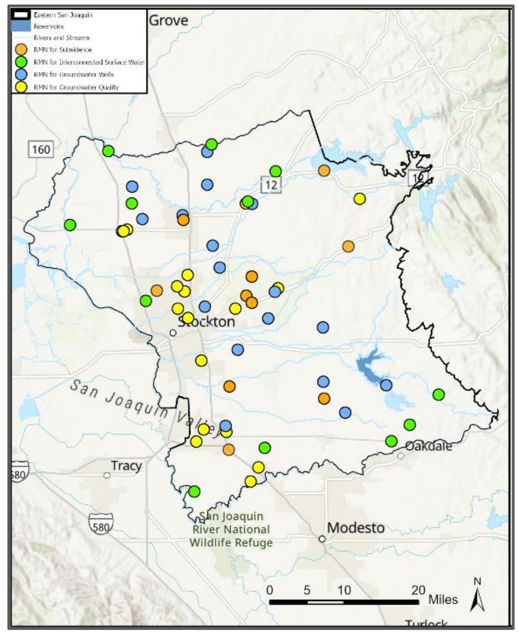
The groundwater evaluations conducted as a part of the developmnet of this GSP Amendment provide revised estimates of the historical, current, and projected groundwater budget conditions. The current analysis was prepared using the best available information and through updates to the Subbasin's groundwater modeling tool, the Eastern San Joaquin Water Resources Model (ESJWRM), Version 3.0. It is anticipated that as additional information becomes available, the model will continue to be updated to continuously refine estimates of annual pumping and overdraft .

As part of the 5-year Periodic Evaluation and preparation of this Amended GSP, the ESJWRM was updated to Version 3.0 to incorporate new data relating to layering, streams, land use, urban water demand, surface water supply and water deliveries and to extend the simulation period through Water Year 2023. The model was then recalibrated for the extended period, and water budgets were updated for historical conditions, current conditions, projected conditions baseline, and projected conditions with the impacts of climate change. Projected conditions scenarios were also updated to incorporate an updated list of projects and management actions as well as updates to the sustainable yield estimate.

Based on these analyses, at projected groundwater pumping levels, the long-term groundwater pumping offset and/or recharge required for the Subbasin to achieve a 0 AF/year change in storage is approximately 95,000 AF/year. Groundwater levels are expected to continue to decline based on projections of current land and water uses. Projects and management actions that offset groundwater pumping and/or increase recharge will help the Subbasin reach sustainability, as illustrated in Figure ES-6.

The projected Subbasin water budget was also evaluated under climate change conditions, which simulate higher demand requiring increased groundwater pumping despite more precipitation and streamflows. The updated version of the Projected Conditions Baseline with Climate Change (PCBL-CC) largely used the same perturbation factors (2070 Central Tendency climate change conditions) as the original simulation, but the updated PCBL-CC extended the simulation time period by three additional years. The overdraft modeled under climate change conditions is simulated to increase above projected conditions without climate change, requiring long-term groundwater pumping offset and/or recharge required for the Subbasin to achieve a 0 AF/year change in storage is approximately 166,000 AF/year.

Figure ES-7: Monitoring Sites



ES-8. MONITORING NETWORKS

This GSP Amendment outlines the representative monitoring networks for five of the six sustainability indicators. (Seawater intrusion is no longer considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin.) The objective of these monitoring networks is to monitor conditions across the Subbasin and to detect trends toward undesirable results. Specifically, the monitoring networks were developed to do the following:

- Monitor impacts to the beneficial uses or users of groundwater
- Monitor changes in groundwater conditions and land surface elevations relative to measurable objectives and minimum thresholds
- Demonstrate progress toward achieving measurable objectives described in the GSP

There are four representative monitoring networks in the Eastern San Joaquin Subbasin: two representative networks for water levels (one for the chronic lowering of groundwater levels sustainability indicator and one for the interconnected surface waters sustainability indicator), a representative network for groundwater quality, and a representative network for inelastic land subsidence. Representative networks are used to determine compliance with the minimum thresholds.

The monitoring networks were designed by evaluating data from the DWR's California Statewide Groundwater Elevation Monitoring (CASGEM) Program, the United States Geological Survey (USGS), the United States Army Corps of Engineers (USACE), the California Department of Transportation (CalTrans), the San Joaquin County Department of Public Works, and participating GSAs. The groundwater level and interconnected surface water monitoring networks consist largely of wells that are already being used for monitoring in the Subbasin. New wells were added to the monitoring networks, including one well located in the Delta, two deep, multi-completion monitoring wells constructed under DWR's Technical Support Services (TSS) program, and five new shallow monitoring wells for interconnected surface water assessment. Figure ES-7 shows the location of existing monitoring sites for all representative monitoring networks.

Wells in the monitoring networks for water levels (for both the groundwater level and interconnected surface water sustainability indicators) and groundwater quality will be measured on a semi-annual schedule. Monitoring for subsidence will also occur semi-annually. Historical measurements have been entered into the Subbasin Data Management System (DMS), and future data will also be stored in the DMS.

A summary of the monitoring sites in the representative monitoring networks is shown in the table below.

Summary of Representative Monitoring Network Wells/Stations	
Data Collected	Well/Station Count
Groundwater Level	23
Interconnected Surface Water	12
Groundwater Quality	21
Subsidence (CGPS stations and survey benchmarks)	10

ES-9. DATA MANAGEMENT SYSTEM

The Eastern San Joaquin DMS was built on a flexible, open software platform that uses familiar Google maps and charting tools for analysis and visualization. The DMS serves as a data-sharing portal that enables use of the same data and tools for visualization and analysis. These tools support sustainable groundwater management and create transparent reporting about collected data and analysis results.

The DMS is web-based; the public can easily access this portal using common web browsers such as Google Chrome, Firefox, and Microsoft Edge. The DMS is currently populated with available historical data. Future data will also be entered into the system as it is collected.

The DMS portal provides easy access and the ability to query information stored in the system. Groundwater data can be plotted for any of the available data points, providing a pictorial view of historical and current data.

Recently, a mobile and tablet interface was developed for the DMS to facilitate the real-time upload of data collected in the field. The mobile interface is implemented using the Esri ArcGIS Field Maps mobile app (or the Collector app if already installed) and is integrated with the DMS via web services to ArcGIS Online*. The mobile interface is intended to provide all ESJGWA staff and their consultants with an easy-to-use interfaces to collect well and groundwater related data in the field. Data collected using the mobile interfaces are pulled into the DMS on a nightly basis where it is quality controlled prior to insertion into the database.

The DMS can be accessed at this link using the Guest Login:
https://opti.woodardcurran.com/esj/

Figure ES-8: Opti DMS Screenshot

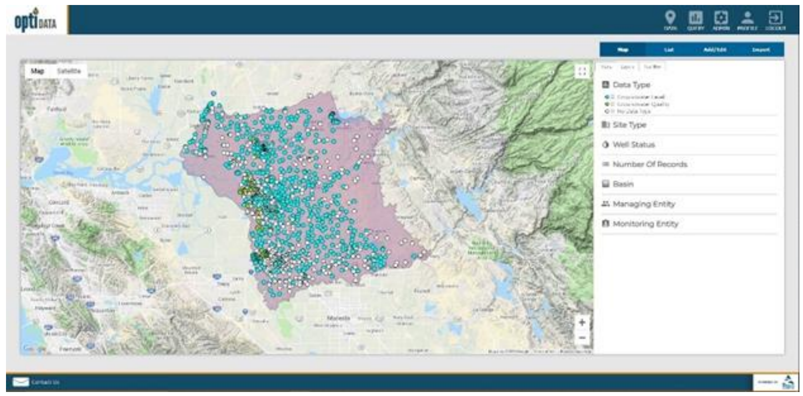
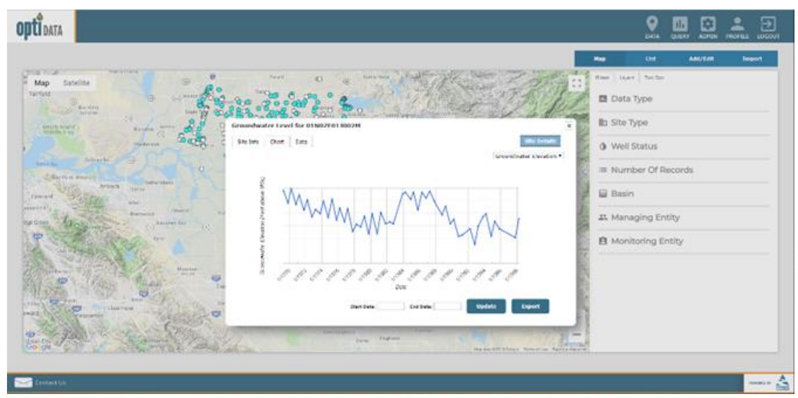


Figure ES-9: Typical DMS Data Display



ES-10. PROJECTS AND MANAGEMENT ACTIONS

Achieving sustainability in the Subbasin requires implementation of projects and management actions. The Subbasin will achieve sustainability by implementing water supply projects that either replace groundwater use or supplement groundwater supplies to attain the current estimated pumping offset and/or recharge need of 95,000 AF/year. It should be noted that this number will be reevaluated in the future after additional data are collected and analyzed. In addition, three projects have been identified that support demand conservation and reduction activities, including water use efficiency upgrades. While the implementation of projects to address sustainabilty has been and will continue to be the cornerstone of the ESJ GSP, the Subbasin is committed to developing a Demand Management Program that would include pumping restrictons if projects are not implemented as expected.

Although the ESJGWA does not have direct authority to require GSAs to implement projects, the ESJGWA will coordinate analysis of GSA-level demands and will compile annual or biannual reports to evaluate progress. If projects do not progress, or if monitoring efforts demonstrate that the projects are not effective in achieving stated recharge and/or offset targets, the Subbasin's Demand Management Program, a new management action in this GSP, will be implemented.

Projects to increase water supply availability in the Subbasin were identified by individual GSAs. The initial set of projects was reviewed with the ESJGWA Board, Steering Committee, and Workgroup. A final list of 41 potential projects are included in the GSP, representing a variety of project types including direct and in-lieu[1] recharge, intra-basin water transfers, demand conservation, water recycling, and stormwater reuse. Four new additional projects were approved by the ESJGWA Board at their September 11, 2024 meeting, and are not included in below. More information on these projects is included in Appendix 6-A. With the addition of these four projects, the GSP now includes 45 total projects. Projects are classified into two categories based on project status: Category A and Category B. Category A projects are those that are completed or are anticipated to advance in the next five years and have existing water rights or agreements. Category B projects are those that are not anticipated to advance in the next five years, but may be implemented in the future. Category A projects were simulated in the projected water budget to evaluate their effectiveness on achieving Subbasin sustainability. Category B projects may be elevated to a Category A project should feasibility studies demonstrate a viable project, if water rights or contracts are firmly identified, if partnerships are formed, and if economic evaluation demonstrate that the projects are cost effective, and remain part of the overall adaptive management strategy that the Subbasin is utilizing in GSP implementation to achieve and maintain Subbasin sustainability. These projects are summarized below.

[1] In-lieu recharge refers to the use of surface water or recycled water supplies for applications where groundwater is currently used. This "in-lieu" use reduces groundwater pumping and allows groundwater to remain in the aquifer.

ATTACHMENT 2

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Category A Projects - projects that were completed or are anticipated to advance in the next five years and have existing water rights or agreements									
Lake Grupe In-lieu Recharge	In-lieu Recharge	SEWD	Groundwater levels	Completed	2020-2023	$2.3 M	$330,000	Installation for new intake and pipeline requires permits from DFW, CVFPB, RWQCB, and USACE	4,900
SEWD Surface Water Implementation Expansion	In-lieu Recharge	SEWD	Groundwater levels	Implementation	2019-2029	$750,000	$100,000	Permit approvals from DFW, RWQCB, CVFPB, and USACE by private landowners	19,000
White Slough Water Pollution Control Facility Expansion	Recycling/ In-lieu Recharge/Direct Recharge	City of Lodi	Groundwater levels	Construction complete	2019-2020	$6 M	$4,664	None (permitting complete)	1,000
CSJWCD Capital Improvement Program	In-lieu Recharge	CSJWCD	Groundwater levels	Can be implemented immediately	2020-2027, on-going with 7-year completion cycles	N/A	$50,000	Individual applications need CSJWCD Board approval and possible streambed alteration permits	24,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
NSJWCD South System Modernization	In-lieu Recharge	NSJWCD	Groundwater levels	Environmental review complete, funding secured for Phases 1, 2 and 3. Landowner improvement district formed. Phases 1-2 complete.	2018-2025 for Phases 1, 2, 3; 2025-2028 for Phase 4; 2028-2035 for future phases	Phase 1&2: $7 M Phase 3: $4 M Phase 4: $8 M Future Phases: $10-20 M	Phase 1&2: $200,000 Phase 3: $200,000 Phase 4: $200,000 Future Phases: $200,000	Permits for pump station work have been completed; minor grading and road encroachment permits may be needed	10,000
Long-term Water Transfer to SEWD and CSJWCD	Transfers	SSJ GSA	Groundwater levels	Infrastructure is in place. CEQA completed and agreements in place	2019-2021	N/A	$9 M	Project must comply with CEQA	20,000
South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	In-lieu Recharge	NSJWCD	Groundwater levels	Pilot Dream Project will be complete by February 2024. Working on expanded banking project	2020-2024	$5 M	$400,000	SWCRB change petition for Permit 10478 and San Joaquin County groundwater export permit, and regulatory permits as needed	4,000
NSJWCD North System Modernization/ Lakso Recharge	In-Lieu Recharge	NSJWCD	Groundwater levels	Constructed Phase 1A, in progress on Phase 1B. Planning Phase 2	2021-2026	$7 M	$150,000	Regulatory permits as needed	4,000
Tecklenburg Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Substantially complete	2022-2024	$1 M	$400,000	CEQA review and possible grading permit	2,000
City of Stockton Phase 1: Groundwater Recharge Project	Direct Recharge	City of Stockton	Groundwater levels	Basin design in progress. Construction to begin spring 2025.	2022-2026	$11.5 M	To be Determined	Project must comply with CEQA	20,000

ATTACHMENT 2

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
West Groundwater Recharge Basin	Direct Recharge	SEWD	Groundwater levels	Ongoing	2032	To be Determined	To be Determined	To be Determined	16,000
NSJWCD Private Pump Partnerships	In-Lieu Recharge/Direct Recharge	NSJWCD	Groundwater levels	Ongoing	2024	To be Determined	To be Determined	To be Determined	3,000
Oakdale Irrigation District In-lieu and Direct Recharge Project	Direct Recharge/In-Lieu Recharge	OID	Groundwater levels	Ongoing	2023-2032	To be Determined	To be Determined	To be Determined	25,000
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Groundwater levels	In progress. Contract awarded in March 2024.	2023-2028	$17 M	To be determined	Not determined	2,000
								Total Category A	*154,900*
Category B Projects - projects that are not anticipated to advance in the next five years, but may be implemented in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets or do not produce a response as simulated in the model									
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Groundwater levels	Experiencing Delays	Not determined	$650,000	$300,000	None	272
City of Lodi Surface Water Facility Expansion & Delivery Pipeline	In-lieu Recharge	City of Lodi	Groundwater levels	Planning phase	2030-2033	$4 M	$2,340,000	SWRCB permitting and CEQA required	4,750
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Groundwater levels	Planning phase	2020-2025	N/A	$50,000	Streambed alteration permit	1,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Manaserro Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Planning phase	2023-2025	$500,000	$50,000	CEQA review, possible grading permit, possible water right change petition	8,000
City of Escalon Wastewater Reuse	Recycling/ In-lieu Recharge/ Transfers	SSJ GSA	Groundwater levels	Planning phase	2020-2028	To be determined$18 M	To be determined$40 0,000	CEQA review, RWQCB permits, and road encroachment permits	672
City of Ripon Surface Water Supply	In-lieu Recharge	SSJ GSA	Groundwater levels	Design complete; environmental permitting underway; negotiations for the right to connect are underway.	2028-2030	To be determined	To be determined	NEPA Categorical Exclusion, CEQA Mitigated Negative Declaration, and road encroachment permits	6,000
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	SSJ GSA	Groundwater levels	Conceptual design; environmental review complete; Council approval are pending further design work and rate study	2028-2030	To be determined	To be determined	Road encroachment permits	2,015
Farmington Dam Repurpose Project	Direct Recharge	SEWD	Groundwater levels	Planning/Initial Study	2030-2050	To be determined	To be determined	Permits and approvals form SWRCB, USBR, DFW, RWQCB, CVFPB, and USACE	60,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	Groundwater levels	Project Development	2024-2040	Not determined	Not determined	Not determined	158,000
NSJWCD Winery Recycled Water	Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	Groundwater levels	Conceptual planning and discussion	2025-2027	To be determined	To be determined	WDR permitting through the RWCQB and minor permits for pipeline construction	750
SSJID Storm Water Reuse	Storm Water/ In-lieu Recharge/ Direct Recharge	SSJ GSA	Groundwater levels	Planning phase	2027-2030	To be determined$30 M	To be determined$30, 000	CEQA review and road encroachment permits	1,100
Wallace-Burson Conjunctive Use Program	Conjunctive Use/Direct Recharge	Eastside GSA	Groundwater levels	Conceptual planning and discussion	2030-2040	To be determined	To be determined	Not determined	3,000
Calaveras River Wholesale Water Service Expansion	In-Lieu Recharge	Eastside GSA	Groundwater levels	Conceptual planning	2020-2040	To be determined	To be determined	Not determined	600
Recycled Water to Manteca Golf Course	Recycling	City of Manteca	Groundwater levels	12-in pipeline installed. Waiting for DWR to determine grant recipients	To Be Determined	To be determined	To be determined	Not determined	406
Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	In-Lieu Recharge/Direct Recharge	Eastside GSA	Groundwater levels	Design	2025	To be determined	To be determined	Not determined	2,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Perfecting Mokelumne River Water Right	In-Lieu Recharge	San Joaquin County	Groundwater levels	Planning	2024-2025	$125,000 (spent to date) Total TBD	To be determined	Not determined	158,000
North System Groundwater Recharge Project - Phase 2	Direct Recharge	NSJWCD	Groundwater levels	Design phase with planned construction in 2025-2026	2026-2029	$10 M	$100,000	Not determined	3,000
Stormwater Collection, Treatment, and Infiltration	Direct Recharge/ Stormwater	City of Manteca	Groundwater levels	Planning/Initial Study	To Be Determined	To be determined	To be determined	Not determined	To Be Determined
Off-Stream Regulating Reservoir	Direct Recharge	SEWD	Groundwater levels	Conceptual Phase	2026-2050	To be determined	To be determined	Not determined	To Be Determined
On-Farm Recharge Project	Direct Recharge	SEWD	Groundwater levels	Planning/Initial Study	2024-2030	N/A	$100,000	Not determined	To Be Determined
Bellota Weir Modifications Project	Direct Recharge/ Stormwater	SEWD	Groundwater levels	SRF loan application submitted. $12.3M grant received. Minor construction started	2023-2030	$ 85 M	$1.5M	USACE, FWS,CVFPB,CEQA,NEPA	5,200
Water Supply Enhancement Project - Distribution Pipelines	In-Lieu Recharge/Direct Recharge	SEWD	Groundwater levels	Design	2024-2040	$7M	To be determined	RWQCB,CEQA, USACE,CVFPB, DFW	17,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Water Treatment Plant Aquifer Storage Recovery Well - 7401	Direct Recharge	SEWD	Groundwater levels	Implementation	2024-2026	$1.5 M	To be determined	RWQCB,CEQA, NEPA	2,420
Beckman Well	Direct Recharge	SEWD	Groundwater levels	Refurbish	2024-2028	$200,000	N/A	RWQCB,CEQA	800
West Linden Project	In-Lieu Recharge/Direct Recharge	SEWD	Groundwater levels	Planning/Design	2024-2035	$60M	To be determined	CEQA,RWQCB, road encroachment permits	60,000
Water Supply Enhancement Project - Direct Recharge	Direct Recharge	SEWD	Groundwater levels	Design	2024-2030	To be determined	To be determined	Not determined	To Be Determined
SSJID Water Master Plan - System Improvements	In-Lieu Recharge	SSJ GSA	Groundwater levels	Feasibility study complete	2023-2040	$ 30 – 40 M	To be determined	Not determined	15,000
								Total Category B	*509,985*

[1] Acronyms defined: Stockton East Water District (SEWD), Central San Joaquin Water Conservation District (CSJWCD), North San Joaquin Water Conservation District (NSJWCD), California Department of Fish and Wildlife (DFW), Central Valley Flood Protection Board (CVFPB), Regional Water Quality Control Board (RWQCB), and U.S. Army Corps of Engineers (USACE), State Water Resources Control Board (SWRCB), California Environmental Quality Act (CEQA), U.S. Bureau of Reclamation (USBR), National Pollutant Discharge Elimination System (NPDES), Waste Discharge Requirements (WDR).

ES-11. GSP IMPLEMENTATION

The overdraft condition in the Subbasin requires either projects to offset groundwater pumping and/or increase recharge, or pumping reduction. The exact amount of required offset/recharge will be reevaluated after additional data are collected and analyzed. As previously noted, the overarching philosophy of the ESJ GSP is to implement projects to address the overdraft condition. Should the projects be delayed or not provide the benefits identified, the Subbasin will implement the Demand Management Program, a new management action in this GSP.

Projects will be administered by the GSA project proponents. GSAs may elect to implement projects individually or jointly with one or more GSAs or with the ESJGWA.

Implementing the GSP will require numerous management activities that will be undertaken by the ESJGWA, including the following:

- Monitoring and recording of groundwater levels and groundwater quality data
- Maintaining and updating the Subbasin DMS with newly collected data
- Maintaining and updating the Subbasin Data Management System (DMS) with newly collected data
- Addressing identified data gaps
- Annual monitoring of progress toward sustainability
- Annual reporting of Subbasin conditions to DWR as required by SGMA
- Refining Subbasin model and water budget planning estimates
- Evaluating the GSP once every 5 years and amending the plan if warranted

The ESJGWA Board adopted a preliminary schedule for project implementation. Project implementation is scheduled to begin in 2020, with full implementation by 2040. This approach provides adequate time to put in place methods necessary to refine model estimates and verify project cost effectiveness.

ES-12. FUNDING

Implementation of the GSP requires funding sources. To the degree they become available, outside grants will be sought to assist in reducing cost of implementation to participating agencies, residents, and landowners of the Subbasin. However, there will be a need to collect funds to support implementation.

The areas associated with ESJGWA-wide management and GSP implementation will be borne by the ESJGWA through contributions from the member GSAs, under a cost-sharing arrangement. These costs include:

- ESJGWA administration
- Groundwater level monitoring and reporting
- Groundwater quality monitoring and reporting

- Inelastic land subsidence monitoring and reporting
- Water use estimation
- Data management
- Stakeholder engagement
- Oversight of management actions
- Annual Report preparation and submittal to DWR
- Developing and implementing a funding mechanism
- Grant applications
- GSP evaluation and updates, if warranted (every 5 years)

For budgetary purposes, the estimated initial cost of these activities is on the order of $600,000 to $1 million per year excluding projects and management actions costs and costs associated with the installation of new monitoring wells and grant writing. Additional one-time costs, such as model refinement, are estimated to be on the order of $350,000.

GSAs will individually fund implementation of projects in their respective areas. Options for GSA funding include fees based on groundwater pumping, acreage, or combinations of these, and pursuit of any available grant funds. The GSAs will evaluate options for securing the needed funding on an individual basis.

The estimated initial costs of projects range from on the order of $50,000 to $85 million, depending on the project. Annual project costs range from $3,000 to $9 million per year to provide funds for operations and maintenance.

ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Agency Information, Plan Area, and Communication

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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Tables

Figures

Appendices

Acronyms

AB	Assembly Bill
ACS	American Community Survey
AEM	Airborne Electromagnetic
AF	acre-feet
AF/year	acre-feet per year
AWMPs	Agricultural Water Management Plans
Cal Water	California Water Service Company Stockton District
California State Parks	California Department of Parks and Recreation
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	Consumer Confidence Report
CCWD	Calaveras County Water District
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CDP	census designated place
CDPH	California Department of Public Health
CDPR	California Department of Pesticide Regulation
CDWA	Central Delta Water Agency
C&E Plan	Communication and Engagement Plan
CEDEN	California Environmental Data Exchange Network
CEQA	California Environmental Quality Act
CGPS	continuous global positioning system
CNRA	California Natural Resources Agency
CSJWCD	Central San Joaquin Water Conservation District
CVRWQCB	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
DACs	Disadvantaged Communities
DDW	Division of Drinking Water
DER	Department of Environmental Resources
DPR	Department of Pesticide Regulations
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utility District
Eastside GSA	Eastside San Joaquin GSA
EO	Executive Order
ESJGWA	Eastern San Joaquin Groundwater Authority
ESJGWA Board	Eastern San Joaquin Groundwater Authority Board of Directors
ESJWRM	Eastern San Joaquin Water Resources Model
EWMPs	efficient water management practices
GAMA	Groundwater Ambient Monitoring and Assessment
GBA	Groundwater Basin Authority
GDE	groundwater dependent ecosystem
GICIMA	Groundwater Information Center Interactive Mapping Application
GMP	Groundwater Management Plan
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
ICU Program	Integrated Conjunctive Use Program
ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
IRWMP	Integrated Regional Water Management Plan
JPL	Jet Propulsion Laboratory

JPA	Joint Powers Agreement
LCSD	Lockeford Community Services District
LCWD	Linden County Water District
LLNL	Lawrence Livermore National Laboratory
MAC	Mokelumne-Amador-Calaveras
MHI	median household income
MOA	memorandum of agreement
MokeWISE	Mokelumne Watershed Interregional Sustainability Evaluation
MUD	Municipal Utilities Department
NASA	National Aeronautics and Space Administration
NDWA	North Delta Water Agency
NOI	Notice of Intent
NSJWCD	North San Joaquin Water Conservation District
NWIS	National Water Information System
OID	Oakdale Irrigation District
OSWCR	Online System for Well Completion Reports
PG&E	Pacific Gas and Electric Company
PMC	Project Management Committee
PS	persistent scatter
RCD	Resource Conservation District
RD	Reclamation District
SAW	Stakeholder Advisory Workgroup
SB	Senate Bill
SCWSP	South County Water Supply Program
SDACs	Severely Disadvantaged Communities
SDWA	South Delta Water Agency
SEWD	Stockton East Water District
SGMA	Sustainable Groundwater Management Act
SJCFCWCD	San Joaquin County Flood Control and Water Conservation District
SJC POC	San Joaquin Valley Point of Contacts
SNMP	Salt and Nutrient Management Plan
SRA	State Recreation Area
SSJID	South San Joaquin Irrigation District
SVRA	State Vehicular Recreation Area
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
UNAVCO	University NAVSTAR Consortium
UNGL	University of Nevada Geodetic Laboratory
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFWS	United States Fish & Wildlife Service
USGS	United States Geological Survey
UWMPs	Urban Water Management Plans
Water Code	California Water Code
WDL	Water Data Library
WDR	Waste Discharge Requirement
WID	Woodbridge Irrigation District
Workgroup	Groundwater Sustainability Workgroup

1. AGENCY INFORMATION, PLAN AREA, AND COMMUNICATION

1.1 INTRODUCTION AND AGENCY INFORMATION

1.1.1 Purpose of the Groundwater Sustainability Plan

The purpose of this Groundwater Sustainability Plan (GSP) is to meet the regulatory requirements set forth in the three-bill legislative package consisting of Assembly Bill (AB) 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA). SGMA defines sustainable groundwater management as "management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results", which are defined by SGMA as any of the following effects caused by groundwater conditions occurring throughout the basin (CA DWR, 2018):

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon
- Significant and unreasonable reduction of groundwater storage
- Significant and unreasonable seawater intrusion
- Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies
- Significant and unreasonable land subsidence that substantially interferes with surface land uses
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water

The Eastern San Joaquin Groundwater Subbasin (Eastern San Joaquin Subbasin or Subbasin) was identified by the Department of Water Resources (DWR) as critically overdrafted. The Eastern San Joaquin Groundwater Sustainability Plan (Eastern San Joaquin GSP, GSP, or the Plan) was originally developed to meet SGMA regulatory requirements by the January 31, 2020 deadline for critically-overdrafted basins while reflecting local needs and preserving local control over water resources. The 2020 GSP was subsequently revised in 2022 to address comments from DWR in their determination letter dated January 28, 2022. This 2024 GSP Amendment addresses comments in DWR's July 6, 2023 determination letter approving the 2022 Revised GSP, and continues to provide a path to achieve and document sustainable groundwater management within 20 years following initial Plan adoption, promoting the long-term sustainability of locally-managed groundwater resources now and into the future.

While the Eastern San Joaquin GSP offers a new and significant approach to groundwater resource protection, it was developed within an existing framework of comprehensive planning efforts. Throughout the Eastern San Joaquin Region, several separate yet related planning efforts have occurred previously or are concurrently proceeding. The following figure (Figure 1-1) shows flagship reports from these efforts, which include integrated regional water management, urban water management, agricultural water management, watershed management, habitat conservation, and general planning. The Eastern San Joaquin GSP fits in with these prior planning efforts, building on existing local management and basin characterization. A description of prior planning efforts can be found in Section 1.2.2.7 of this document.

Figure 1-1: Interconnected Planning and Modeling Efforts for Water Resource Protection

1.1.2 Sustainability Goal

A sustainability goal is the culmination of conditions resulting in a sustainable condition (absence of undesirable results) within 20 years of the GSP's initial adoption in 2020. The sustainability goal reflects this requirement and succinctly states the GSP's objectives and desired conditions of the Subbasin.

The sustainability goal description for the Eastern San Joaquin Subbasin is *to maintain an economically-viable groundwater resource for the beneficial use of the people of the Eastern San Joaquin Subbasin by operating the Subbasin within its sustainable yield or by modification of existing management to address future conditions. This goal will be achieved through the implementation of a mix of supply and demand type projects consistent with the GSP implementation plan* (see Chapter 6: Projects and Management Actions).

Additional discussion of the sustainability goal can be found in Chapter 3: Sustainable Management Criteria.

1.1.3 Contact Information

The San Joaquin County Department of Public Works Director has been designated as Plan Manager and record keeper. As Plan Manager, the Public Works Director is tasked with submitting a single, jointly-composed GSP to DWR on behalf of the entire Subbasin. Contact information for the submitting agency and Plan Manager is provided in Figure 1-2.

Figure 1-2: Plan Manager and Agency Contact Information

Agency Contact

Eastern San Joaquin Groundwater Authority
1810 E. Hazelton Avenue,
P.O. Box 1810
Stockton, CA 95201

info@esjgroundwater.org
www.esjgroundwater.org

Plan Administrator

Fritz Buchman, C.E., T.E., CFM
Director
San Joaquin County Department of Public Works
1810 E. Hazelton Ave.,
Stockton, CA 95205
(209) 468-3101

fbuchman@sjgov.org

1.1.4 Agency Information

The Eastern San Joaquin GSP was developed jointly by the members of the Eastern San Joaquin Groundwater Authority (ESJGWA), which is a joint powers authority formed by the 16 groundwater sustainability agencies (GSAs) within the Eastern San Joaquin Subbasin. The ESJGWA includes the Central Delta Water Agency (CDWA), Central San Joaquin Water Conservation District (CSJWCD), City of Lodi, City of Manteca, City of Stockton, Eastside San Joaquin GSA (Eastside GSA) (composed of Calaveras County Water District [CCWD], Calaveras County, Stanislaus County, and Rock Creek Water District), Linden County Water District (LCWD), Lockeford Community Services District (LCSD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), San Joaquin County No. 1, San Joaquin County No. 2, South Delta Water Agency (SDWA), South San Joaquin GSA (composed of South San Joaquin Irrigation District [SSJID] including Woodward Reservoir, City of Ripon, and City of Escalon), Stockton East Water District (SEWD), and Woodbridge Irrigation District (WID). Collectively, these 16 GSAs will be referred to as “GSAs.” Figure 1-3 below indicates the jurisdictional boundaries of the individual GSAs.

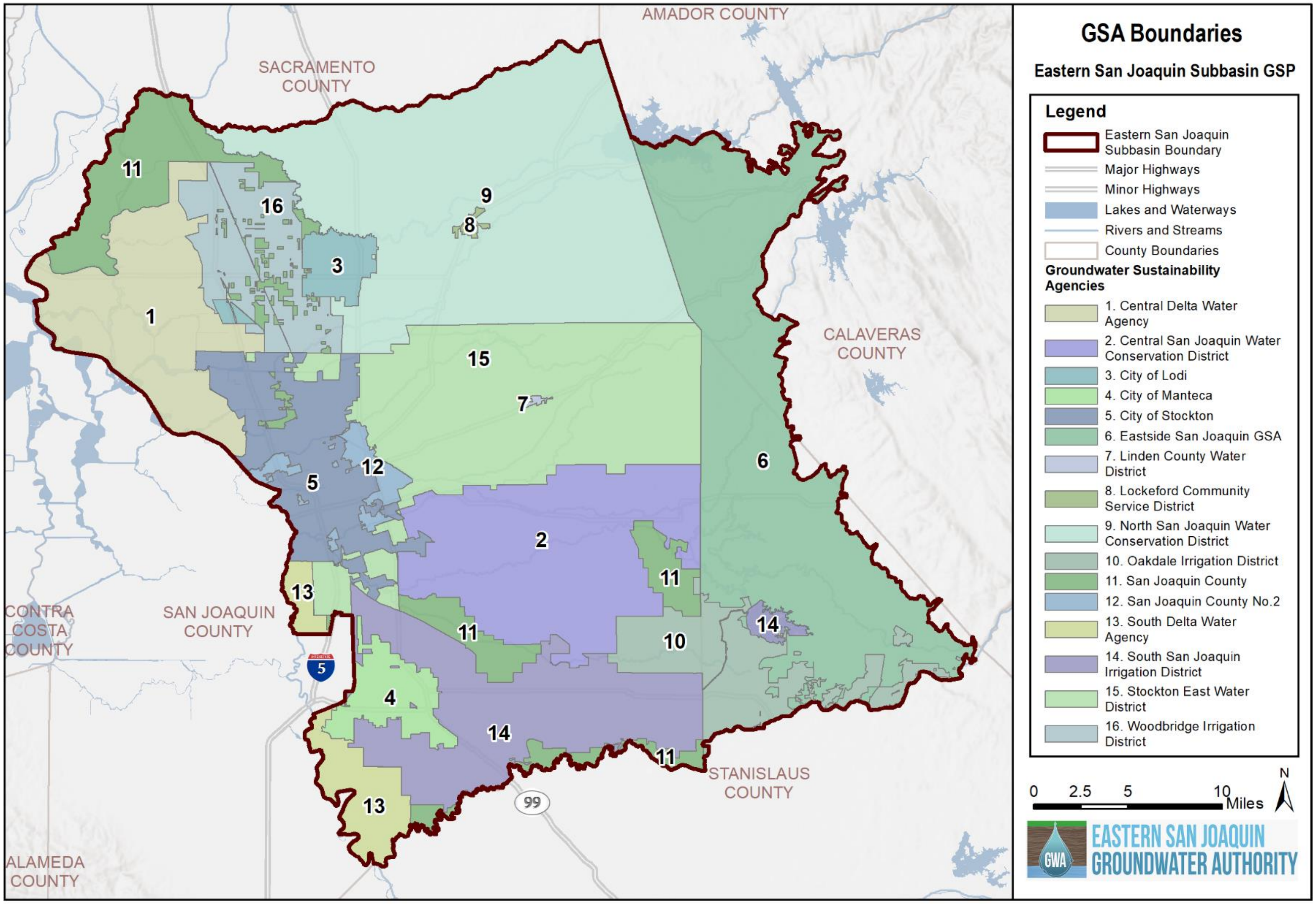
The GSAs represent a diverse range of water management organizations. The agencies include water agencies, irrigation districts, water conservation districts, and local governments at the city and county level. The GSAs work through the ESJGWA to coordinate implementation of the GSP by each GSA to cover the entire geographic extent encompassed by the boundaries of the Eastern San Joaquin Subbasin.

California Water Service Company Stockton District (Cal Water) formed a partnership with San Joaquin County to participate in the process as part of the San Joaquin County No. 2 GSA, since its status as an investor-owned utility prohibited it from forming its own GSA under SGMA regulations until later amendments under SB 13 (Pavley). As a major purveyor of water in the Stockton region, Cal Water’s participation is considered essential to the development and implementation of a comprehensive plan for sustainable groundwater management in the Subbasin.

The portion of the City of Lathrop located east of the San Joaquin River was initially involved in the Eastern San Joaquin Subbasin 2020 GSP development process as a 17th GSA (City of Lathrop GSA) and was part of the ESJGWA. The City of Lathrop GSA voluntarily withdrew its status from the ESJGWA in March 2019 following DWR’s approval of their request for a basin boundary modification between the Eastern San Joaquin Subbasin and the neighboring Tracy Subbasin, which moved the City of Lathrop entirely within the Tracy Subbasin.

WID voluntarily withdrew its status as a GSA and its membership in the ESJGWA in December 2018; WID reinstated its status as a GSA and its membership in the ESJGWA in October 2019.

Figure 1-3: Eastern San Joaquin Groundwater Sustainability Agencies



1.1.4.1 Eastern San Joaquin Groundwater Authority Joint Powers Agreement

The Joint Powers Agreement (JPA) provides the basis for forming the ESJGWA. The ESJGWA submitted an Initial Notification to jointly develop a GSP for the Eastern San Joaquin Subbasin on February 8, 2017. The agreement and bylaws are provided in Appendix 1-A.

The purpose of the ESJGWA is to act as the coordinating agency and cooperatively carry out the purposes of SGMA in the Eastern San Joaquin Subbasin. The ESJGWA is a public entity separate from the member organizations and holds the authority to coordinate and exercise the common powers of its members within the geographical area of the Eastern San Joaquin Subbasin consistent with the terms and conditions of the JPA.

Since its formation, the ESJGWA has employed a consensus-based approach in its goal to provide a dynamic, cost-effective, and collegial organization to achieve initial and ongoing SGMA compliance within the Subbasin. Collaboration among the ESJGWA member agencies has strengthened the potential for broad public support for groundwater management activities as well as the ability to leverage local, state, and federal funds (Eastern San Joaquin GWA, 2017b).

1.1.4.2 Organization and Management Structure of the GSAs

The governing body of the ESJGWA, the ESJGWA Board of Directors (ESJGWA Board), convenes every second Wednesday of the month at 10:30 a.m. to coordinate efforts to implement the GSP by debating and finalizing key discussion points and decisions incorporated into the Plan. Each of the 16 GSAs has a voice on the ESJGWA Board and has appointed two representatives to serve: one Board member and one Alternate member to attend in the Board member's absence.

The ESJGWA Board is tasked with developing actions including, but not limited to, the following:

- Approving budget(s) and appropriate cost sharing for any project or program that requires funding from the ESJGWA
- Proposing guidance and options for obtaining grant funding
- Adopting rules, regulations, policies, and procedures related to the JPA
- Approving any contracts with consultants or subcontractors that would undertake work on behalf of the GSAs and/or relate to Basin-wide issues and, if applicable, recommend the funding that each GSA should contribute towards the costs of such contracts
- Reporting to the GSA's respective governing boards
- Approving and implementing a GSP

The ESJGWA Board is guided by a Steering Committee that is made up of one representative from each GSA and convenes every second Wednesday of the month at 8:30 a.m. The Steering Committee is responsible for developing recommendations on technical and substantive Subbasin-wide matters. The Steering Committee is tasked with developing actions including, but not limited to, the following:

- Recommending the action and/or approval of technical or policy elements for the implementation of the GSP, including groundwater conditions, thresholds, and projects and management actions
- Recommending the action and/or approval of a GSP

To support the 5-year Periodic Evaluation of the GSP and development the 2024 GSP Amendment, the Steering Committee recommended that the chair of the ESJGWA form an Ad Hoc Project Management Committee (PMC).

Approved by the Steering Committee in December 2023, the PMC was comprised of six GSA volunteers representing the varied interests in the Subbasin and covering both urban and agricultural areas. At the time of the development of the 2024 GSP Amendment, the six members of the PMC represented the following GSAs: City of Stockton, North San Joaquin Water Conservation District, Oakdale Irrigation District, San Joaquin County, South San Joaquin Irrigation District, and Stockton East Water District. The PMC met bi-monthly during the GSP Periodic Evaluation and GSP amendment process, and was tasked with driving the review and update process and coordinating other SGMA implementation efforts, including development of a Well Mitigation Program, coordination of stakeholder outreach and engagement, and annual and long-term budgeting. PMC members reviewed draft work products and other meeting materials to provide input and direction as needed at the bi-monthly meetings. The PMC was also responsible for recognizing and flagging items requiring discussion and direction from stakeholders, the Steering Committee, and the ESJGWA. While the PMC informed administrative concepts and reviewed draft work products at the staff level, they did not have decision-making authority.

Decisions of the ESJGWA Board are made by an affirmative majority of Board members, except in the following cases which require a two-thirds supermajority vote: approval or modification or amendment of the ESJGWA annual budget; decisions related to the levying of taxes, assessments, or property-related fees and charges; decisions related to the expenditure of funds by the ESJGWA beyond expenditures approved in the annual budget; adoption of rules, regulations, policies, bylaws, and procedures related to the function of the ESJGWA; decisions related to the establishment of the members' percentage obligations for payment of the ESJGWA's operating and administrative costs; approval of any contract over $250,000 or contracts for terms that exceed two years; decisions regarding the acquisition and the holding, use, sale, letting, and disposal of real and personal property including water rights, and the construction, maintenance, alteration, and operation of works or improvements; decisions related to the limitation or curtailment of groundwater pumping; and approval of a GSP. Each member of the ESJGWA Board has one vote. A process for dispute resolution and noncompliance, including internal resolution and mediation prior to judicial or administrative remedies, is set forth in the ESJGWA Bylaws in Appendix 1-A.

GSAs share in the general operating and administrative costs of the ESJGWA in accordance with percentages determined by the ESJGWA Board.

1.1.4.3 Description of Participating Agencies

A brief description of each of the GSAs that make up the ESJGWA is provided in the sections below.

Central Delta Water Agency – The Central Delta Water Agency (CDWA) service area encompasses a total of 52,000 acres in the northwestern portion of the Eastern San Joaquin Subbasin. The primary land use in this area is agriculture with crops such as vineyards, fruit and nut trees, row crops, and field crops. CDWA protects water supply within its service area (which extends outside of the Subbasin), assists landowners and reclamation districts with water issues, and represents landowners in flood control matters. CDWA does not own any facilities, and surface water from the Delta is the area's only utilized source of water, along with limited private groundwater pumping. Approximately 5,000 acres of the GSA overlap with the sphere of influence of the City of Stockton (Eastern San Joaquin County GBA, 2014).

Central San Joaquin Water Conservation District – The Central San Joaquin Water Conservation District (CSJWCD) was formed in 1959 under provisions of the California Water Conservation Act of 1931. The CSJWCD includes approximately 73,000 largely agricultural acres, of which 6,300 acres are within the sphere of influence of the City of Stockton. To mitigate declining groundwater levels, the CSJWCD contracted with the United States Bureau of Reclamation (USBR) for 80,000 acre-feet per year (AF/year) from New Melones Reservoir on the Stanislaus River. Irrigation facilities have been installed and operated by individual landowners through a surface water incentive program sponsored by the CSJWCD. At the regional level, CSJWCD has participated as a member agency of the Eastern Water Alliance and the Groundwater Basin Authority (GBA), two preceding efforts to the ESJGWA that focused on groundwater management (Eastern San Joaquin County GBA, 2014).

City of Lodi – The City of Lodi is located northeast of the City of Stockton along Highway 99. The City of Lodi relies on both groundwater and surface water to satisfy customer needs. In 2003, Lodi entered into a 40-year agreement with WID for up to 6,000 AF/year of Mokelumne River water. The City of Lodi built the Lodi Surface Water Treatment Plant and associated conveyance facilities necessary to deliver this supply, which were completed and operational at the end of 2012. The City of Lodi currently provides up to 3,000 AF/year of treated wastewater to agricultural land in the vicinity of the wastewater treatment plant, White Slough Water Pollution Control Facility. The GSA for the City of Lodi covers 9,000 acres and includes the White Slough Water Pollution Control Facility area (City of Lodi, 2015).

City of Manteca – The City of Manteca's approximately 13,000 acres straddles Highway 99 south of the City of Stockton. Potable water supplies consist of a combination of groundwater and treated surface water from the South County Water Supply Program (SCWSP). Manteca currently receives up to 11,500 AF/year of treated surface water and ultimately can receive up to 18,500 AF/year in Phase II of the SCWSP. Up to 700 AF/year of reclaimed wastewater is applied to fodder crops on City-owned and leased lands (City of Manteca, 2020).

City of Stockton – The City of Stockton Municipal Utilities Department (MUD) service area generally encompasses portions of the City of Stockton north of the Calaveras River and south of the Cal Water service area. Water use measured in 2015 shows approximately 27 percent of the Stockton MUD's water deliveries come from groundwater, with 73 percent from treated surface water from SEWD and the Delta Water Supply Project. The Delta Water Supply Project came online in 2012 and utilizes surface water both from the San Joaquin River (City of Stockton water right) and Mokelumne River through a 40-year agreement with WID initiated in 2008 for up to 6,500 AF/year with more water as the City of Stockton grows. The City of Stockton GSA (approximately 39,000 acres) overlaps with the extent of the Cal Water service area (City of Stockton, 2015).

Eastside San Joaquin GSA – Eastside San Joaquin GSA (Eastside GSA) is a partnership between Calaveras County Water District, Calaveras County, Stanislaus County, and Rock Creek Water District. The area covers over 126,000 acres, stretching into the western portion of Calaveras County and northern portion of Stanislaus County.

- <u>Calaveras County Water District</u> – The Calaveras County Water District (CCWD) provides water service to approximately 13,360 municipal and residential customers in six service areas and shares the same boundaries as Calaveras County. Supply for CCWD comes from reservoir releases on the Calaveras, Stanislaus, and Mokelumne Rivers for a total of approximately 6,000 AF/year for primarily agricultural and residential use. CCWD has several customers with riparian rights along the Calaveras River, has one service area that relies solely on groundwater, and has several areas that utilize recycled water.

- <u>Calaveras County</u> – Calaveras County has a total area of 1,037 square miles and extends beyond the boundaries of the Eastern San Joaquin Subbasin. Calaveras County Water District is the only public water supplier to residents located in the portion of the County overlying the Subbasin. The only incorporated city, Angels Camp, is located outside of the Subbasin. Calaveras County had one of the fastest growing annual percent increases in population in California between 2000 and 2010 (CCWD, 2020). For the portion of Calaveras County that falls within the Eastern San Joaquin Subbasin, there are numerous domestic, municipal, and monitoring wells.

- <u>Stanislaus County</u> – Stanislaus County has a total area of 973,000 acres and nine incorporated cities and extends beyond Eastern San Joaquin Subbasin. There are approximately 30 water suppliers that serve water to Stanislaus County for domestic, commercial, and agricultural uses. The majority of the county's population resides in incorporated cities due to urban development and steady population growth within city boundaries. These incorporated cities are outside of the Subbasin. The portions of Stanislaus County that fall within the Eastern San Joaquin Subbasin not already included in a GSA have partnered with CCWD, Calaveras County, and Rock Creek Water District as the Eastside GSA. The land is mostly unirrigated, and water needs are met by private pumping.

- Rock Creek Water District – Rock Creek Water District was formed in 1941 and covers approximately 1,800 acres in northeastern Stanislaus County. Through the Salt Spring Valley Reservoir in Calaveras County, Rock Creek Water District delivers agricultural water for irrigation (Stanislaus LAFCO, 2018).

Linden County Water District – Linden County Water District (LCWD) provides water and wastewater services to the 300 acres of the unincorporated community of Linden. LCWD is located approximately 12 miles northeast of the City of Stockton along State Route 26. LCWD lies entirely within the boundaries of the SEWD. Between 2000 and 2010, the population in Linden increased by 61 percent from approximately 1,100 to 1,800 residents. LCWD relies on groundwater to meet residential demands in Linden (SJC, 1992).

Lockeford Community Services District – Lockeford Community Services District (LCSD) was established in 1976 and superseded the San Joaquin County Water Works District No. 1 and Lockeford Sanitary District. LCSD provides water and wastewater services to approximately 3,200 residents (as of 2010) in the unincorporated urban community of Lockeford located 17 miles northeast of the City of Stockton on State Routes 12 and 88. LCSD lies within the boundaries of the NSJWCD; however, LCSD's jurisdiction area is its own GSA and is not part of the NSJWCD GSA. LCSD's GSA area is approximately 800 acres and encompasses primarily residential and commercial uses. LCSD anticipates that, as community build-out occurs, it may serve over 5,000 residents. Groundwater from the Eastern San Joaquin Subbasin is LCSD's only source of potable water (SJC, 2016a).

North San Joaquin Water Conservation District GSA – North San Joaquin Water Conservation District (NSJWCD), organized in 1948 under provisions of the Water Conservation District Act of 1931, includes approximately 149,000 acres east of the City of Lodi, including about 70,000 acres of irrigated agriculture. NSJWCD also includes approximately 4,740 acres within the Lodi city limits and the community of Lockeford. Pursuant to agreements between NSJWCD, Lockeford, and Lodi, the Lodi and Lockeford acreage is excluded from the NSJWCD GSA. NSJWCD straddles the Mokelumne River and has Dry Creek as its northern boundary. Prior to a basin boundary modification approved in 2016, NSJWCD was located in both the Cosumnes and the Eastern San Joaquin Subbasins. NSJWCD has a 20,000 AF Mokelumne River surface water right which is generally available in normal to wet years. NSJWCD provides surface water deliveries to irrigated acreage and conducts groundwater recharge, but much of the NSJWCD area relies on private groundwater pumping. At the regional level, NSJWCD has participated as a member agency of the Eastern Water Alliance and the GBA, two preceding efforts to the ESJGWA that focused on groundwater management (Eastern San Joaquin County GBA, 2014).

Oakdale Irrigation District – Oakdale Irrigation District (OID) comprises about 81,000 acres, primarily located in the northern portion of Stanislaus County, but with a small portion located within San Joaquin County. A little less than 40 percent of the District's area overlies the Eastern San Joaquin Subbasin (over 31,000 acres), and the remaining portion overlies the Modesto Subbasin. SSJID and OID jointly own facilities to provide water from the Stanislaus River for agricultural use (Eastern San Joaquin County GBA, 2014).

San Joaquin County – The San Joaquin County GSA consists of 51,000 acres of areas within the Eastern San Joaquin Subbasin not covered by the other GSAs. Overlapping agencies include North Delta Water Agency (NDWA), unincorporated county, riparian land along Stanislaus River, and areas in the City of Stockton served by the City of Stockton MUD. In collaboration with the Northeast San Joaquin County Groundwater Banking Authority, San Joaquin County led the development of the Eastern San Joaquin Groundwater Basin Groundwater Management Plan in 2004 to review, enhance, and coordinate existing groundwater management policies and programs in the region and to develop new policies and programs for the long-term sustainability of groundwater resources. San Joaquin County has also supported the development of studies and plans in the region, such as the Groundwater Basin Authority System Plan and San Joaquin County Water Management Plan.

- North Delta Water Agency – The NDWA was formed by a special act of the Legislature in 1973 to protect the water supply against seawater intrusion and to ensure a reliable water supply to meet current and future water needs. The NDWA service area now includes approximately 277,000 acres within the counties of Sacramento, San Joaquin, Solano, and Yolo. Most of the land is devoted to agriculture use and supplied with surface water from the Delta (NDWA, 2015). The reclamations districts within the NDWA and the Eastern San Joaquin Subbasin include Reclamation District (RD) 38 – Staten Island, RD 2086 – Canal Ranch, and RD 348 – New Hope Tract.

San Joaquin County No. 2 (Cal Water) – San Joaquin County No. 2 GSA includes approximately 7,000 acres of the unincorporated San Joaquin County portion of the Cal Water Service Area. Cal Water is an investor-owned public utility regulated by the California Public Utilities Commission; it is a signatory to the California Urban Water Conservation Council. Cal Water has approximately 42,000 connections in the greater Stockton area, primarily south of the Calaveras River. Cal Water utilizes surface water delivered from SEWD and groundwater pumped by Cal Water wells to meet customer demands. Cal Water's Stockton District was formed in 1927 with the purchase of the water system from Pacific Gas and Electric Company (PG&E).

South Delta Water Agency – The South Delta Water Agency (SDWA) was originally formed to address local water supply and water quality concerns in the south Delta area. The SDWA encompasses a total of approximately 150,000 acres within its boundaries, and almost 18,000 acres overlap with the southwestern portion of the Eastern San Joaquin Subbasin. The SDWA does not own any facilities or water rights. Instead, the SDWA protects property owners who have individual water rights. Surface water is the primary source of water used within the agency boundaries given that most of the groundwater is highly saline (Eastern San Joaquin County GBA, 2014).

South San Joaquin GSA – South San Joaquin GSA's 64,000 acres encompass most of the South San Joaquin Irrigation District (SSJID), including Woodward Reservoir and canals leading to SSJID; the City of Ripon; and the City of Escalon. The portion of SSJID within the incorporated City of Manteca is included in the City of Manteca GSA.

- South San Joaquin Irrigation District – SSJID was formed in 1909 under the Irrigation District Act and covers approximately 72,000 acres in the southeastern portion of San Joaquin County located within the Eastern San Joaquin Subbasin boundaries. The cities of Manteca, Ripon, and Escalon account for approximately 20,000 acres of the SSJID area. SSJID in 2005 began the delivery of up to 32,000 AF/year currently (and up to 43,000 AF/year in Phase II) of treated surface water from Woodward Reservoir to the cities of Manteca, Lathrop, and Tracy for the SCWSP, with Escalon to receive water in the future (Eastern San Joaquin County GBA, 2014).

- City of Ripon – The City of Ripon is located at the southern edge of San Joaquin County along Highway 99. The population in 2015 was approximately 16,000 people and is expected to grow to about 30,800 people by 2040 (U.S. Census Bureau, 2020). The city's potable water is provided by city groundwater wells and supplied over 4,000 acre-feet (AF) in 2015. Non-potable groundwater and surface water from SSJID are used for irrigation purposes and recharge (City of Ripon, 2015).

- City of Escalon – The City of Escalon is located within the San Joaquin County boundaries along State Route 120. Incorporated in 1957, the City of Escalon was home to approximately 7,400 residents in 2020 (U.S. Census Bureau, 2020). The City of Escalon has an allotment of 2,015 AF of treated water from the SSJID and the SCWSP; however, the city is not utilizing its allotment and currently relies solely on groundwater wells to serve the city's population as well as commercial customers. The City of Escalon is selling its allotment of treated water to the City of Tracy but intends to construct a pipeline to convey SSJID water to meet domestic and industrial needs in the City of Escalon (SSJID, 2015b).

Stockton East Water District – Stockton East Water District (SEWD) was formed in 1948, includes a total of 143,300 acres, overlaps with portions of WID, and includes the entire City of Stockton and the entire Cal Water service area. The SEWD GSA covers 101,000 acres of the district, with the remaining SEWD areas covered by the City of Stockton, San Joaquin County, and San Joaquin County No. 2 GSAs. SEWD is guaranteed 56.5 percent of New Hogan Reservoir's yield and is provided a total amount of 75,000 AF/year from New Melones Reservoir through agreements with USBR. SEWD delivers wholesale drinking water to the City of Stockton, Cal Water, San Joaquin County, and Woodbridge Irrigation District (WID) areas in the Stockton MUD (Eastern San Joaquin County GBA, 2014). At the regional level, SEWD has participated as a member agency of the Eastern Water Alliance and the GBA, two efforts preceding the current ESJGWA that focused on groundwater management (Eastern San Joaquin County GBA, 2014).

Woodbridge Irrigation District – WID, organized in 1924 under the California Irrigation District Act, encompasses a gross area of approximately 42,900 acres with over 29,000 acres covered by the WID GSA. WID is discontiguous, resulting in patches of non-district lands within its boundary, and overlaps with portions of NSJWCD, SEWD, and the City of Lodi. WID owns and operates the Woodbridge Diversion Dam, located on the Lower Mokelumne River northeast of the City of Lodi, as well as an extensive canal system serving approximately 13,000 acres west of Lodi and north of Stockton. Recent improvements made to the new Woodbridge Diversion Dam include state-of-the-art fish and diversion works which enable WID to keep Lodi Lake full year-round. At the regional level, WID has participated as a member agency in regional groundwater management efforts, including the GBA.

1.1.4.4 Legal Authority

Any local public agency that has water supply, water management, or land use responsibilities in a basin can decide to become a GSA under SGMA. A single local agency can become a GSA, or a combination of local agencies can decide to form a GSA by using either a JPA, a memorandum of agreement (MOA), or other legal agreement (CA DWR, 2016a).

In the Eastern San Joaquin Subbasin, the ESJGWA has legal authority to jointly prepare, adopt, and implement a GSP consistent with the terms of the JPA Agreement and the ESJGWA Bylaws (Eastern San Joaquin GWA, 2017a). The ESJGWA's JPA calls out the following powers granted to GSAs by SGMA:

- Become a GSA individually or collectively;
- Approve any portion, section, or chapter of the GSP adopted by the ESJGWA;
- Act through GSAs to implement SGMA and the GSP; and
- Exercise the powers conferred to GSAs by SGMA.

Each GSA that is a member of the ESJGWA has its own legal authorities. For example, NSJWCD has the legal authorities granted to a GSA under the California Water Code (Water Code) as well as the legal authorities granted to a Water Conservation District pursuant to Water Code § 74000 et seq. The legal authorities of each GSA are listed in Appendix 1-B. Agency resolutions to become GSAs are provided in Appendix 1-C.

1.1.4.5 Estimated Costs and Approach to Meeting Costs

Implementation of the GSP requires funding sources. To the degree they become available, outside grants will be sought to assist in reducing the cost of implementation to participating agencies, residents, and landowners of the Subbasin. However, there will be a need to collect funds to support implementation.

For budgetary purposes, the estimated initial cost of these activities is on the order of $600,000 to $1 million per year excluding projects and management actions costs and costs associated with the installation of new monitoring wells and grant writing. Additional one-time costs, such as model refinement, are estimated to be on the order of $315,000. The ESJGWA Board will evaluate options for securing the needed funding. Additional detail on GSP implementation costs and funding sources are detailed in Chapter 7: Plan Implementation.

1.1.5 GSP Organization

This GSP is organized according to DWR's "GSP Annotated Outline" for standardized reporting (CA DWR, 2016b). The Preparation Checklist for GSP Submittal in DWR formatting can be found in Appendix 1-D (CA DWR, 2016d).

1.2 PLAN AREA

1.2.1 Description of Plan Area

This section provides a detailed description of the Eastern San Joaquin Subbasin, including major streams and creeks, institutional entities, agricultural and urban land uses, locations of groundwater wells, and locations of state lands. The Plan Area document also describes existing surface water and groundwater monitoring programs, existing water management programs, and general plans in the Plan Area.

1.2.1.1 Summary of Jurisdictional Areas and Other Features

The Eastern San Joaquin Subbasin falls within the larger San Joaquin Valley Groundwater Basin (see Figure 1-4). Basin designations by DWR were first published in 1952 in Water Quality Investigations Report No. 3, *Ground Water Basins in California*, and subsequently updated in Bulletin 118 in 1975, 1980, 2003, and 2020. The San Joaquin River Hydrologic Region contains 11 distinct subbasins, where the Eastern San Joaquin Subbasin (Bulletin 118 Basin Number 5-022.01) is bordered to the north by the Cosumnes Subbasin (Bulletin 118 Basin Number 5-022.16), the South American Subbasin (Bulletin 118 Basin Number 5-021.65), and the Solano Subbasin (Bulletin 118 Basin Number 5-021.66); to the south by the Modesto Subbasin (Bulletin 118 Basin Number 5-022.02); and to the west by the Tracy Subbasin (Bulletin 118 Basin Number 5-022.15) and East Contra Costa Subbasin (Bulletin 118 Basin Number 5-022.19) (see Figure 1-5).

The Eastern San Joaquin Subbasin includes lands south of Dry Creek between the San Joaquin River on the west and the crystalline basement rock of the Sierra Nevada foothills on the east. The Eastern San Joaquin Subbasin boundary to the south stretches along the San Joaquin County line and continues along the Stanislaus River into Calaveras County to the east. Geologic units in the Eastern San Joaquin Subbasin consist of consolidated rocks and unconsolidated deposits (CA DWR, 2006).

No adjudicated areas or areas covered by an alternative to a GSP exist within the Eastern San Joaquin Subbasin.

Figure 1-4: Placement within the San Joaquin Valley Groundwater Basin

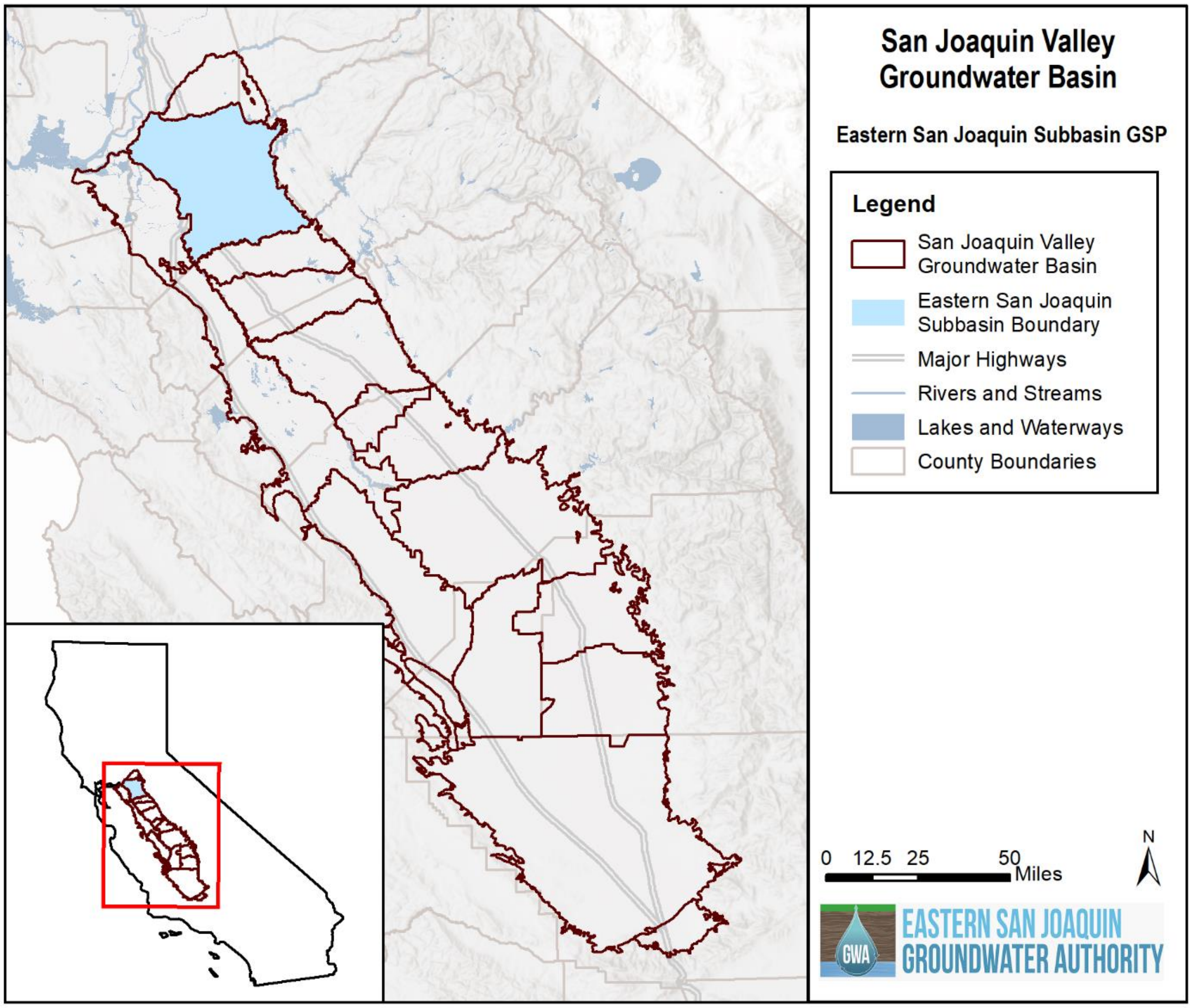
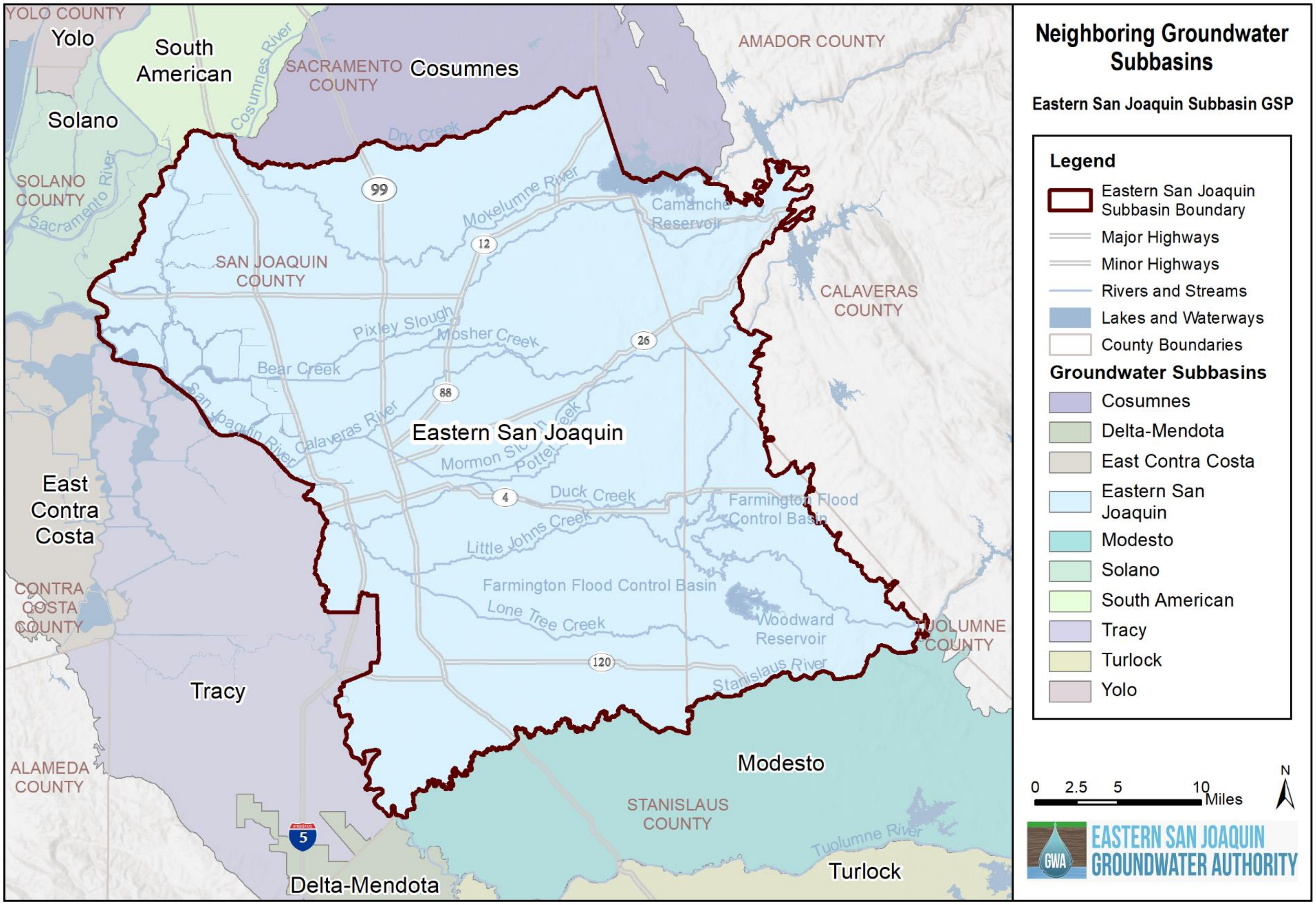


Figure 1-5: Neighboring Groundwater Subbasins



The Eastern San Joaquin Subbasin underlies areas of San Joaquin, Stanislaus, and Calaveras Counties. Figure 1-6 shows the location of these three counties within the State of California as well as the three other counties bordering the Eastern San Joaquin Subbasin: Sacramento, Amador, and Contra Costa.

Figure 1-6: Underlying and Surrounding Counties

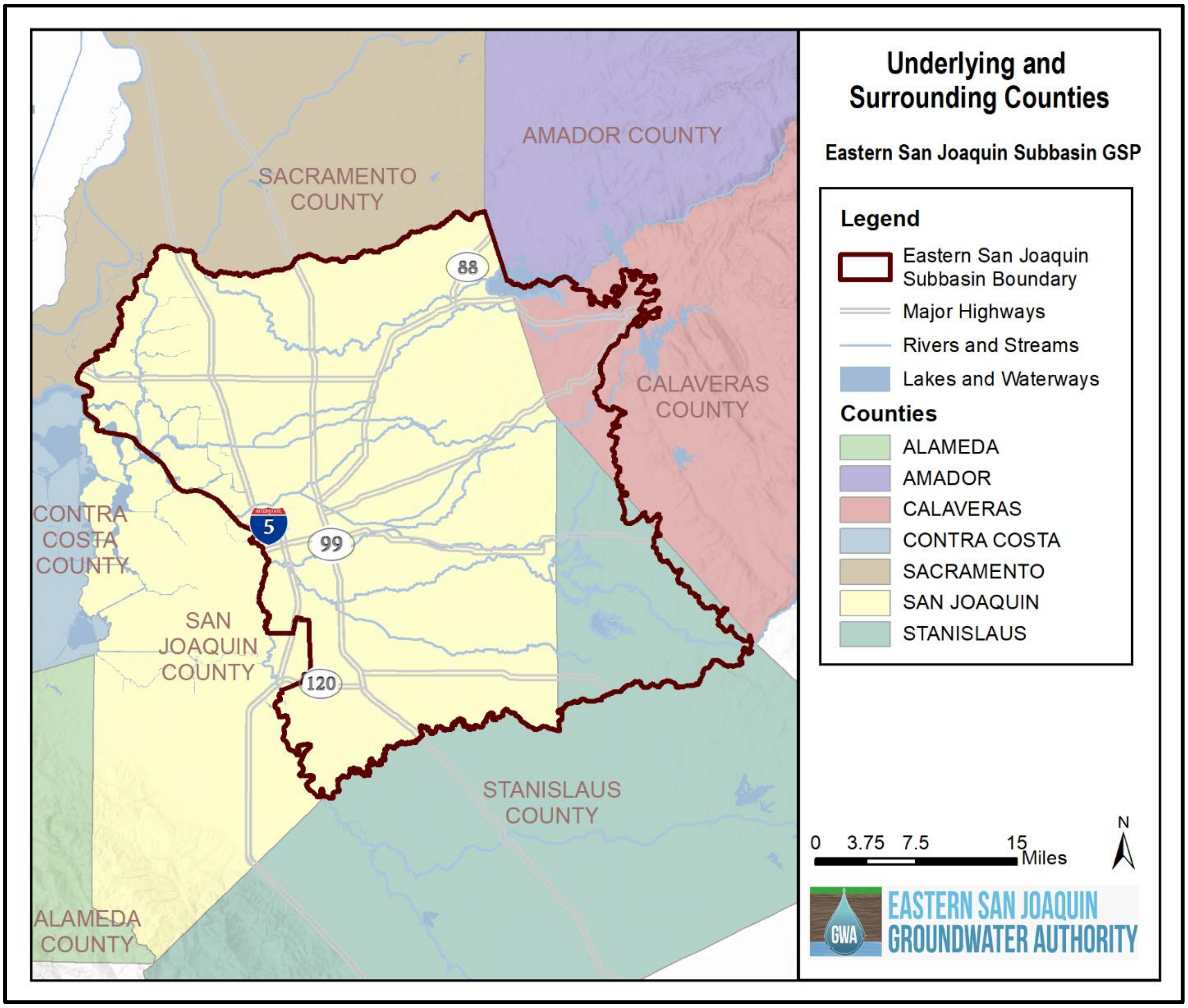


Figure 1-7 shows the Eastern San Joaquin Subbasin and the Subbasin's key geographic features. The Subbasin encompasses an area of about 1,195 square miles. There are eight entities within the region with land use jurisdiction: the County of San Joaquin, the County of Calaveras, the County of Stanislaus, the City of Stockton, the City of Lodi, the City of Manteca, the City of Escalon, and the City of Ripon. The cities of Lodi, Escalon, Manteca, and Ripon are contained entirely within the Subbasin, while western portions of San Joaquin County and the City of Stockton, and eastern portions of Calaveras and Stanislaus counties lie in neighboring subbasins or outside of groundwater subbasins altogether. The Eastern San Joaquin Subbasin encompasses the following unincorporated communities: Acampo, Adela, Atlanta, August, Bear Creek, Burson, Clements, Collierville, Country Club, Dogtown, East Oakdale, Eugene, Farmington, French Camp, Garden Acres, Goodmans Corner, Jenny Lind, Kennedy, Knights Ferry, Lake Camanche Ranches, Lincoln Village, Linden, Lockeford, Milton, Morada, Mormon, Oak Grove, Peters, South Camanche Shore, Taft Mosswood, Terminous, Thornton, Valley Home, Valley Springs, Victor, Wallace, Waterloo, Woodbridge, and Youngstown.

Figure 1-7: City Boundaries

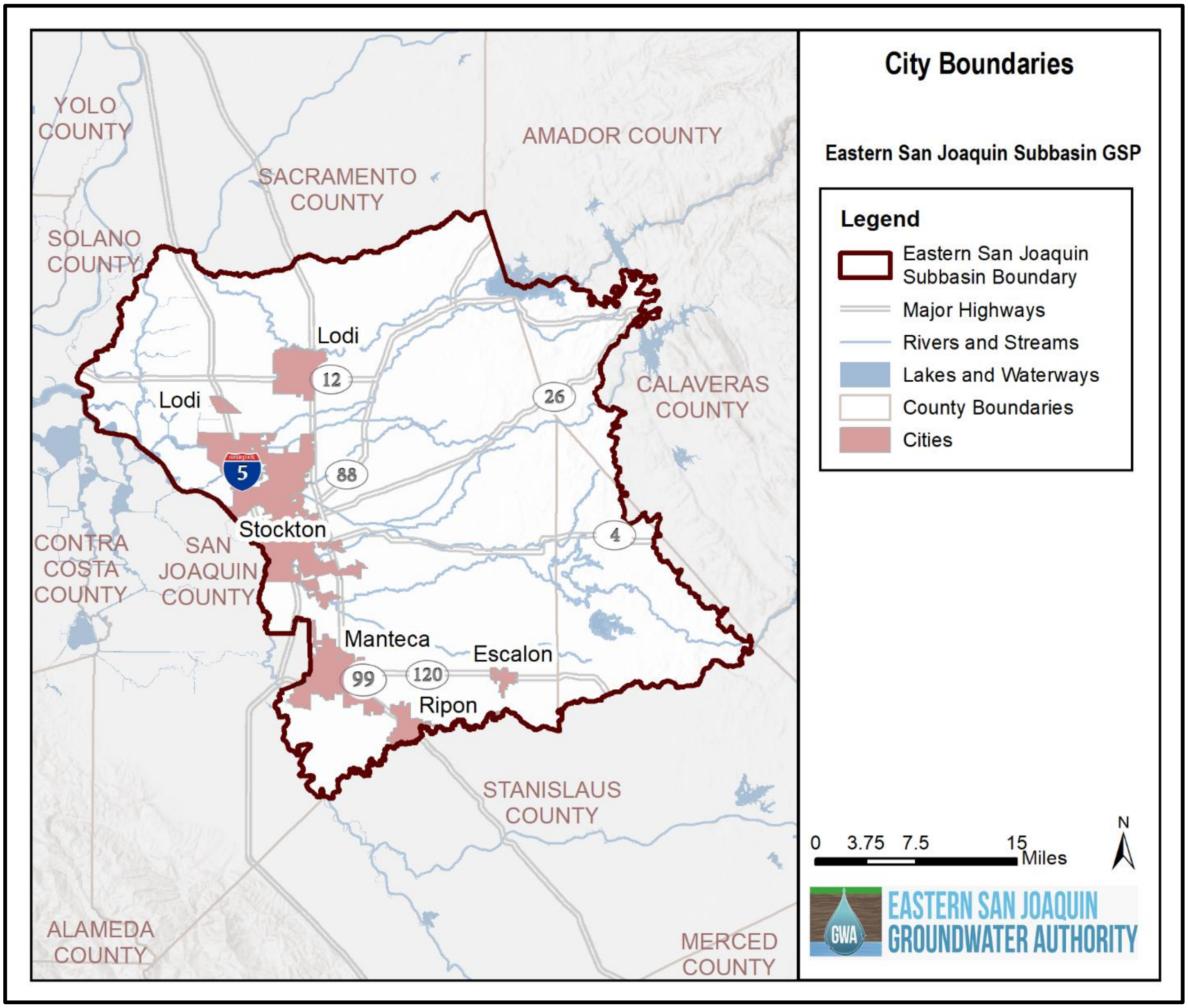


Figure 1-8 shows the spatial extent of Disadvantaged Communities (DACs) and Severely Disadvantaged Communities (SDACs) in the Eastern San Joaquin Subbasin. DWR defines DACs as census geographies (census tracts, census block groups, and census-designated places) with an annual median household income (MHI) that is less than 80 percent of the statewide annual MHI. SDACs are defined as census geographies with an MHI less than 60 percent of the statewide annual MHI. DWR uses the most recently available 5-year American Community Survey (ACS) dataset to identify these areas. For this GSP, the 2016-2020 ACS dataset was used, establishing statewide MHI as $78,672 (CA DWR, Mapping Tools).

Figure 1-8: Disadvantaged Communities (DACs)

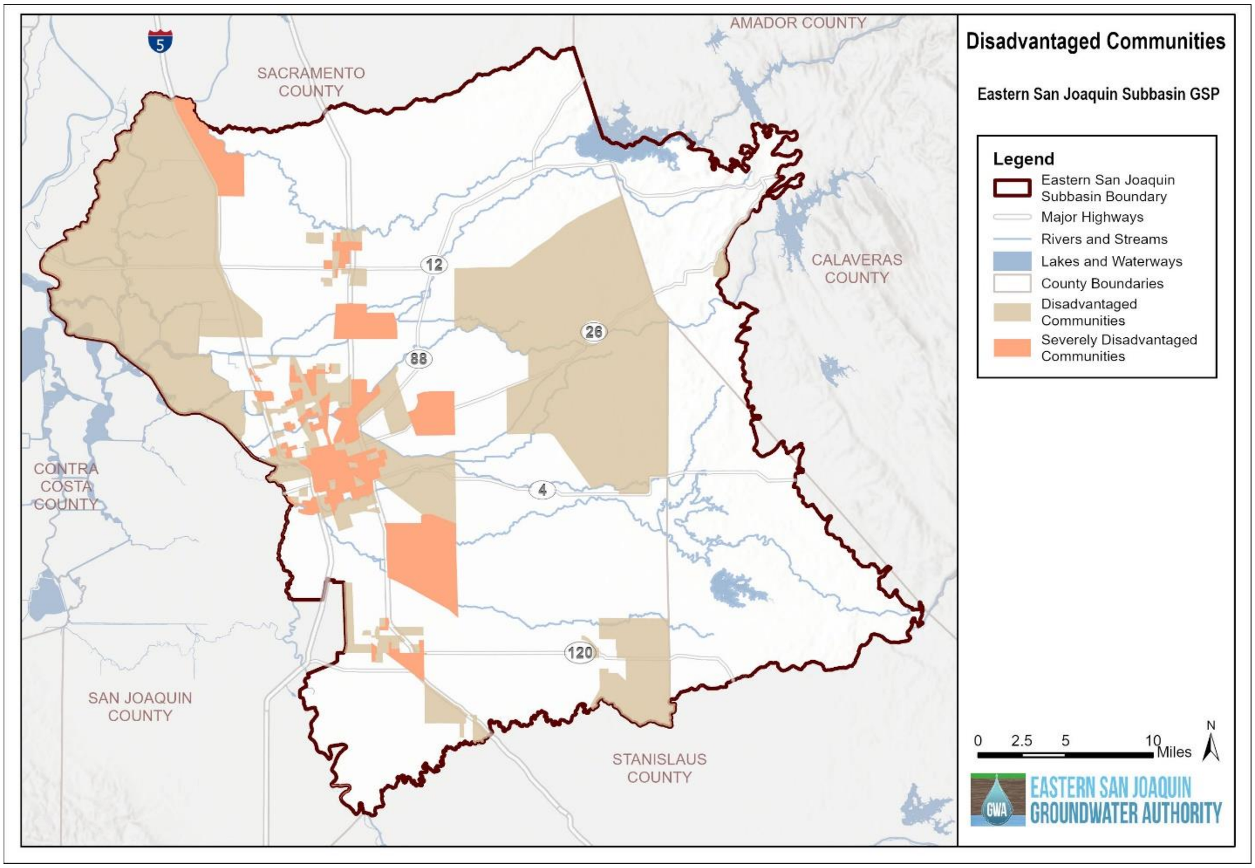
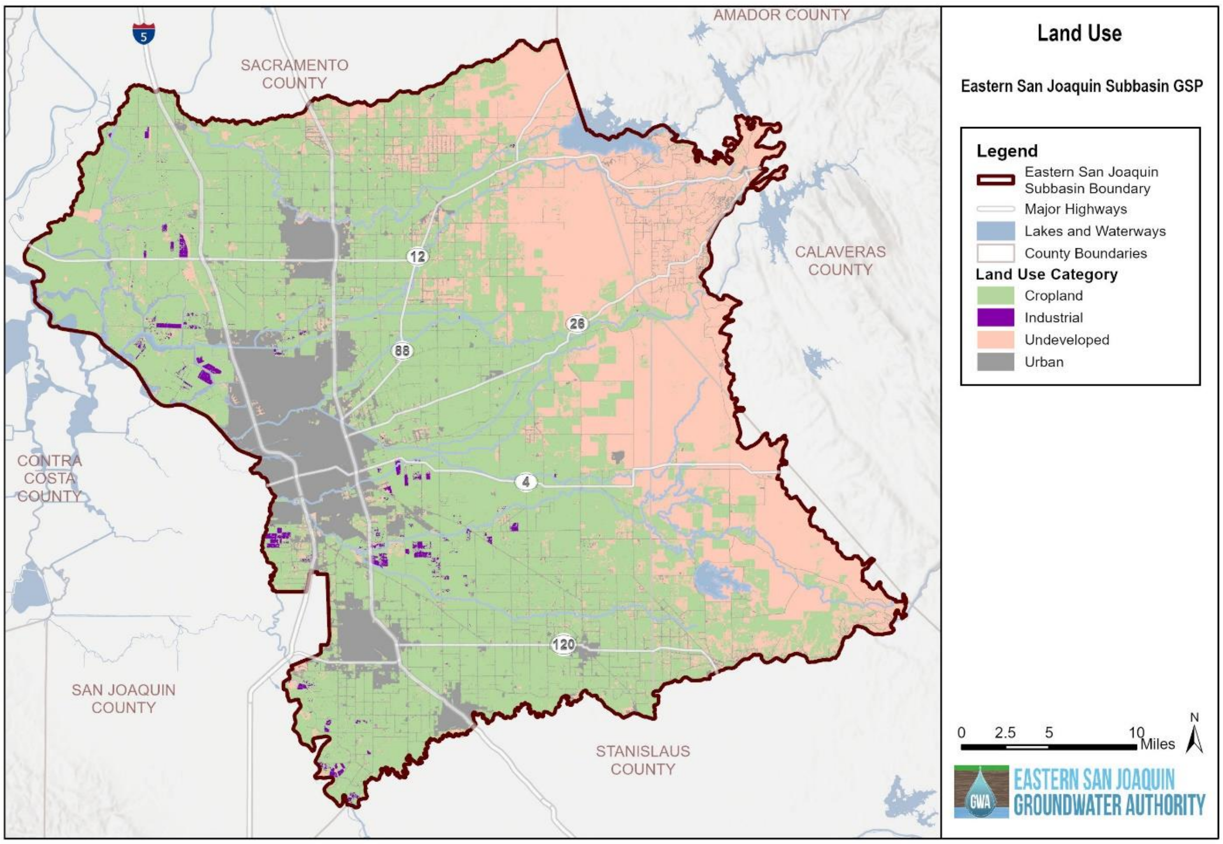


Figure 1-9 shows a map of land use in the Eastern San Joaquin Subbasin across four general categories: cropland, industrial, undeveloped, and urban. These categories were mapped based on categories identified from the United States Department of Agriculture's (USDA) CropScape 2022 dataset.

Land use patterns in the Eastern San Joaquin Subbasin are dominated by agricultural uses, including nut and fruit trees, vineyards, row crops, grazing, and forage. Both agricultural and urban land use rely on a combination of surface water and groundwater, with some agricultural lands using recycled or reusing water. Land use is primarily controlled by local agencies. Land use patterns in the low foothills to the east are dominated by native vegetation and unirrigated pasture lands (USDA, 2022).

Figure 1-9: Land Use



Crop type varies by region, with fruit and nut trees and vine crops comprising the majority of agriculture in the Subbasin. Almond orchards dominate the southern portion of the Subbasin, cherry and walnut orchards dominate the central portion of the Subbasin, and vineyards dominate the northern portion (Figure 1-10). Irrigated crop acreage in the Subbasin are 37 percent fruit and nut trees, 24 percent vineyards, and 11 percent alfalfa and irrigated pasture, according to the 2022 CropScape dataset (USDA, 2022).

Figure 1-10: Land Use by Crop Type

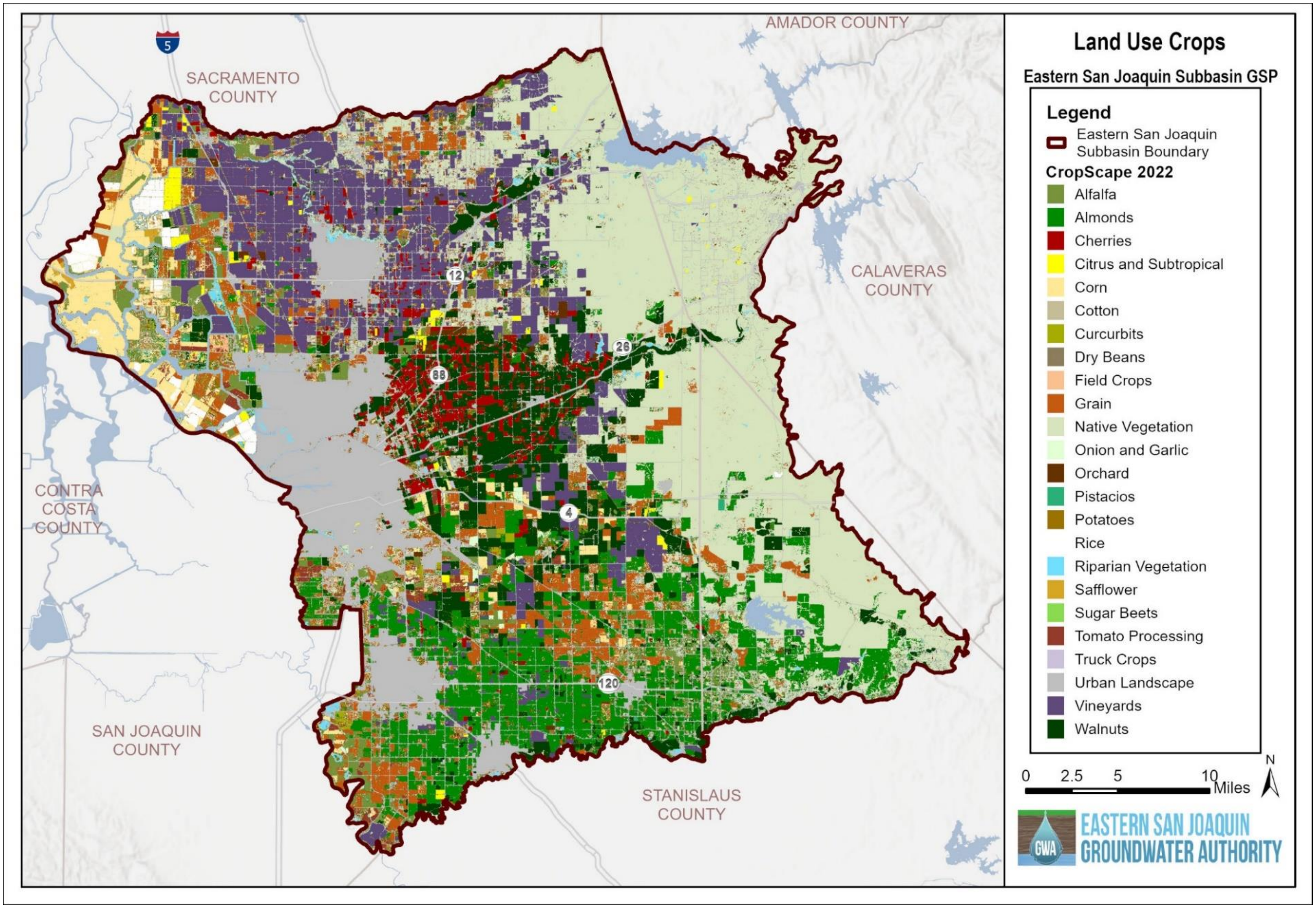


Figure 1-11 shows a map with boundaries of federal and state public lands within the region that includes the Eastern San Joaquin Subbasin. The United States Fish and Wildlife Service (USFWS) manages the San Joaquin River National Wildlife Refuge situated in Stanislaus County where the Tuolumne, Stanislaus, and San Joaquin rivers meet. Established in 1987 to provide habitat for migratory birds and endangered species, the refuge is 7,000 acres and is located just outside the southern boundary of the Subbasin (USFWS, 2012).

The California Department of Parks and Recreation maintains the Caswell Memorial State Park located along the Stanislaus River near Ripon (California State Parks, 2019). The Caswell Memorial State Park protects a riparian oak woodland and is home to the riparian brush rabbit, an endangered species (California State Parks, 2019). This is the only state park within the Eastern San Joaquin Subbasin boundary. The Franks Tract State Recreation Area (SRA) and the Carnegie State Vehicular Recreation Area (SVRA) are also managed by California State Parks; however, both of these areas are located outside of the Subbasin boundary.

The California Department of Fish and Wildlife (CDFW) owns 880 acres of man-made ditches, canals, and marshes with both grassland and riparian habitat, recognized as the White Slough Wildlife Area. The property was designated by the Fish and Game Commission in 1980 and provides recreational opportunities such as fishing, hunting, and hiking (CDFW, 2019a). CDFW also maintains the 353-acre Woodbridge Ecological Reserve to protect primarily the sandhill crane population, but also other migratory waterfowl. The sandhill crane was listed as a threatened species in 1983. Woodbridge Ecological Reserve and the greater Stockton Delta wetlands make up the largest freshwater marsh in California (CDFW, 2019b). Lastly, Vernalis Ecological Reserve is also shown in Figure 1-11. It serves as a public access area owned by CDFW for hunting and wildlife viewing (CDFW, 2019c).

Figure 1-11: US Fish and Wildlife Service, California State Parks, and California Department of Fish and Wildlife Boundaries

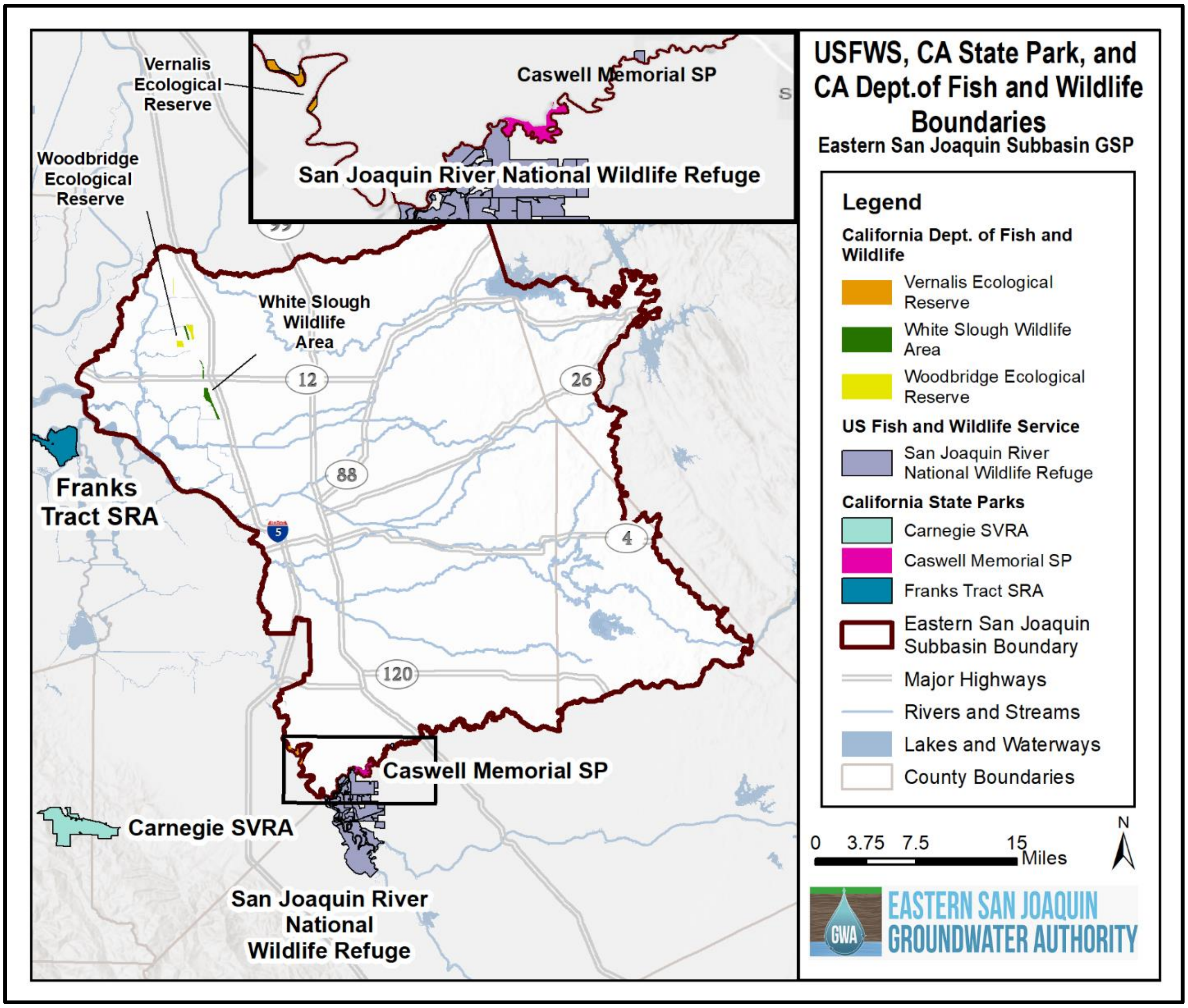


Figure 1-12 to Figure 1-14 shows the density, as of 2019, of domestic, public, and production wells per square mile in the Eastern San Joaquin Subbasin, as classified by the DWR Online System for Well Completion Reports (OSWCR), which is discussed in Section 1.2.2.1. This includes approximately 1,000 unique wells collected primarily from DWR's Water Data Library (WDL), but also other state, regional, and local monitoring entities (CA DWR, n.d.). Though there are overlaps and discrepancies in the designation of wells, domestic wells are largely private residential wells, public wells are municipal-operated wells, and production wells are for irrigation, municipal, public, and industrial purposes (CA DWR, 2019). Areas with few wells exist in the Subbasin, particularly in the northwestern corner of the Subbasin and to the east. Wells containing groundwater level data are described further in Section 1.2.2.1. Community water systems, defined by the State Water Resources Control Board (SWRCB) as wells serving 15 or more connections or more than 25 people per day, are identified in Appendix 1-E. Appendix 1-E contains additional detail on where community water systems are found in the Subbasin.

Figure 1-12: Density of Domestic Wells per Square Mile

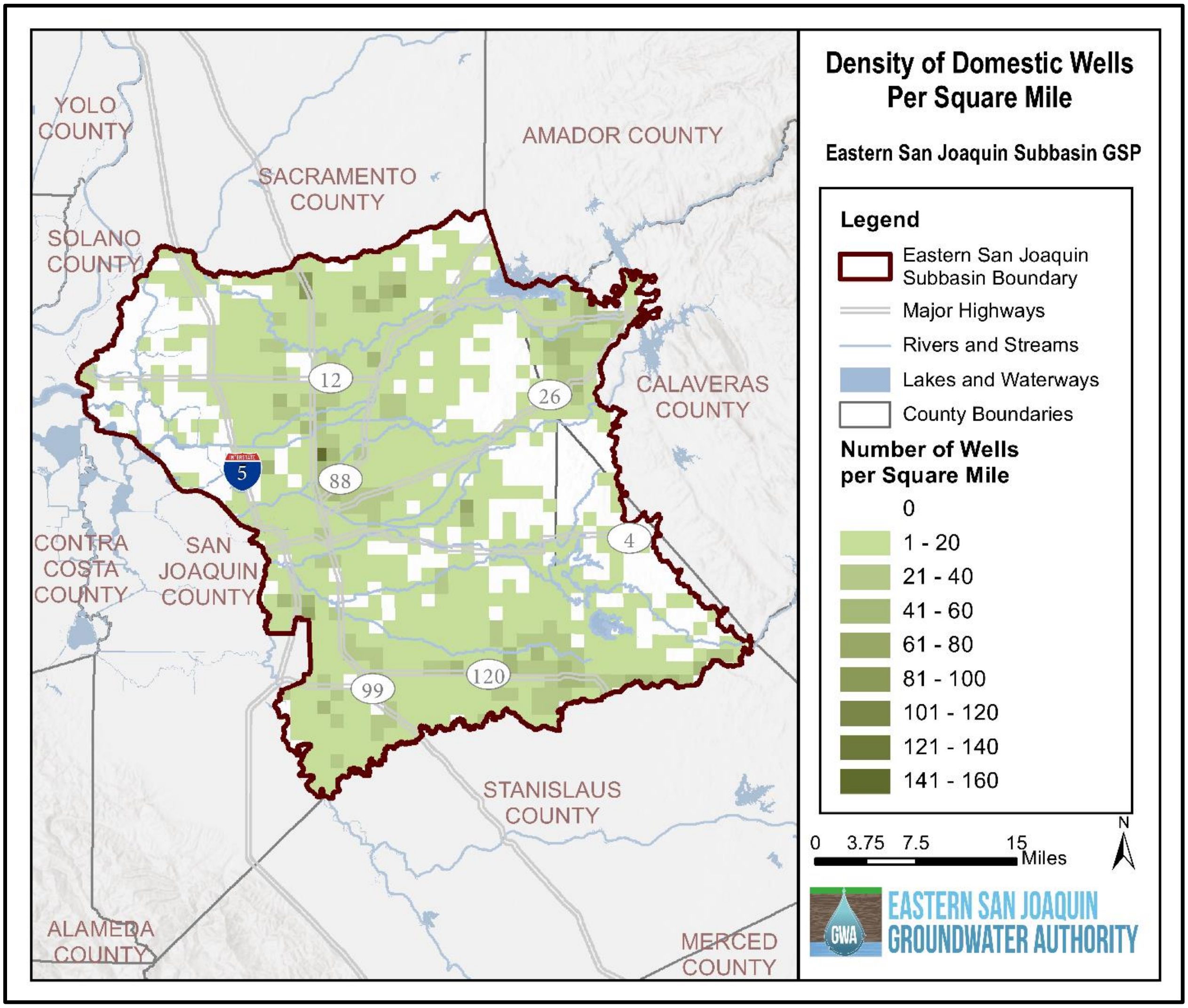


Figure 1-13: Density of Public Wells per Square Mile

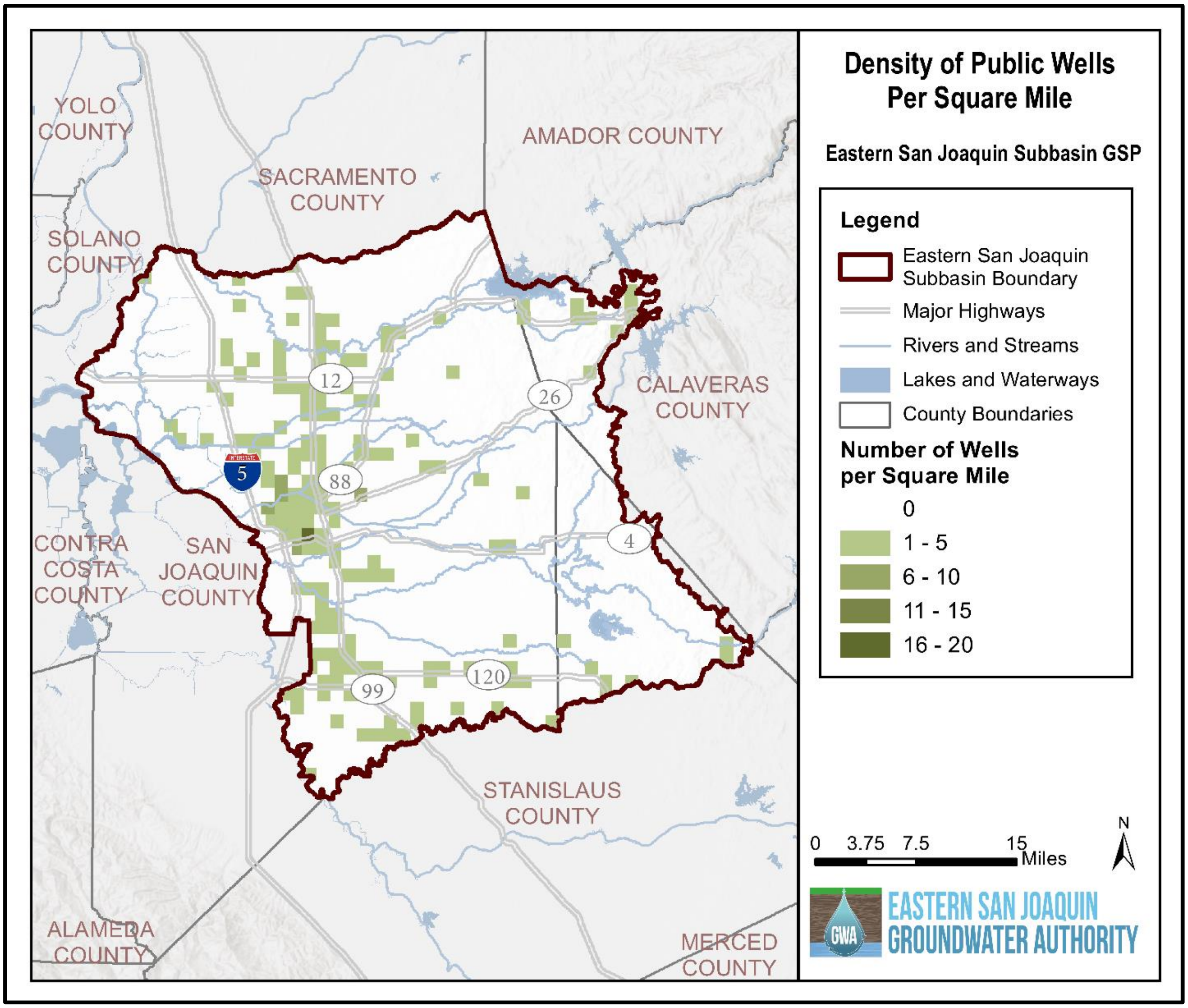
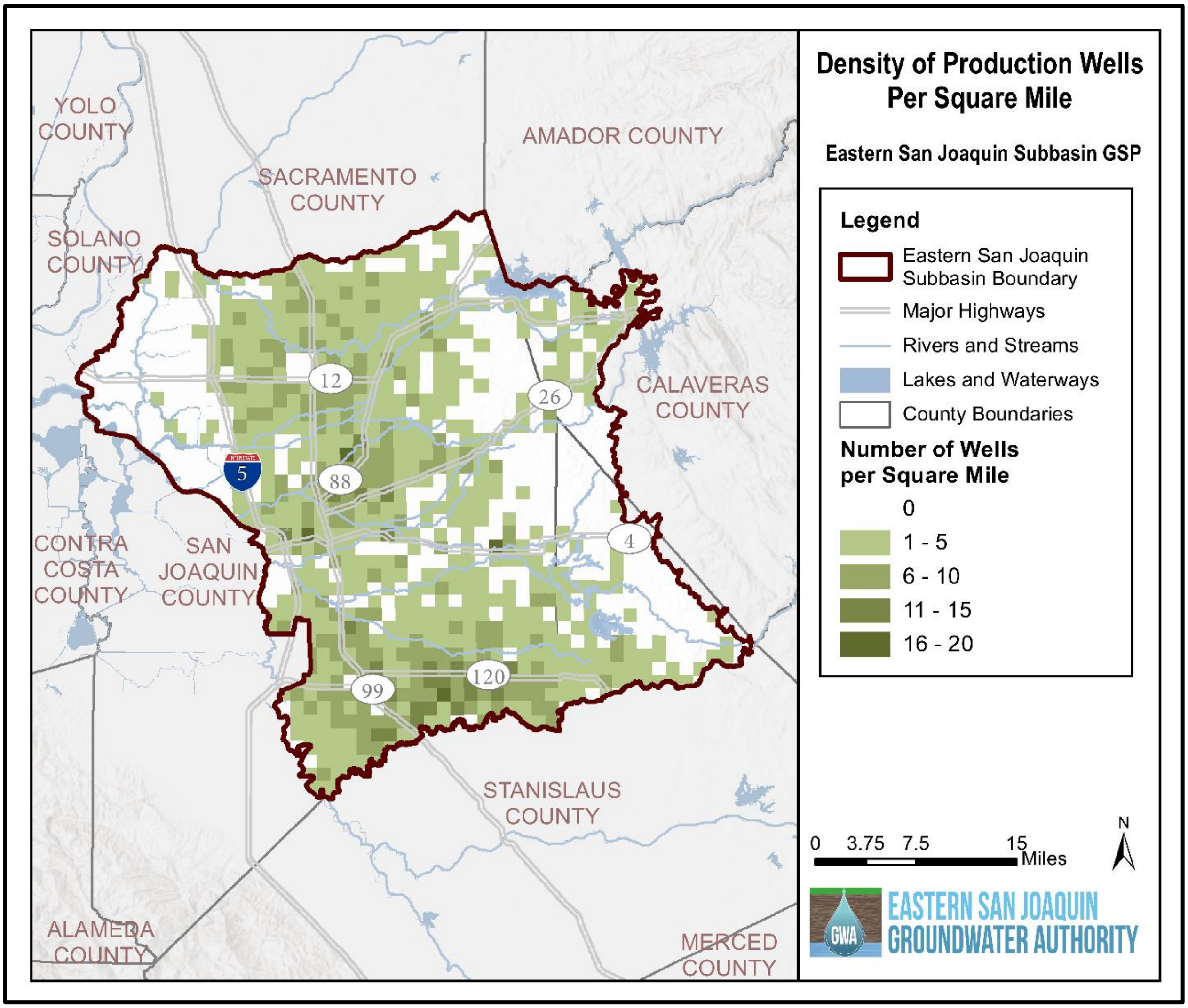


Figure 1-14: Density of Production Wells per Square Mile



1.2.2 Water Resources Monitoring and Management Programs

The existing monitoring and management landscape within the Eastern San Joaquin Subbasin is a patchwork of local, regional, state, and federal programs, each serving its own specific function. This patchwork provides valuable data that have supported past needs and will assist in meeting monitoring needs under SGMA. This patchwork of programs includes redundancies, inconsistent protocols, and inconsistent timing of monitoring that may be improved during SGMA implementation.

Existing monitoring within the Eastern San Joaquin Subbasin is extensive, complex, and performed for a variety of purposes by a variety of entities. During a review of existing groundwater monitoring data and programs, data were collected from the following agencies and programs. Programs and agencies are listed by the jurisdiction they operate across: statewide, regional, or local. The sections that follow describe in detail the programs most heavily relied upon in the development of the GSP and are organized by data type. Section 1.2.2.3 addresses the interconnection between databases.

Statewide Monitoring Programs (Agencies and Databases):

- California Data Exchange Center (CDEC)
- California Department of Pesticide Regulation (CDPR)
- California Environmental Data Exchange Network (CEDEN)
- California State Water Resources Control Board (SWRCB), Division of Drinking Water (DDW)
- Department of Water Resources (DWR):
  - Airborne Electromagnetic (AEM) Surveys
  - California Statewide Groundwater Elevation Monitoring (CASGEM)
  - California Statewide Groundwater Elevation Monitoring Groundwater Information Center Interactive Mapping Application (GICIMA)
  - Online System for Well Completion Reports (OSWCR)
  - Water Data Library (WDL)
- Groundwater Ambient Monitoring and Assessment (GAMA) Program
- GeoTracker
- University NAVSTAR Consortium (UNAVCO)
- United States Bureau of Reclamation (USBR)
- United States Geological Survey (USGS)

Regional Monitoring Programs:

- Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)
- California Department of Public Health (CDPH)
- Central Valley Regional Water Quality Control Board (CVRWQCB) Waste Discharge Requirement (WDR) dairy data, Dairy Cares
- USGS's National Water Information System (NWIS)
- Central Valley Dairy Representative Monitoring Program
- EnviroStor
- Groundwater Quality Trend Monitoring Program through SWRCB Irrigated Lands Regulatory Program (ILRP)
- San Joaquin River Restoration Program

Local Monitoring Agencies

- Cal Water

- Calaveras County Water District
- City of Lodi
- City of Manteca
- City of Stockton
- Linden County Water District
- Lockeford Community Services District
- North San Joaquin Water Conservation District
- Oakdale Irrigation District
- San Joaquin County
- South San Joaquin Irrigation District
- Stockton East Water District

A description of the monitoring programs that will be used in GSP implementation is provided in Chapter 4: Monitoring Networks.

1.2.2.1 Groundwater Level Monitoring and Data Sources

1.2.2.1.1 CASGEM

DWR maintains several groundwater level monitoring programs, tools, and resources covering California. The California Statewide Groundwater Elevation Monitoring (CASGEM) Program is DWR's primary resource for groundwater level data and has been used extensively in the development of this GSP. The CASGEM Program was authorized in 2009 by SB X7-6 to establish collaboration between local monitoring parties and DWR to collect and make public statewide groundwater elevation data. The program provides the framework for local agencies or other organizations to "assume responsibility for monitoring and reporting groundwater elevations in all or part of a basin or subbasin" (Water Code §10927). As part of SGMA implementation, wells that are in the Subbasin's representative monitoring network have been migrated out of CASGEM and into SGMA; all other pre-existing CASGEM wells remain in that program under voluntary monitoring status.

Three CASGEM monitoring entities exist in the Eastern San Joaquin Subbasin: CCWD, San Joaquin County Flood Control and Water Conservation District (SJCFCWCD), and Stanislaus County. These three agencies have completed separate CASGEM Monitoring Plans, which are included in the references section.

- CCWD CASGEM Monitoring Plan: CCWD adopted a CASGEM Monitoring Plan in November 2012, with the following objectives:
    - Collect semi-annual groundwater levels from a selected monitoring well network
    - Upload groundwater levels to the CASGEM website after data quality steps have been completed
    - Maintain and update the monitoring well network plan documents including additions and removals from the monitoring network

These objectives are helpful to this planning effort, as they include regular monitoring of groundwater levels and data upload to CASGEM. The CCWD plan also includes a description of the CASGEM monitoring network and groundwater level measurements. The monitoring network includes two USGS nested monitoring wells equipped with pressure transducers, which continuously monitor groundwater levels. The monitoring network also includes seven other wells that are not USGS wells. These wells are not equipped with pressure transducers, and manual groundwater elevation measurements are taken at all wells twice a year. As stated in the CCWD CASGEM plan, the non-USGS wells are owned by private landowners, and additional wells may need to be added in the future if owners opt out of the monitoring network (CCWD, 2012). This monitoring network covers the portion of Calaveras County within the Eastern San Joaquin Subbasin.

- SJCFCWCD CASGEM Monitoring Plan: The SJCFCWCD CASGEM Monitoring Plan provides a description of the CASGEM monitoring network and groundwater conditions in San Joaquin County. This plan covers the portions of the Eastern San Joaquin and Tracy Subbasins within San Joaquin County. The SJCFCWCD has been taking semi-annual water level measurements since 1971 at wells owned by a variety of entities and by private individuals. A large portion of wells in the district's network are privately owned (SJCFCWCD, 2006). SJCFCWCD sent out consent forms to these private well owners to release well information to CASGEM; about 40 of these forms were signed and returned, and construction information for these wells was uploaded to CASGEM. This information includes attributes such as well depth, coordinates, reference point elevation, and depth of screened interval.

- Stanislaus County CASGEM Monitoring Plan: The Stanislaus County Department of Environmental Resources (DER) established a CASGEM monitoring plan in 2016 to cover the portion of Stanislaus County within the Eastern San Joaquin Subbasin, often referred to as the northern triangle. This plan details the groundwater level monitoring history, protocols, and network for the northern triangle portion of Stanislaus County. This area is rural and most of the development exists between the Stanislaus River and near the Woodward Reservoir. Wells selected for the CASGEM program are in the developed areas. 17 wells are included in this CASGEM plan to be measured semi-annually, consisting of one domestic and ten irrigation wells, plus six wells that are of unknown type. Well information such as depth and screened interval was uploaded to CASGEM for these wells (Stanislaus County DER, 2016).

1.2.2.1.2 San Joaquin County Flood Control and Water Conservation District

The SJCFCWCD publishes semi-annual groundwater reports covering groundwater conditions in San Joaquin County. These reports include tables, hydrographs, and maps on groundwater levels. Groundwater level results from each semi-annual report are compared with values from the previous period. Groundwater level data collected by the district include the data mentioned in the CASGEM section, above, and additional data that are not incorporated into CASGEM. The data are maintained by the SJCFCWCD.

1.2.2.1.3 Water Data Library

DWR's WDL contains measurements of groundwater elevations from water supply and monitoring wells monitored by numerous entities, such as DWR and local agencies. Groundwater level measurements available from the WDL are either continuously or periodically measured. Continuous measurements are provided by automatic water level measuring devices that take readings at wells; periodic measurements are manual recordings typically occurring at monthly or semi-annual time intervals. Measurements displayed through the WDL are taken through other programs, such as CASGEM. The WDL lists the organization responsible for collecting each water level measurement. The WDL water level measurements are available through the California Natural Resources Agency (CNRA) Open Data website as a bulk download, or through the WDL website on a per station basis.

1.2.2.1.4 USGS – National Water Information System

The NWIS is a USGS program comprising several water datasets, including groundwater level measurements, river flow, and river stage data. Like the WDL, NWIS contains continuous and periodic water measurements for recent and historical conditions. Within the Eastern San Joaquin Subbasin, there are only a few active NWIS sites and many inactive sites with historical records. For stream measurements, active sites are largely along major streams, such as the Mokelumne River, the Stanislaus River, and the San Joaquin River; along Delta waterways; or in the Sierra Nevada foothills, upstream of reservoirs.

1.2.2.1.5 Data Received Directly from GSAs

A number of the GSAs collect water level and water quality information within their GSAs at varying frequencies and detail. These data were provided as part of the Eastern San Joaquin Water Resources Model (ESJWRM) data collection efforts and were compared with and included in groundwater level and water quality datasets analyzed for updates to the ESJWRM model and the preparation of this GSP.

The development and update of the ESJWRM took place in an open and transparent process. Coordination efforts took place through the Eastern San Joaquin County GBA, the organizational structure for agency coordination that proceeded SGMA regulations and the formation of the ESJGWA, and through the Subbasin Steering Committee. Through this effort, many of the staff and consultants representing the GSAs forming the ESJGWA participated as a forum to review model input data and assumptions. The group facilitated major modeling decisions and provided input data, including groundwater pumping records, surface water delivery records, urban demand, and local water levels and quality data.

Local agencies with consistent representation in meetings related to the development of the ESJWRM included San Joaquin County, WID, City of Lodi, NSJWCD, LCSD, CCWD, City of Stockton, Cal Water, SEWD, City of Lathrop, City of Manteca, SSJID, City of Escalon, OID, and Stanislaus County. Other agencies contributed local data to information collection efforts later in the GSP development and revision process.

Online System for Well Completion Reports – The OSWCR is a DWR program used to document and compile boring or well completion records throughout California. There are as many as 2 million domestic, irrigation, and monitoring water wells in California included in this dataset, including approximately 10,000 domestic wells located in the Eastern San Joaquin Subbasin. When a well is constructed, modified, or destroyed, drilling contractors are required to submit a Well Completion Report to DWR for upload to the interactive OSWCR web site. OSWCR is used as a data source for wells identified for monitoring. In this GSP, the OSWCR database was used to describe the Plan area and identify sustainable management criteria.

1.2.2.2 Groundwater Quality Monitoring and Data Sources

1.2.2.2.1 Groundwater Ambient Monitoring and Assessment Program

The GAMA Program is an extensive groundwater quality monitoring program that was established by the SWRCB in 2000. The program compiles groundwater quality data from several agencies including the DWR, USGS, Department of Pesticide Regulations (DPR), Lawrence Livermore National Laboratory (LLNL), and others. Agencies submit data from monitoring wells for 258 constituents including total dissolved solids (TDS), nitrates and nitrites, arsenic, and manganese. GAMA data for the Eastern San Joaquin Subbasin contains water quality results collected by the SWRCB-DDW (formerly DHS-DDW), DPR, DWR, LLNL, and USGS from the 1940s to present. Figure 2-3 in Chapter 2: Basin Setting shows the GAMA well locations throughout the Eastern San Joaquin Subbasin, roughly 6,800 monitoring points.

1.2.2.2.2 Water Data Library

DWR's WDL contains groundwater quality data in addition to the groundwater level records described previously. This information includes data from discrete groundwater quality samples collected by DWR and other cooperating entities.

These water quality data list the entity responsible for taking the sample but do not specify what program the sample was taken under. The WDL water quality measurements are available through the CNRA Open Data website as a bulk download, or through the WDL website on a per-station basis. WDL water quality measurements in this GSP are utilized for basin characterization but are acquired from the other programs.

1.2.2.2.3 National Water Information System

The USGS NWIS contains groundwater quality data, in addition to the groundwater level measurements previously discussed. Groundwater quality results in NWIS relate to GAMA records, but there is no direct link between the two databases. Some NWIS sites have a State ID listed, which is a common identifier used for wells. This indicates these wells can be connected to other databases using the State ID information. However, differences in the format of the State ID between NWIS and other databases create challenges in cross referencing between databases. In this GSP, NWIS water quality measurements are utilized for basin characterization but are acquired from the other programs.

1.2.2.2.4 Division of Drinking Water

The SWRCB DDW monitors public water system wells for Title 22 requirements such as organic and inorganic compounds, metals, microbial, and radiological analytes. Data are available for active and inactive drinking water sources for water systems that serve the public – defined as wells serving 15 or more connections or more than 25 people per day. Data are electronically transferred from certified laboratories to DDW daily. Data generated from this program are used for regulatory compliance by water purveyors and become part of Consumer Confidence Reports (CCR) and GAMA.

1.2.2.2.5 GeoTracker

GeoTracker, operated by the SWRCB, contains records for sites that require cleanup, such as leaking underground storage tank sites, Department of Defense sites, and cleanup program sites. GeoTracker also contains records for various unregulated projects as well as permitted facilities including: ILRP, future CV-SALTS, oil and gas production, operating permitted underground storage tanks, and land disposal sites. GeoTracker receives records and data from SWRCB programs and other monitoring agencies.

1.2.2.2.6 Irrigated Lands Regulatory Program

The Irrigated Lands Regulatory Program (ILRP) is a program established by the CVRWQCB focused on monitoring and regulating the concentration of pesticides, toxicity, and nutrients (such as TDS and nitrates) in surface and groundwater. General orders under the ILRP require agricultural users in the Central Valley to prevent sediment, fertilizer, pesticides, manure, and other materials used in farming from leaving the field in irrigation or stormwater and entering surface waters or leaching below the root zone to groundwater. Agricultural users biannually sample and submit data for irrigation and domestic wells. As part of the ILRP, the San Joaquin County & Delta Water Quality Coalition members monitor drinking water wells on enrolled parcels for nitrates. This requirement began January 1, 2019, based on the February 7, 2018 revision of ILRP WDR (Order) for the Eastern San Joaquin River Watershed by the SWRCB. The ILRP program is in the process of developing a comprehensive monitoring network for future use to address the ILRP data objectives. The San Joaquin County & Delta Water Quality Coalition members also monitor domestic wells for nitrate in high vulnerability areas.

1.2.2.2.7 Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS)

The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program was launched by the CVRWQCB in 2006 in an effort to develop sustainable salinity and nitrate management plans and solutions to the salinity problem in the Central Valley. CV-SALTS is a coalition of agricultural, business, and industry parties along with local, regional, and state governments which facilitate and fund efficient management systems of salinity, technical studies, and the 2017 Final Salt and Nitrate Management Plan (SNMP). The 2017 SNMP was developed based on a detailed water quality analysis conducted for salinity (represented by TDS) and nitrates using measurements from wells across multiple agencies from 2000-2016. Appendices to the SNMP and supporting documents contain summary information about these constituents by Subbasin, including Eastern San Joaquin. Basin Plan Amendments identify specific actions and recommendations for individual basins in the Central Valley. Efforts are underway to implement a salinity monitoring program and the CV-SALTS program will likely require monitoring and data submittal.

1.2.2.3 Interconnection of Databases

Several of the databases discussed above utilize the same water level or water quality data. These records often specify the monitoring entity responsible for the measurement. Although these data overlap between databases, the correlation between databases is not specified. For example, water level data in the WDL are also in CASGEM, but this link is not mentioned in WDL records. This lack of connection poses problems for gathering water level and quality data in the Eastern San Joaquin Subbasin and throughout California. For instance, if certain water level data are gathered through CASGEM but not uploaded to NWIS, users who gather water level measurements through NWIS would miss the CASGEM data. Efforts have been made in the development of this Plan to overcome the issue related to overlap and poor correlation between databases, but the issue remains. It is recommended that agencies work together to utilize a common unique identifier to ease use of multiple datasets.

1.2.2.4 Land Subsidence Monitoring

Subsidence monitoring is performed using continuous global positioning system (CGPS) stations, extensometers, and Interferometric Synthetic Aperture Radar (InSAR) surveys. CGPS data are primarily available from two programs.

UNAVCO's Plate Boundary Observatory Program – Reporting since 2004, the UNAVCO (formerly University Navigation Satellite Timing and Ranging or NAVSTAR Consortium) Plate Boundary Observatory network consists of a network of about 1,100 continuous global positioning system (CGPS) and meteorology stations in the western United States to measure deformation resulting from the constant motion of the Pacific and North American tectonic plates in the western United States. Stations located within the Subbasin contain data from at least 2006 to current and include station P309 located east of Linden and station P273 located west of Lodi. Other stations are also available in nearby Subbasins.

University of Nevada Geodetic Laboratory (UNGL) - Several additional CGPS stations from the University of Nevada Geodetic Laboratory (UNGL) were also located in the Subbasin. These stations provide additional subsidence data for the Subbasin; however, these stations have drawbacks, such as data gaps, and discontinuous monitoring, and are used on an academic/research basis that may result in increased monitoring gaps. Station CA15 is located north of the city of Stockton and has a continuous period of record between September 2013 and October 2021. Station CMNC is located along the southern edge of the Camanche Reservoir and has observations in 2020 and between February 2022 through January 2024. These locations also provided additional spatial coverage to the UNAVCO and SOPAC CGPS stations

Subsidence analyses have also been conducted using satellite-based methods over limited time periods, as described below.

United States Geological Survey – The USGS report *Land Subsidence along the Delta-Mendota Canal in the Northern Part of the San Joaquin Valley, California, 2003-10* (Sneed et al., 2013) presents land subsidence data in the southwestern portion of the Eastern San Joaquin Subbasin from 2007 to 2010. Data for about 100 square miles of the Subbasin were recorded using Interferometric Synthetic Aperture Radar (InSAR) processing, a satellite-based remote sensing technique that can detect ground-surface deformation. Two InSAR techniques were used: conventional InSAR and persistent scatter (PS) InSAR. Both sources of data were collected from the Japanese Aerospace Exploration Agency's Advanced Land Observing Satellite.

California Department of Water Resources –- DWR has made two InSAR datasets available for SGMA application: TRE Altamira InSAR point and raster data and the National Aeronautics and Space Administration's Jet Propulsion

Laboratory's (NASA JPL) raster data. Vertical displacement approximations in both datasets are collected by the European Space Agency's Sentinel-1A satellite. The two different datasets represent two different processing results, one by TRE Altamira Inc. and one by NASA JPL. The TRE Altamira data have coverage between January 2015 and June 2018. Both annual and total raster datasets from TRE Altamira are available and represent interpolations of the vertical displacement point features. The NASA JPL processed dataset spans Spring of 2015 to Summer of 2017 (CA DWR, 2019). The TRE Altamira dataset is mapped in Figure 2-64 and discussed in Section 2.2.5.

There are no DWR or USGS extensometers in the Eastern San Joaquin Subbasin.

1.2.2.5 Groundwater Storage Monitoring

There are no existing programs that conduct regular monitoring specific to groundwater storage in the Eastern San Joaquin Subbasin. The ESJWRM historical model was used to generate estimates for historical groundwater storage based on a series of inputs including historical groundwater elevation data. The ESJWRM generated estimates for current and projected volumes of groundwater in storage based on assumptions for how future conditions may change relative to historical conditions.

1.2.2.6 Interconnected Surface Water Monitoring

There are no existing programs that conduct regular monitoring specific to the interconnection of surface water to groundwater in the Eastern San Joaquin Subbasin. However, surface water monitoring and groundwater level monitoring will be integrated to characterize spatial and temporal exchanges between surface water and groundwater and to estimate potential depletions of surface water caused by groundwater extractions. Additional information on how the depletions monitoring network was developed, monitoring frequency, and summary protocols is provided in Chapter 4: Monitoring Networks. Sources of groundwater level data are described in Section 1.2.2.1. Surface water data on stream flows and levels from stream gages are available from the USGS, CDEC, and local agencies.

1.2.2.7 Other Water Management Programs and Plans

The subsections below contain descriptions of historical and current water management programs and plans, including Integrated Regional Water Management Plans (IRWMPs), Agricultural Water Management Plans (AWMPs), and Urban Water Management Plans (UWMPs) that apply to the Eastern San Joaquin Subbasin.

1.2.2.7.1 Groundwater Management Plan

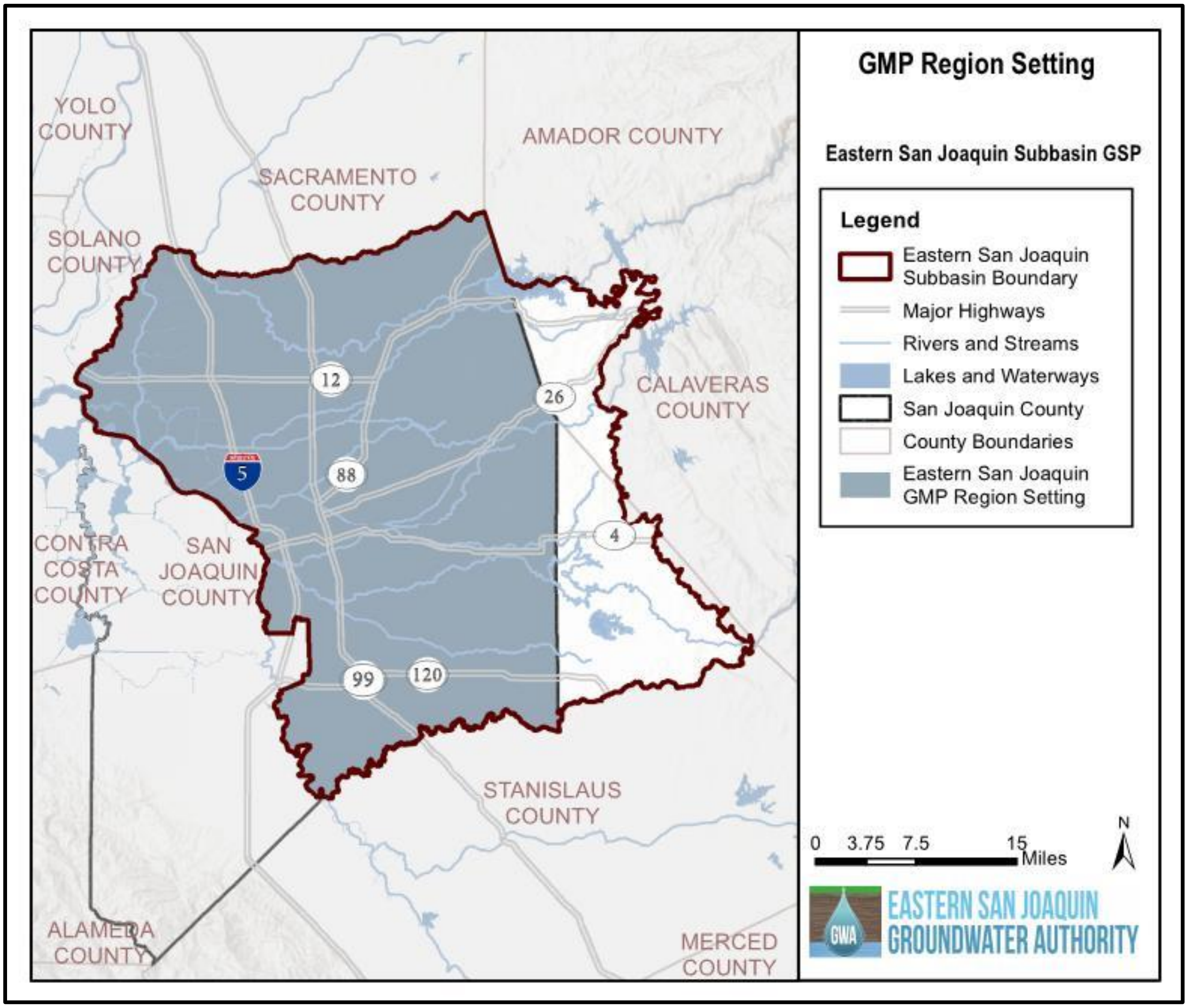
The Eastern San Joaquin Groundwater Basin Groundwater Management Plan (GMP), developed by the Northeastern San Joaquin County Groundwater Banking Authority in September 2004, was a collaborative effort between local water interests with historically diverse viewpoints to reinforce local control and provide direction for the sustainable development of groundwater resources. The GMP covered a geographic region that included the entire Eastern San Joaquin Subbasin that falls within San Joaquin County but excluded portions within Calaveras and Stanislaus counties to the east. The GMP boundaries were generally defined by the San Joaquin County line to the east, the San Joaquin River to the west, Dry Creek to the north, and the Stanislaus River to the south. A map of the Eastern San Joaquin GMP Region is shown in Figure 1-15.

Now a legacy document superseded by the Eastern San Joaquin GSP, the 2004 GMP provided valuable resources related to potential concepts, projects, and monitoring strategies that were leveraged in the early versions of this GSP (Northeastern San Joaquin County Groundwater Banking Authority, 2004). The following management objectives influenced the development and implementation of the GSP:

- Maintain or enhance groundwater elevations to meet the long-term needs of groundwater users within the Groundwater Management Area

- Maintain or enhance groundwater quality underlying the Basin to meet the long-term needs of groundwater users within the Groundwater Management Area
- Minimize impacts to surface water quality and flow due to continued Basin overdraft and planned conjunctive use
- Prevent inelastic land subsidence due to continued groundwater overdraft

Figure 1-15: Eastern San Joaquin GMP Region Setting



1.2.2.7.2 Integrated Regional Water Management Plan

The Eastern San Joaquin Integrated Regional Water Management Plan (Eastern San Joaquin IRWMP) is a collaborative regional planning document that was published in June 2014, with an Addendum released in February 2021. The IRWMP defines and integrates key water management strategies to establish protocols and courses of action to implement the Eastern San Joaquin Integrated Conjunctive Use Program (ICU Program). The ICU Program was designed to implement a comprehensive, prioritized set of projects and management actions to meet adopted

Best Management Objectives, moving the Eastern San Joaquin County Region toward the goal of sustainable and reliable water supplies (San Joaquin County, 2021).

The following IRWMP objectives related to groundwater use would potentially influence implementation of the GSP:

- Minimize adverse impacts to agriculture, communities, and the environment
- Maximize efficiency and beneficial use of supplies
- Protect and enhance water rights and supplies

1.2.2.7.3 Mokelumne Interregional Sustainability Program Report

The Mokelumne Watershed Interregional Sustainability Evaluation (MokeWISE) was formed following efforts made by the Mokelumne River Forum over seven years by a diverse set of stakeholders in the Upper and Lower Mokelumne River watersheds, with the objective to develop and evaluate alternatives to optimize water resources management within the Mokelumne-Amador-Calaveras (MAC) and Eastern San Joaquin IRWM planning regions. The plan offers a bi-regional approach by bringing together stakeholders, and it brings together the interregional sections of two IRWM regions identified as the Mokelumne River Forum (San Joaquin GBA, 2015).

The following MokeWISE objectives related to groundwater use would potentially influence implementation of the GSP:

- Groundwater is not considered a viable additional source in Amador and Calaveras counties
- The Eastern San Joaquin Subbasin is considered critically overdrafted
- Groundwater is not considered a viable additional supply source in Amador and Calaveras counties due to low yield, unreliability, age of groundwater, and limited storage options, although conjunctive use and recharge opportunities may be available

1.2.2.7.4 Agricultural Water Management Plans

AWMPs were developed and adopted by OID, SEWD, SSJID, and WID in 2015 in compliance with SB X7-7 of 2009, which requires certain agricultural water suppliers to prepare an AWMP and implement Efficient Water Management Practices (EWMPs). The Critical EWMPs include:

- Measure the volume of water delivered to customers with sufficient accuracy to comply with requirements of the Water Code
- Adopt a pricing structure based at least in part on quantity delivered (Volumetric Pricing)

Applicable Conditional EWMPs that have the benefit of less applied water or increasing system efficiency include:

- Facilitate alternative land use for lands with exceptionally high water duties
- Facilitate use of available recycled water
- Facilitate financing of capital improvements for on-farm irrigation systems
- Implement an incentive pricing structure that promotes one or more of the goals identified in the Water Code
- Expand line or distribution systems, construct regulating reservoirs to increase distribution system flexibility and capacity, decrease maintenance, and reduce seepage
- Increase flexibility in water ordering by, and delivery to, water customers within operational limits

- Construct and operate supplier spill and tailwater recovery systems
- Increase planned conjunctive use of surface water and groundwater
- Automate canal control structures
- Facilitate or promote customer pump testing and evaluation
- Designate a water conservation coordinator who will develop and implement the water management plan and prepare progress reports
- Provide for the availability of water management services to water users
- Evaluate the policies of agencies that provide the supplier with water to identify the potential for institutional changes to allow more flexible water deliveries and storage
- Evaluate and improve the efficiencies of the supplier's pumps

The updated 2020 AWMPs provide a framework of management practices to help meet water management goals that align with the goals of the Eastern San Joaquin GSP.

1.2.2.7.5 Urban Water Management Plans

UWMPs are developed by Cal Water, CCWD, City of Lodi, City of Manteca, City of Ripon, City of Stockton, SSJID, and SEWD every five years according to requirements of the Water Code.

Agencies acting as GSAs use the following actions to encourage conservation and efficient use of water:

- Water waste prohibition ordinances
- Metered distribution systems
- Tiered water rates and conservation pricing
- Public education and outreach efforts
- Water conservation program coordination and staffing support
- Free residential plumbing retrofit devices
- Washing machine rebate program

1.2.2.8 Canal Diversions and Seepage

Canal seepage in the Eastern San Joaquin Subbasin is tracked on a district-by-district basis. All of the major irrigation districts utilize a combination of natural watercourses, canals, and pipelines to distribute surface water diversions to their customers.

OID diverts water from the Stanislaus River at Goodwin Reservoir through the Joint Main Canal on the north side and the South Main Canal on the south side. Approximately 330 miles of laterals carry water to landowners off of the main canals. While the entire lateral system historically consisted of open, unlined ditches, 100 miles of the laterals have been converted to pipelines; 105 miles are open, concrete-lined ditches; and the rest remain unlined. Approximately 40 percent of the OID service area is within the Eastern San Joaquin Subbasin.

In SSJID, similarly, the primary source of recharge in the groundwater system is conveyance seepage and deep percolation of applied water. SSJID diverts from the Stanislaus River initially and then sends the water through a system of lateral canals to its customers. Like OID, the entire system was open and unlined, but over time it has been slowly concrete lined and replaced with buried pipelines.

SEWD uses two unlined canal systems to deliver water from the Stanislaus River: Upper Farmington Canal and Lower Farmington Canal. SEWD also uses natural watercourses to distribute their water, such as rivers, creeks, and sloughs. CSJWCD also uses the Upper Farmington Canal for distribution, as well as natural watercourses within its boundaries.

Historically, WID has also made efforts to improve the efficiency of the delivery infrastructure it maintains. Water for WID is diverted from the Mokelumne River and from the Delta at the end of Beaver Slough. In 2015, WID had about 100 miles of lined and unlined canals, and pipelines.

Canal seepage, generally considered a loss to districts in the short term, provides groundwater recharge and has played and will continue to play a crucial role in the long-term sustainability of groundwater resources in the Eastern San Joaquin Subbasin.

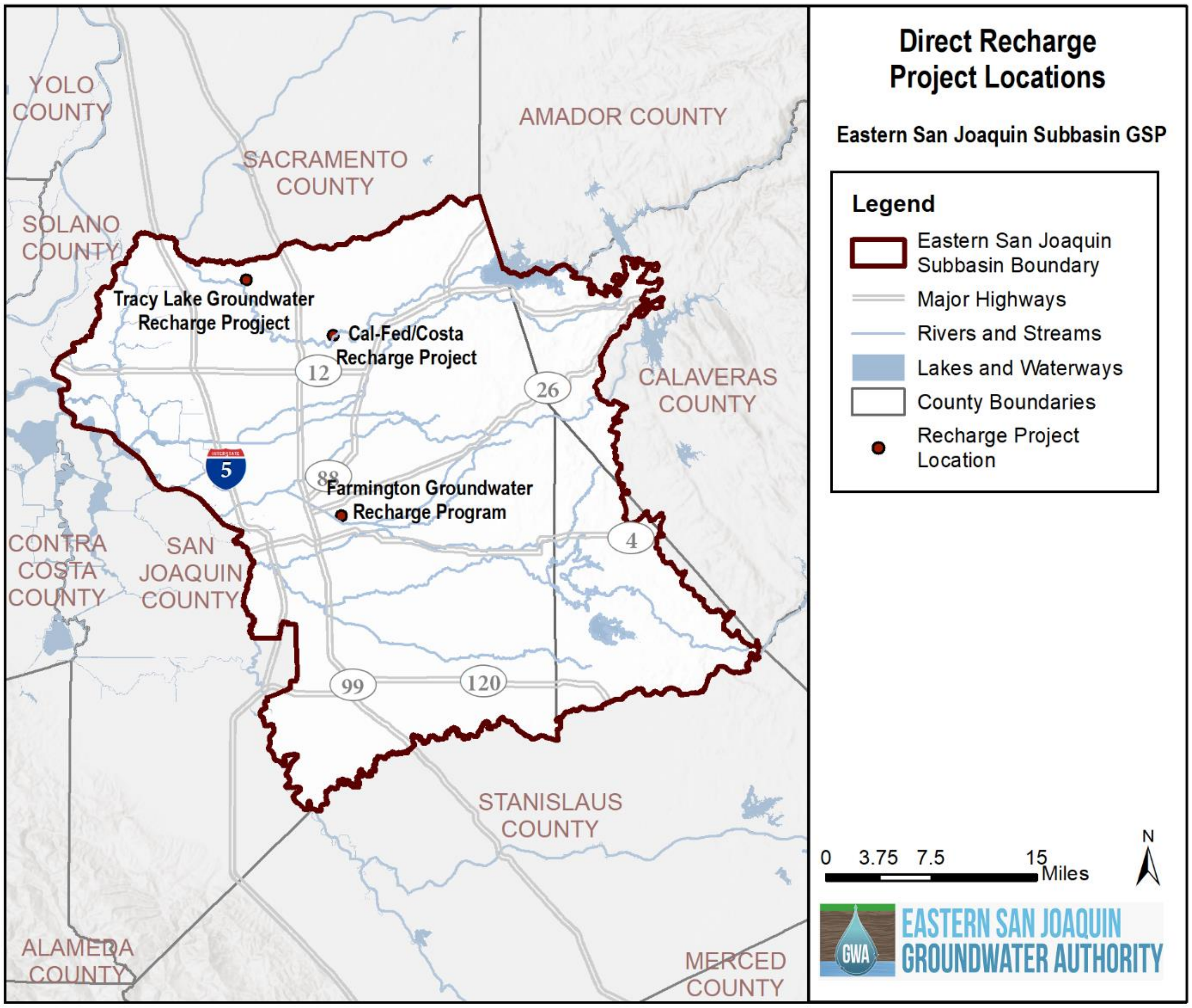
1.2.2.9 Conjunctive Use Programs Prior to SGMA Implementation

Conjunctive use is the use of surface water to allow the Subbasin to recharge and store additional water supply, either through in-lieu use or direct recharge. This section describes conjunctive use programs that were in place in the Eastern San Joaquin Subbasin prior to the beginning of SGMA implementation in 2020, including both in-lieu recharge and direct recharge projects.

In-lieu recharge occurs for both agricultural and municipal purposes wherever surface water is being delivered to offset the use of groundwater. Agencies that conducted in-lieu recharge prior to SGMA implementation include CCWD, City of Lodi, City of Manteca, City of Stockton, CSJWCD, OID, SEWD, SSJID, and WID. Riparian users of surface water also benefit from in-lieu recharge.

Direct recharge projects existed in NSJWCD and SEWD, as shown below in Figure 1-16. NSJWCD's Tracy Lake Groundwater Recharge Project includes direct recharge of 500 to 1,000 AF/year by placing surface water in the bed of South Tracy Lake to allow for percolation. The Cal-Fed/Costa Recharge project includes direct recharge of about 300 AF/year by flooding about 20 acres of vineyards post-harvest. NSJWCD is expanding these programs to add additional in-lieu and direct recharge projects in its service area. SEWD's Farmington Groundwater Recharge Program was developed in 2001 with a conceptual plan to recharge surface water via field flooding on about 1,200 acres. SEWD has operated a 60-acre recharge site since 2003 as a result of the Farmington Program with additional 73 acres added in 2020. The observed recharge amount ranges from 2,800 AF/year to 5,800 AF/year with an average of 4,400 AF/year for a total recharge volume of about 65,000 AF since the inception of the project. SEWD also has several wells to pump some of this recharged water for municipal supply during especially dry years.

Figure 1-16: Locations of Groundwater Recharge Projects Prior to SGMA Implementation



1.2.3 Land Use Elements or Topic Categories of Applicable General Plans

1.2.3.1 General Plans in the Plan Area

San Joaquin County has jurisdiction over land use planning for the majority of the surface area of the Subbasin. Stanislaus County, Calaveras County, and the incorporated cities of Stockton, Manteca, Lodi, Ripon, and Escalon make up the remaining area. Implementation of the Eastern San Joaquin GSP may be affected by the policies and regulations outlined in the San Joaquin County General Plan, as well as the General Plans for the five cities, given that the long-term land use planning decisions that would affect the Subbasin are under the jurisdiction of the counties and respective cities.

This section describes how implementation of the various General Plans may change water demands in the Subbasin, how the General Plans may influence the GSP's ability to achieve sustainable groundwater use, and how the GSP may affect implementation of General Plan land use policies. Policies outlined in the General Plans that will potentially influence implementation of the GSP are discussed below and listed in Appendix 1-F.

1.2.3.1.1 San Joaquin County General Plan

The San Joaquin County General Plan describes the official county "blueprint" on the location of future land use, type of development encouraged, and decisions regarding resource conservation. Stakeholder input informed the development of the county's vision and guiding principles, which represent the county's core values and establish benchmarks for the General Plan's goals and policies. The General Plan encourages preservation of the San Joaquin County's groundwater resources and states that future urban and agricultural growth should occur within the sustainable capacity of these resources (SJC, 2016b).

1.2.3.1.2 Calaveras County General Plan

The Calaveras County General Plan has provided a framework for growth and development in Calaveras County. The Calaveras County General Plan, initially developed in 1996, underwent an extensive update process in collaboration with local stakeholders and policymakers to understand the challenges facing the community and to enact a common vision for the future. This update, with its various elements, was finalized in 2019. (The Housing Element was finalized in 2023.)

The Calaveras County General Plan recognizes that water is a limited and valuable resource and that the region is experiencing localized problems with both water supply and quality. To mitigate these issues, the General Plan delineates policies and goals that promote sustainable water resources management in the region (Calaveras County, 2019).

1.2.3.1.3 Stanislaus County General Plan

The Stanislaus County General Plan provides a comprehensive, long-term plan to guide development within the Stanislaus County boundaries through 2035. The General Plan was updated and adopted in 2016 to reflect the evolving conditions of the region. While Stanislaus County's economic base remains predominantly agricultural, the county's land use and economy continue to diversify in response to increased pressure to convert productive agricultural lands to non-agricultural uses. To address the region's changing water needs, the Stanislaus County General Plan supports goals, policies, and implementation measures that promote sustainable water management and protect the local groundwater sources (Stanislaus County, 2016).

1.2.3.1.4 City of Stockton General Plan

The City of Stockton General Plan establishes the City's 2040 vision and provides supporting goals, policies, and actions needed to achieve it. The General Plan for the 2040 vision was built upon the prior 2035 Stockton General Plan (adopted in 2007) and was a collaborative process that involved a diverse group of stakeholders and interests. The General Plan update incorporated feedback from City Council study sessions, Planning Commission study sessions, community workshops, and numerous other public meetings and outreach events (City of Stockton, 2016).

The City of Stockton's General Plan recognizes that groundwater supplies are vital to Stockton's ability to meet current and future water demands. The city has focused attention on optimizing available surface water supplies and cooperating with agencies in the region to manage the groundwater resources at a sustainable yield and to address regulatory pressures, droughts, and saline intrusion (City of Stockton, 2016).

1.2.3.1.5 City of Lodi General Plan

The City of Lodi General Plan Update, published in 2010, outlines a vision for Lodi's future and provides a set of policies and programs that guide community growth and development. The 2010 General Plan Update replaced the 1991 General Plan and was informed by input from community members and stakeholders who participated in the planning process through different avenues, including public workshops and meetings, mail surveys, interviews, presentations, and newsletters (City of Lodi, 2010).

The General Plan recognizes that groundwater contamination and overdraft in the Eastern San Joaquin Subbasin can threaten the city's ability to meet current water demands and limit future development (City of Lodi, 2010).

1.2.3.1.6 City of Manteca General Plan

The City of Manteca adopted the current Manteca General Plan in February 2024 to reflect the current conditions of the city. This recent version updated the 2003 General Plan and was the result of a collaborative process between community members, city staff, and decision-makers to produce a General Plan that is current, progressive, flexible, and viable. The General Plan Update also reevaluates the existing vision for Manteca through 2040, incorporates new planning strategies, and brings the General Plan into compliance with recent social and environmental justice policies and laws (City of Manteca, 2024).

The Manteca General Plan Update recognizes that groundwater is a large source of potable water supply for the city and that the Eastern San Joaquin Subbasin is in overdraft. To address groundwater overdraft in the city, a significant number of policies in the General Plan promote increased understanding of the Eastern San Joaquin Subbasin.

1.2.3.1.7 City of Escalon General Plan

The Escalon General Plan was developed by the city in 1994 and updated in 2010 to reflect the most current conditions of the city and to provide comprehensive planning for future development. The Escalon General Plan was developed through a cooperative effort involving the City Council and Planning Commission, city staff and their consultants, and stakeholders (City of Escalon, 2010). The Escalon General Plan delineates policies that support the long-term preservation of water supplies and water quality in the Eastern San Joaquin Subbasin (City of Escalon, 2010).

1.2.3.1.8 City of Ripon General Plan

The City of Ripon's General Plan was updated in 2006 to guide the use of private and public lands within the community's boundaries through 2040. The General Plan update provides a framework for promoting growth and reevaluates where growth should be located. The General Plan development process was informed by community members representing a wide variety of interests, city department heads, and staff representatives of public agencies (City of Ripon, 2006).

The General Plan supports the preservation of groundwater quantity and quality as it is an important source of water supply for the City of Ripon. Future development within the planning area is expected to have minimal effects on groundwater supplies, although it is unknown how development will impact groundwater quality. The General Plan predicts that the City of Ripon may have to abandon a large number of wells as sources of potable water due to localized contamination, and, as a result, additional development may be prohibited until an adequate source of potable water can be identified. Surface water is expected to meet water demands for surrounding agricultural uses (City of Ripon, 2006).

1.2.3.2 Effect of GSP Implementation on Applicable General Plans

The General Plans in the Subbasin provide guidelines to facilitate anticipated growth within the sustainable capacity of existing resources. Successful land use planning also promotes sustainable water supply and use within the region. Due to the complementary nature of the General Plans and the GSP, the goals and policies in the General Plans support the ability of the GSAs to achieve sustainability.

Implementation of the GSP, including changes in groundwater management, may influence the type of land use and location of future development, depending on the level of changes set forth by the GSP, such as enacted programs, plans, and policies. While General Plan implementation may result in land use changes and changes in water consumption, minimal change in water demand is expected from GSP implementation. The potential for future management actions, which could impact water supplies and development, is discussed in Section 6.5. Most of the land within the Eastern San Joaquin Subbasin is currently developed to some use, and conversion from agricultural uses to urban uses is not anticipated to increase water demand. However, conversion from agriculture to urban use may have an effect on water source, depending on the location in the Subbasin, and may shift supply from groundwater to surface water.

1.2.3.3 Land Use Plans Outside the Plan Area

Land use decisions in neighboring areas experiencing overdraft are likely to affect groundwater conditions in the Eastern San Joaquin Subbasin. Ongoing coordination with neighboring groundwater subbasins will include updates on major land use planning that may impact the groundwater system. The cities of Tracy, Lathrop, Modesto, Galt, and Elk Grove are the largest urban areas neighboring the Eastern San Joaquin Subbasin. The portions of the Tracy and the Delta-Mendota Subbasins that are adjacent to the Eastern San Joaquin Subbasin are also located within San Joaquin County. These land use planning areas are covered by the San Joaquin County General Plan described in Section 1.2.3.1.1.

The City of Tracy, located within San Joaquin County and the Tracy Subbasin, updated its General Plan in 2011. The City of Tracy General Plan identifies the Tracy Subbasin as a source of water supply for the city. The City of Tracy is working towards reducing its reliance on groundwater and reserving its use for emergency situations and droughts (City of Tracy, 2011).

The City of Lathrop, located within San Joaquin County and the Tracy Subbasin, relies on potable water supplies consisting of a combination of groundwater and treated surface water from the South County Water Supply Program. The General Plan for the City of Lathrop was first adopted in 1991 and last amended in 2022. The General Plan reflects the city's long-range aspirations by defining goals and policies for current and future development and by providing guidance on proposed projects.

The City of Modesto, located in Stanislaus County, relies on the Modesto and Turlock Subbasins for its groundwater supplies. The City of Modesto General Plan, last updated in March 2019, identifies historical declining groundwater levels as a result of increased urban demands. While steps have been taken to address groundwater levels, the General Plan calls for continued protection and conservation of groundwater sources while pursuing additional water supplies to meet continued growth (City of Modesto, 2019).

The City of Galt, located in Sacramento County, is on the southern edge of the Cosumnes Subbasin and last updated its General Plan in 2009. Groundwater from the Cosumnes Subbasin is the sole source of water supply for the city. The General Plan outlines policies to ensure groundwater availability and protection (City of Galt, 2009).

The City of Elk Grove, located in Sacramento County, relies heavily on groundwater from the South American Subbasin. To address years of drought conditions and low precipitation, the City of Elk Grove Draft General Plan outlines several goals and policies to protect groundwater supplies while meeting increased water demands from agricultural production and a growing population (City of Elk Grove, 2018).

1.2.3.4 Well Permitting

On 28 March 2022, Governor Newsom signed Executive Order (EO) N-7-22 to amend prior proclamations of states of emergency due to California's ongoing drought conditions. EO N-7-22 required that additional steps be taken by well permitting agencies to approve a permit for the construction of a new well or alternation of an existing well located in a medium- or high- priority basin subject to SGMA. For applicable wells, permitting agencies must obtain written verification from the GSA managing the area of the basin where the proposed well is to be located that the well would not conflict with the GSP or decrease the likelihood of the basin reaching its Sustainability Goal. EO N-7-22 was subsequently rescinded once the drought-related state of emergency was lifted.

On 13 February 2023, Governor Newsom signed EO N-3-23 to keep in place some of the provisions originally contained EO N-7-22 One of the provisions retained by EO N-3-23 is the requirement that well permitting agencies not approve a permit for a new well or alteration of an existing well without first obtaining written verification of GSA approval that groundwater extraction by the proposed well would not be inconsistent with the GSP and the programs it contains. The EO exempts *de minimis* new wells and new wells that replace existing, actively permitted wells with wells that will produce an equivalent quantity of water when the existing well is being replaced because it has been acquired by eminent domain or while under threat of condemnation.

The Basin GSAs are working with the permitting agencies (i.e., counties) to review and provide written verifications for permit applications within their jurisdictions as required under the EO. As described above, several counties have already amended their well permitting processes to incorporate GSA verification.

1.2.3.4.1 San Joaquin County

San Joaquin County oversees a well permitting program for any new, replacement, back-up, and de minimis well construction. The purpose of this program is to prevent groundwater contamination and safety hazards by regulation of the location, construction, repair, and destruction of water supply, monitoring, and geophysical wells and borings. Pursuant to Water Code §13808, all new wells that do not meet the exemption criteria must submit additional information prior to the issuance of a permit by the Environmental Health Department. The permit program is enforced by Ordinance Code of San Joaquin County §9-1115, and Municipal Codes of Stockton, Lodi, Manteca, Tracy, Escalon, and Ripon. Applicants must provide information about groundwater elevation estimates, land elevation estimates, extraction volume estimates, depth of Corcoran Clay, and other basic well characteristics.

San Joaquin County has established water well standards for new wells that define property line setbacks (at least 10 feet depending on well type), casing perforations, gravel packing, well seals, backflow prevention, disinfection requirements, sampling taps, and more, as well as the requirement for installing monitoring device(s) for groundwater extraction, elevation, and/or water quality. Other setbacks for potential sources of contamination or pollution require at least 50 feet depending on the contamination source and well type.

The San Joaquin County Well Standards outline well grouting and construction standards to prevent contamination, pollution, and degradation of water wells and of the groundwater by intrusion of poor-quality water. Wells must have a watertight annular seal near the land surface to keep surface water and other potential contamination out of the well. The minimum depth of the annular seal depth for wells in San Joaquin County is summarized in Table 1-1 (SJC EHD, 1993).

Table 1-1: Minimum Depth of Seal Below Ground Surface for Wells in San Joaquin County

Well Type	Feet
Public Water Supplies	100
Individual Domestic Well	100
Industrial Wells	100
Agricultural Wells	50

In response to EO N-3-23, San Joaquin County updated its well permitting process to require applicants to fill out either a Well Exemption Statement (for exempt wells) or a New Well Information Form (for non-exempt wells). For non-exempt wells, the New Well Information Form is forwarded with the rest of the application to the applicable GSA for review and consideration for a written verification.

1.2.3.4.2 Calaveras County

The Calaveras County Board of Supervisors adopted a well construction and destruction ordinance in 1998. The ordinance mandates that a permit must be obtained from the Calaveras County Environmental Health Department prior to development or modification of any well within the Calaveras County boundaries. The purpose of the program is to regulate the construction, alteration, abandonment, and destruction of wells such that groundwater will not be contaminated and that groundwater supplies will not jeopardize the health, safety, or welfare of Calaveras County residents.

To prevent polluted or contaminated water from entering the well, the well program established a minimum depth at which the annular space should be filled as well as minimum horizontal setback requirements. Horizontal setbacks from property lines range from 10 feet (for small parcels) to 150 feet (for underground storage with nearby wells at least 25 feet away). The minimum annular seal depths for wells in Calaveras County are summarized in Table 1-2 (Calaveras County Board of Supervisors, 2008).

Table 1-2: Minimum Depth of Seal Below Ground Surface for Wells in Calaveras County

Well Type	Feet
Public drinking water well	50
Commercial well	50
Industrial well	50
Individual domestic well	20
Agricultural well	20
Vertical geothermal exchange wells	20
Wells within 25 feet of a water way	20 feet below the bed of the water way

In response to EO N-3-23, Calaveras County updated its well permitting process to require applicants to fill out either a Well Exemption Statement (for exempt wells) or a New Well Information Form (for non-exempt wells). For non-exempt wells, the New Well Information Form is forwarded with the rest of the application to the applicable GSA for review and consideration for a written verification.

1.2.3.4.3 Stanislaus County

Pursuant to Chapter 9.36 of the Stanislaus County Code, well owners must first receive a valid permit from Stanislaus County to construct, install, repair, or destroy any well or well seal within the county. Stanislaus County DER is responsible for reviewing the applications and issuing permits. The Stanislaus County Code also states that all wells must have an annular seal, except for agricultural wells that are not used for domestic purposes and are located more than 300 feet from a domestic well (Stanislaus County, 2019a).

In 2014, the DER adopted a groundwater ordinance to prohibit unsustainable extraction of groundwater in unincorporated areas of the county. The DER reviews each well permit application and determines whether the well is subject to, or exempt from, the prohibitions in the Groundwater Ordinance. Permit applications for wells intended to extract 2 AF/year of groundwater or less are exempt from the prohibitions in the groundwater ordinance (Stanislaus County, 2019b). If the permit applicant is not exempt, a non-exempt wells supplemental application must be submitted and show that the groundwater pumped from the well is being sustainably extracted and will not cause any of the "Undesirable Results" listed in § 97.030 (9) of the groundwater ordinance. Additional permit application fees may be required, and the application review is conducted at the expense of the applicant (Stanislaus County, 2019c).

The minimum annular seal depths for wells in Stanislaus County are summarized in, and are consistent with the state well standards (CA DWR, 1991).

Table 1-3: Minimum Depth of Seal Below Ground Surface for Wells in Stanislaus County

Well Type	Feet
Community water supply well	50
Industrial well	50
Individual domestic well	20
Agricultural well	20
Air conditioning well	20
All other types	20

In response to EO N-3-23, Stanislaus County updated its well permitting process to refer applicable well permits to the GSAs for approval. If a GSA finds that a well permit application is not consistent with requirements in its GSP to prevent Undesirable Results, the applicant must provide substantial evidence that the proposed extraction is will not cause or contribute to their occurrence in accordance with Stanislaus County's Discretionary Well Permitting Implementation Guidelines.

1.2.3.4.4 Sacramento County

Sacramento County, which borders the northern boundary of the Eastern San Joaquin Subbasin (see Figure 1-6), oversees well permitting within their jurisdiction and requires property owners to obtain a permit for work including well construction, modification, repair, inactivation, destruction, installation, and replacement. Each well or pump requires its own permit application and fee, but waivers can be considered for multiple wells or exploratory borings of similar construction (Sacramento County, 2019).

The Sacramento County Code water well standards are designed to meet or exceed the water well standards in DWR's Bulletin 74-81 and 74-90. These standards apply to all types of monitoring wells, vapor extraction wells where applicable, and any other well installed in an area where special precautions are necessary to protect groundwater quality. The Sacramento County Environmental Management Department has the power under special circumstances to grant a variance from provisions in Chapter 6.28 of the Sacramento County Code and to prescribe alternative requirements in their place (Sacramento County, 2019).

The minimum annular seal depth for wells in Sacramento County is 50 feet for all well types, except for in cases of special approval (Sacramento County, 2019).

1.2.4 Additional GSP Elements

The Additional GSP Elements section of the GSP provides GSAs with the opportunity to discuss "any additional Plan elements included in Water Code §10727.4 that the Agency determined to be appropriate". These additional elements include:

- Control of saline water intrusion
- Wellhead protection areas and recharge areas
- Migration of contaminated groundwater
- A well abandonment and well destruction program
- Replenishment of groundwater extractions
- Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage

- Well construction policies
- Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects
- Efficient water management practices, as defined in Water Code §10902, for the delivery of water and water conservation methods to improve the efficiency of water use
- Efforts to develop relationships with state and federal regulatory agencies
- Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity
- Impacts on groundwater dependent ecosystems

Each of the Additional Elements listed are relevant and important to the Eastern San Joaquin Subbasin, and are discussed throughout this GSP, as identified below.

Control of saline water intrusion – Section 2.2.3 describes the current status of saline water intrusion in the Subbasin. Section 3.2.4 addresses seawater intrusion as a sustainability indicator. Actions to identify and monitor for saline water intrusion is described in Section 3.3.3.

Wellhead protection areas and recharge areas – Section 1.2.3.4 addresses wellhead protection programs in San Joaquin County, Calaveras County, and Stanislaus County.

Migration of contaminated groundwater – The migration of contaminated groundwater that may impair water supplies is addressed in Section 3.3.3.

A well abandonment and well destruction program – Requirements and procedures for well destruction and abandonment are discussed in Section 1.2.3.4.

Replenishment of groundwater extractions – Proposed projects and management actions that will facilitate replenishment of groundwater extraction are discussed in Chapter 6: Projects and Management Actions. Areas where potential groundwater replenishment could occur through direct recharge are described in Section 2.1.4.5.

Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage – Existing conjunctive use projects are identified in Section 1.2.2.9. The proposed projects and management actions that will address implementing, opportunities for, and removing impediments to, conjunctive use or underground storage projects in the Subbasin are discussed in Chapter 6: Projects and Management Actions.

Well construction policies – Section 1.2.3.4 addresses well construction policies in San Joaquin County, Calaveras County, and Stanislaus County. Annular well seal depth requirements are tabulated in Tables 1-1, 1-2, and 1-3.

Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects – Proposed projects and management actions that address groundwater recharge, in-lieu use, diversions to storage, conservation, and water recycling are discussed in Chapter 6: Projects and Management Actions.

Efficient water management practices, as defined in Section 10902, for the delivery of water and water conservation methods to improve the efficiency of water use – Ongoing efforts to implement efficient water management practices are described in Section 1.2.2.7. Conservation methods and efficiency of water use are also noted in many local or regional general plans, detailed in Section 1.2.3. Projects relevant to this topic are discussed in Chapter 6: Projects and Management Actions.

Efforts to develop relationships with state and federal regulatory agencies – A strong relationship between the GSAs and existing regulatory agencies is valuable to the success of this GSP. Efforts to develop this relationship are described in Chapter 7: Plan Implementation.

Processes to review land use plans and efforts to coordinate with land use planning agencies to assess activities that potentially create risks to groundwater quality or quantity – Summaries of land use plans both inside the Subbasin and in nearby Subbasins can be found in Section 1.2.3. Efforts are being made at the local level to develop a formal opportunity for GSAs to provide input on the land use and water-related elements of future General Plans and California Environmental Quality Act (CEQA) documentation to promote consistency with the GSP.

Impacts on groundwater dependent ecosystems – Groundwater dependent ecosystems (GDEs) are defined in Section 2.2.7. The methodology for identifying GDEs can be found in Section 2.2.7.1. A map of identified GDEs in the Subbasin is shown in Section 2.2.7.2. Adverse impacts to GDEs are described under Depletions of Interconnected Surface Water, Section 3.3.6, as part of the undesirable results discussion.

1.3 NOTICE AND COMMUNICATION

1.3.1 Beneficial Uses and Users in the Basin

The CVRWQCB designates all groundwaters in the Sacramento River Basin and San Joaquin River Basin as suitable or potentially suitable, at a minimum, for municipal and domestic water supply, agricultural supply, industrial service supply, and industrial process supply (CVRWQCB, 2016).

As listed in Water Code §10723.2, beneficial uses and users of groundwater in the region include the following interests:

- Agricultural users and domestic well owners that hold overlying groundwater rights.
- Public water systems/municipal well operators in the Subbasin.
- Community water systems (wells serving 15 or more connections or more than 25 people per day). 433 community water systems were identified in the Eastern San Joaquin Subbasin and are presented in Appendix 1-E Of these 433 community water systems, 182 are located in DAC or SDAC areas, shown also in Appendix 1-E.
- Local agencies that have land use planning jurisdiction. These include counties of San Joaquin, Calaveras, and Stanislaus, and cities of Stockton, Lodi, Manteca, Escalon, and Ripon.
- Environmental users of groundwater, including species and habitat reliant on instream flows, as well as wetlands and GDEs. Identified GDEs are mapped in Figure 2-69 in Section 2.2.7.2. Freshwater species in the Eastern San Joaquin Subbasin are listed in Appendix 1-G.
- Irrigation districts in the Subbasin that divert surface water to deliver to their customers.
- Lands managed by the federal government. The San Joaquin River National Wildlife Refuge lies just outside of the Subbasin boundary. While managed by the State of California, Caswell Memorial SP is in the Subbasin and Carnegie SVRA and Franks Tract SRA are situated just outside of the Subbasin.
- DACs and SDACs. DACs and SDACs are mapped in Figure 1-8 and are primarily in the western portions of the Subbasin. Approximately 27 percent of the Subbasin area is considered disadvantaged and 5.4 percent is considered severely disadvantaged. 33 percent of the Subbasin population is considered either DAC or SDAC; within that, 16.5 percent of the population is SDAC. DACs include the following census designated

places (CDPs)[1]: Stockton City CDP, Terminous CDP, Taft Mosswood CDP, and French Camp CDP. Severely disadvantaged communities include: Kennedy CDP, August CDP, Garden Acres CDP, and Thornton CDP.

- Entities that monitor and report groundwater elevations. Monitoring in the Subbasin is extensive. A list of monitoring agencies can be found in Section 1.2.2.
- California Native American tribes

1.3.2 List of Public Meetings Where the 2024 GSP was Discussed

During the 2024 update of the ESJ GSP, meetings of the ESJGWA Board and Steering Committee were open to the public with meeting information noticed, as appropriate, and posted to the ESJGWA website (discussed below in Section 1.3.4.2.2). In addition, public meetings and an informational open house event were held throughout the GSP update process (see Section **Error! Reference source not found.**).

Below is a list of the public meetings where elements of this 2024 GSP Amendment were discussed.

Meeting Type	Date
Steering Committee Meeting	November 8, 2023
Steering Committee Meeting	December 13, 2023
ESJGWA Board Meeting	January 10, 2024
Steering Committee Meeting	March 13, 2024
ESJGWA Board Meeting	March 13, 2024
Steering Committee Meeting	April 10, 2024
ESJGWA Board Meeting	June 12, 2024
Stakeholder Advisory Workgroup Meeting #1	June 27, 2024
Stakeholder Advisory Workgroup Meeting #2	July 17, 2024
Steering Committee Meeting	August 14, 2024
ESJGWA Board Meeting	August 14, 2024

[1] A census designated place is a concentration of population identified by the United States Census Bureau for statistical purposes. CDPs are delineated for each decennial census as the statistical counterparts of incorporated places, such as cities, towns, and villages.

Meeting Type	Date
Steering Committee Meeting	September 11, 2024
GSA Open House	September 25, 2024
ESJGWA Board Meeting	December 11, 2024

1.3.3 Decision-Making Process

The ESJGWA Board is tasked with the vote and approval of policy decisions for the development and implementation of this GSP. The ESJGWA Board receives input from the Steering Committee, the PMC, and the public, as described in Section 1.1.4.2.

The governing bodies of each of the individual GSAs take action and provide direction to their Board member representatives and must individually adopt the final GSP Amendment. Projects will be administered by the GSA project proponents. Although the ESJGWA does not provide direct authority to require GSAs to implement projects, the ESJGWA will be working on GSA-level water budgets and evaluating the best ways to evaluate progress. Work toward implementing projects and management actions is further described in Sections 6.2 and 6.3, respectively. If the implementation of projects is not sufficient to achieve sustainability goals, a demand management policy, included as a management action in the 2024 GSP Amendment, provides a framework for how the GSAs of the Subbasin plan to achieve sustainability through other means. A description of the agencies that comprise the GSAs can be found in Section 1.1.4.3.

1.3.4 Opportunities for Public Engagement and How Public Input was Used

Throughout the process of the initial development of the GSP and this particular update, the ESJGWA engaged both stakeholders and the public. This effort has been greatly aided by the facilitation support provided through DWR's Facilitation Support Services Program. In some cases, outreach and engagement opportunities were specific to the initial development of the 2020 GSP; these are detailed in Section 1.3.4.1. In other cases, outreach and engagement opportunities began during the 2020 GSP development process and have been adapted or modified for this 2024 GSP Amendment; these are discussed in Section 1.3.4.2.

1.3.4.1 Opportunities Specific to the 2020 GSP Development Process

1.3.4.1.1 Groundwater Sustainability Workgroup

When developing the initial 2020 GSP, the ESJGWA convened a Workgroup in order to promote stakeholder input and relied upon the Workgroup when developing the 2020 GSP. The Workgroup began with an application process to ensure a diverse cross section of populations were represented to serve on the Workgroup. Workgroup members participated and provided valuable input throughout the 2020 GSP development process.

Applications were distributed to organizations within every GSA to establish a Workgroup that represented the region's broad interests, perspectives, and geography. The Workgroup included members from a variety of organizations who represent one or more of the interested parties' groups. Table 1-4 lists the organizations and interests represented on the Workgroup. While this Workgroup was not active during the 2024 GSP amendment process, the information collected during their involvement remains relevant and a guiding factor in this update and GSP implementation activities.

Table 1-4: Groundwater Sustainability Workgroup Interests (Collected During Development of 2020 GSP)

Eastern San Joaquin Groundwater Authority
Groundwater Sustainability Workgroup – Interests Represented

AG	Agricultural	BUS	Business
CM	Community Neighborhood	DAC	Disadvantaged Communities
ENV	Environmental	INST	Institutional
FM	Flood Management	NA	Native American
GU	Groundwater User		

Role/Organization	AG	BUS	CM	DAC	ENV	FM	GU	INST	NA	Application Notes
2Q Farming	✓		✓			✓				2Q Farming is interested in making a difference for agriculture and communities, and in preserving water rights for future generations so they will have the ability to irrigate and access the water necessary for life.
Agricultural Business – Farmer Representative	✓	✓	✓	✓	✓	✓	✓			As a representative of agricultural business, this member sees SGMA as an opportunity to manage the Subbasin while keeping jurisdiction, implementation, monitoring, and oversight at the local level.
Calaveras County Resource Conservation District	✓		✓	✓	✓	✓	✓	✓		Calaveras County RCD hopes to partner with groundwater users in the western part of Calaveras County to address sustainability and recharge.
California Sportfishing Protection Alliance	✓				✓	✓	✓	✓		California Sportfishing Protection Alliance, longtime Mokelumne River stakeholder, is interested in reducing groundwater overdraft, managing surface water responsibly, and resolving longstanding conflicts. Representative is interested in the technical aspects of groundwater management and gaining a better understanding of recharge.

Eastern San Joaquin Groundwater Authority
Groundwater Sustainability Workgroup – Interests Represented

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FM	Flood Management	NA	Native American
GU	Groundwater User		

Role/Organization	AG	BUS	CM	DAC	ENV	FM	GU	INST	NA	Application Notes
Catholic Charities of the Diocese of Stockton			✓	✓	✓	✓	✓			The Environmental Justice Program of the Catholic Charities of the Diocese of Stockton works with disadvantaged communities. Some of these communities have concerns regarding drinking water quality and toxic contamination of groundwater supplies.
Environmental Justice Coalition for Water			✓	✓		✓	✓			The Environmental Justice Coalition for Water is interested in ensuring that environmental justice interests are present, informed, and meaningfully engaged in a process that bears considerable importance for health, wealth, and growth.
J.R. Simplot Co.	✓	✓			✓					As a local industry representative with a stake in groundwater quality, this representative sees benefit in being part of the stakeholder process.
Lima Ranch	✓	✓			✓	✓	✓			Lima Ranch views water as a precious commodity that must be conserved and used sustainably. Representative values preserving water rights and using water efficiently.
Machado Family Farms	✓		✓				✓			Representative manages a family farm and brings agricultural experience and experience with the California Public Utilities Commission to provide a balanced perspective.
Manufacturers Council of the Central Valley	✓	✓			✓	✓	✓			Through their involvement as a stakeholder, Manufacturer's Council of the Central Valley provides resources to manufacturers impacted by the implementation of GSPs and to GSAs looking to work with the sector.

Eastern San Joaquin Groundwater Authority
Groundwater Sustainability Workgroup – Interests Represented

AG	Agricultural	BUS	Business
CM	Community Neighborhood	DAC	Disadvantaged Communities
ENV	Environmental	INST	Institutional
FM	Flood Management	NA	Native American
GU	Groundwater User		

Role/Organization	AG	BUS	CM	DAC	ENV	FM	GU	INST	NA	Application Notes
Restore the Delta			✓	✓	✓	✓	✓			Representative is interested in the link between surface water flows for the Sacramento-San Joaquin Delta and groundwater management. Additionally, this member brings connections for broad environmental justice outreach.
San Joaquin Audubon					✓					San Joaquin Audubon is interested in overall water use and environmental issues.
San Joaquin County Environmental Health Department			✓		✓		✓			The San Joaquin County Environmental Health Department plays a role in protecting the area's groundwater resource, drinking water, and public health.
San Joaquin Farm Bureau	✓	✓	✓			✓	✓			The San Joaquin Farm Bureau is interested in helping manage and utilize the groundwater reservoir to better supply all needs for the short and long term.
Sequoia ForestKeeper					✓					Sequoia ForestKeeper has been submitting comments on water-related issues to the SWRCB since 2015.
Sierra Club - Delta-Sierra Group	✓		✓	✓	✓	✓	✓			Sierra Club cares about the future of the Eastern San Joaquin Subbasin and sustainability. They believe that representation of individuals is lacking and there is insufficient outreach.
Spring Creek Golf & Country Club		✓	✓		✓	✓	✓			Representative is golf course superintendent at Spring Creek Golf & Country Club and is interested in groundwater rights and contributing to the stakeholder Workgroup.

Eastern San Joaquin Groundwater Authority Groundwater Sustainability Workgroup – Interests Represented										
AG Agricultural CM Community Neighborhood ENV Environmental FM Flood Management GU Groundwater User	BUS Business DAC Disadvantaged Communities INST Institutional NA Native American									
Role/Organization	AG	BUS	CM	DAC	ENV	FM	GU	INST	NA	Application Notes
The Hartmann Law Firm	✓	✓	✓			✓	✓			Representative is Advisory Water Commissioner, District Counsel for multiple reclamation districts.
The Wine Group	✓	✓			✓		✓			The Wine Group has technical knowledge and provides a unique viewpoint that supports the successful development of a GSP for the Eastern San Joaquin Subbasin.
Trinchero Family Estates and Sutter Home Winery	✓	✓	✓		✓		✓			Trinchero Family Estates and Sutter Home Winery is interested in helping develop a balanced approach for communities and businesses.
University of the Pacific		✓	✓			✓				Representative is an Emeritus Professor of Operations/Engineering Management at the University of the Pacific and is engaged in research on stream flow diversion for groundwater recharge.

1.3.4.1.2 Situation Assessment

During development of the initial 2020 GSP, the ESJGWA applied for and received facilitation support through DWR's Facilitation Support Services Program to conduct a Situation Assessment, the purpose of which was to facilitate the stakeholder engagement process by determining stakeholder concerns related to the GSP development process. The facilitation services supported third-party interviews conducted with the members of the Workgroup in the winter of 2018 as part of the Situation Assessment. All Workgroup members were invited to participate in the Situation Assessment, and 17 were interviewed during a series of in-person and phone interview sessions. Assessment summary and highlights are available on the ESJGWA website.

Situation Assessment questions covered topics including:

- Outreach and engagement approach
- Meeting presentations
- Meeting discussions
- Strengthening the Workgroup process
- Decision making and input
- GSP development and plan content
- Resource and management conditions data
- Implementation considerations

Based on Situation Assessment findings, changes were made to the 2020 GSP development process, including meeting presentations and discussions, the draft GSP, and its review schedule.

1.3.4.2 Continuing Opportunities for Public Engagement

The sections below detail the opportunities for public engagement that were specific to this 2024 GSP Amendment. Many began with the development of the initial 2020 GSP and have been continued and modified as appropriate to fit the needs of this particular GSP Amendment process.

1.3.4.2.1 Communication and Engagement Plan

With the support of the Workgroup, the ESJGWA developed an initial Stakeholder Outreach and Engagement Plan in June 2018 during the development of the 2020 GSP. This plan was updated as part of the 2024 GSP amendment process and renamed the Eastern San Joaquin Communication and Engagement Plan (C&E Plan). The ESJGWA supported the update of this Plan (see Appendix 1-H) for the San Joaquin Subbasin, which details communications and engagement recommendations for GSAs to consider as the GSP continues to be implemented and the needs of interested parties in the region evolves. The original goals of the Outreach and Engagement Plan are still relevant in the recent iterations of this plan:

- Keep interested list of stakeholders informed and aware of opportunities for involvement through email communications and/or their preferred mode of communication
- Engage DWR for facilitated support to aid in the development of the GSP
- Open ESJGWA planning efforts to the public with agendas and meeting minutes published on the ESJGWA website

- Inform and obtain comments from the general public through public meetings held on an approximately quarterly basis
- Facilitate productive dialogue among participants at Advisory Committee, Workgroup, and public meetings through the use of qualified facilitators to obtain, consider, and integrate feedback accordingly throughout the planning process
- Seek the input of interest groups during the implementation of the GSP and any future planning efforts
- Obtain input about preferred locations to conduct public informational meetings to reach diverse audiences and disadvantaged communities
- Provide timely and accurate public reporting of planning milestones through the distribution of outreach materials and posting of materials on the ESJGWA website for the GSP
- Secure quality media coverage that is accurate, complete, and fair
- Maintain an active communications tracking tool to capture stakeholder engagement and public outreach activities and to demonstrate the reporting of GSP outreach activities

The ESJGWA used various methods to engage with and solicit input from interested parties during the 2020 GSP development process. In order to evolve the updated C&E Plan with the needs of the community, the development process started with a review of previously established commitments made by Subbasin GSAs and the ESJGWA in various SGMA-related documents and by the needs and ideas presented by interested parties. Seven individual or small group interviews were conducted between March and July of 2023 with key interested parties in the Subbasin to gather feedback on communication and engagement strategies taken during GSP implementation. Interviewees represented diverse interests, including disadvantaged communities, municipal and industrial, agricultural, domestic well, and those representing environmental water users.

Gaps or inefficiencies throughout GSP implementation were identified, showing a consistent lack of adequate support in key areas:

- Concerns over Demand Management Program: Respondents expressed concerns about potential demand reduction strategies that could be overly restrictive and disruptive to their lives and livelihoods.
- Lack of Clarity on Sustainability Approaches: There was a perceived lack of clear answers and progress regarding long-term sustainability approaches.
- Cost Concerns: High water management costs and increased water rates were a concern, indicating a lack of public understanding around GSAs approach to funding.
- Bureaucratic Processes: Respondents noted overly bureaucratic processes that might limit the effectiveness of the GSAs and the ESJGWA if things escalate beyond the local level.
- Lack of Consistency and Transparency: There was a significant lack of consistency and transparency, particularly in how, where, and when GSAs share information and engage with each other and the public.

In order to address these key areas, the C&E Plan details the following strategies that could be implemented or expanded:

- Communications and Engagement Tracker: A strategy that involves the GSAs establishing a record-keeping system to catalogue the type and timing of outreach activities, enhancing their level of organization and compliance with requirements, with the support of the ESJGWA where necessary and feasible.

- Outreach Toolkit: A comprehensive approach by the GSAs to create a suite of standardized outreach materials and a library of relevant guides, aiming to ensure consistent messaging and best practices in communications and engagement, with the support and coordination of the ESJGWA.

- Interested Parties Database: GSAs create a shared and comprehensive database, supported by the ESJGWA, to distribute information tailored to different jurisdictions and audiences, with the database managed by a third-party platform for easy maintenance, access, and tracking of public engagement.

- Targeted Outreach: GSAs, in compliance with applicable regulations, implement specific efforts to identify, contact, educate, and engage with underrepresented groundwater users and non-English speakers on groundwater resource management, with coordination and collaboration support from the ESJGWA.

- Workgroups and Committees: GSAs, in compliance with applicable regulations, consider establishing a committee or workgroup focused on small and underrepresented communities to engage on well protection and other related projects affecting these groundwater users, with support from the ESJGWA,

- Native American Heritage Commission: GSAs submit and receive a Tribal and Sacred Land tribal contact list to the Native American Heritage Commission, ensuring they stay informed and in contact with recognized Indigenous communities in the region, a core component of inclusive engagement, especially for project implementation, with support from the ESJGWA

- Website Management: GSAs, in compliance with applicable regulations, establish and maintain web pages on their own or the ESJGWA websites, containing clear and accessible information, updates, and resources related to groundwater management, with the choice of management depending on the GSAs' comfort and discretion.

- Enterprise Management System Management and Transparency: GSAs and/or the ESJGWA, in compliance with applicable regulations, maintain a catalog of data management systems and publish their methodology for maintaining and using the collected data, ensuring full transparency.

- Comment Portal: GSAs and/or the ESJGWA, in compliance with applicable regulations, establish, maintain, and respond to public comments through an email contact portal, which collects data on the commenter and allows for categorization of comments, with links to the portal clearly available on their websites.

- Funding and Financing: ESJGWA, in compliance with applicable regulations, coordinate with its member agencies to evaluate funding, grant, or in-kind support resources for facilitation, media relations, or outreach coordination services, supporting the addition of new staff or a dedicated outreach coordinator for the Subbasin to enhance communications and engagement efforts related to GSP implementation.

- Outreach Coordinator: Recommendation to contract with an outreach coordinator to assist the ESJGWA and its member agencies with the tactics listed in the C&E Framework and any other ongoing communications and engagement efforts in the Subbasin, in compliance with all applicable codes and regulations.

1.3.4.2.2 ESJGWA Website

The ESJGWA website has been online since 2018 and continues to be maintained on a regular basis at www.esjgroundwater.org. It contains an introduction to SGMA, details on member agencies, and ESJGWA Board updates with meeting information and materials posted regularly. There are detailed sections for GSP resources, technical reports and data, educational materials, and meeting notices with the accompanying presentation materials and minutes. A section of the website is devoted to press releases, newsletters, public notices, and other major events and accomplishments. Contact information is readily available for interested parties to communicate with ESJGWA members and staff, and members of the public can subscribe to the ESJGWA mailing list to receive updates on GSP development and outreach events. Improvements to the website itself and the approach for its use will be continuously updated to meet the public engagement goals of the Subbasin.

1.3.4.2.3 Stakeholder Database

The ESJGWA developed a database of stakeholders who represent the region's interests, perspectives, and geography. The database was developed by leveraging existing stakeholder lists and databases from prior Eastern San Joaquin Subbasin engagement efforts, conducting new research, and obtaining referrals from key stakeholders and stakeholder groups.

During the initial development of the stakeholder database, the ESJGWA worked with those responsible for implementing the GSP to obtain contact lists of interested parties within the Subbasin as well as other diverse contact lists they maintain.

This robust stakeholder list of interested parties includes, but is not limited to, the following:

- Community water systems
- Agricultural well owners
- Domestic well owners
- Municipal well operators
- Groundwater users (including agricultural)
- Local land use planning agencies
- Government agencies
- Nonprofit organizations
- Environmental organizations
- Higher education institutions
- Community based organizations
- Neighborhood organizations
- California Native American Tribes
- Disadvantaged communities
- Private citizens

The Stakeholder Database has been regularly updated by adding additional parties who expressed interest at public meetings and through website signups. Contacts were updated or removed as needed. The database continues to serve as the foundation for targeted outreach and communication and was also used to:

- Provide a single repository to collect, store, and organize information on Subbasin stakeholders
- Allow individuals to self-identify their SGMA interests when they sign up as an interested stakeholder
- Identify the interests and concerns of organization contacts and individual stakeholders

- Plan meetings and send notices to stakeholders based upon their identified interests and role
- Document all stakeholders invited to GSP development meetings and their primary input at the meetings
- Post meeting agendas and minutes
- Produce communication and engagement summary reports

Table 1-5 provides a summary breakdown of the number of parties and interests represented in the Stakeholder Database.

Table 1-5: Stakeholder Database Summary

Eastern San Joaquin Groundwater Authority Stakeholder Database	
Interest Represented	Number of Stakeholders
Government Agency (i.e. County, State)	64
Business (i.e. Consultant, Local Business, Legal Representation)	41
Nonprofit (i.e. Environmental Organization, Thinktank)	5
Higher Education	3
Community Based Organization (i.e. Farm Bureau)	2
Water Purveyors (i.e. Public Utilities, Irrigation Districts)	77
No Affiliation Provided	93
Total	**285**

Outreach materials promoting informational open house events were distributed via email to the stakeholder database, and hard copies were distributed to this list throughout implementation process since the 2020 GSP.

The following section describes the stakeholder education and outreach activities completed during the development of the 2024 GSP Amendment.

1.3.4.2.4 Stakeholder Education and Outreach

Recognizing that an inclusive outreach and education process supports the success of a well-prepared GSP, the ESJGWA has prioritized stakeholder involvement and outreach in plan development and implementation, dedicating staff and financial resources for this high-priority effort.

- The ESJGWA held two public Stakeholder Advisory Workgroup (SAW) meetings and one informational open house event devoted to SGMA outreach and providing information to the public on the 2024 GSP Amendment development process. The purpose was to provide participants with information on GSP development, seek feedback from stakeholders and the public, provide a forum for the public to interact with their GSA representatives, and address questions in a transparent manner. These events were held on an approximately quarterly basis in different locations throughout the Subbasin, as listed below.
  - o June 26, 2024 – Robert J. Cabral Agricultural Center, Stockton (23 attendees)
  - o July 17, 2024 – Robert J. Cabral Agricultural Center, Stockton (18 attendees)
  - o September 25, 2024 – Robert J. Cabral Agricultural Center, Stockton (40 attendees)
- Additionally, GSA member agencies hosted local informational community meetings related to the SGMA process and to publicize the release of the Public Draft GSP for public comment.

- Individually, member GSAs provided targeted outreach materials to their constituencies through the distribution of outreach and informational materials
- Community events, including guided tours of facilities for the community, grower outreach meetings, and a tour for community leaders, were held to promote recharge projects and plans, and discuss challenges.
- Member GSAs provided SGMA and project related updates to their Boards and other leadership bodies, including the Water Advisory Committee and the Linden-Peters Chamber of Commerce.
- Factsheets, email announcements, and newsletters were used to raise awareness about topics and events relevant to the GSP and SGMA.
- Social media channels, such Facebook, were used to distribute targeted information relevant to SGMA, the GSP, and specific projects.
- Comment cards, provided in postcard format at the public informational open house, allowed the public and stakeholders to contribute written comments, solicit additional information, make suggestions, and submit other feedback as appropriate.

1.3.4.2.5 Incorporation of Stakeholder Feedback

The development of this GSP was informed and supported by stakeholder feedback, which was documented, addressed, and incorporated at numerous points throughout the development process. The public was invited to provide input at each Steering Committee and ESJGWA Board meeting. Information provided for GSP development was refined based on input from public meetings. Stakeholder involvement was additionally supported through the two public meetings and the open house held in September 2024 to solicit input on the draft Amended GSP from a wide range of beneficial users of groundwater in the Subbasin. Questions raised by participants at these meetings were addressed and, as needed, follow-up content presented and discussed at subsequent meetings.

In addition to influencing GSP development and decisions related to groundwater management, feedback from stakeholders played a key role in enhancing education and outreach efforts, and the stakeholder involvement process more broadly. Interviews in the initial stages of the C&E Plan development and survey responses received during the later stages, both provided valuable insight into how engagement can be improved. The second in-person SAW meeting also yielded some feedback, centering on two areas.

- How to fund efforts toward sustainability, both at the GSA level and the ESJGWA level.
- How to increase involvement of more diverse interests beyond water managers.

1.3.4.2.6 Draft 2024 GSP Amendment Public Comment Review Period

The Public Draft 2024 GSP Amendment was posted on the ESJGWA website for a 31-day public comment period from October 1, 2024 through October 31, 2024. Notices and press releases were provided in English and Spanish publicizing the public comment period and inviting members of the public to attend the September 2024 informational open house event for more information. This event was scheduled to align with the release of the Public Draft 2024 GSP Amendment to provide a forum for the public to receive information, ask questions, and provide input. Hard copies were made available upon request.

The ESJGWA received 52 public comment submissions from a range of interested parties, including non-government organizations, neighboring subbasins, ESJGWA GSAs, state and federal agencies, and others. These individuals and organizations are listed below, and comments are provided in Appendix 1-I.

- Barton Ranch, Inc.

- Calaveras County Water District
- California Department of Fish and Wildlife
- City of Stockton
- Sierra Club, Delta-Sierra Group
- NV5
- Restore the Delta

The PMC was responsible for reviewing and summarizing public comments, and drafting proposed response to comment recommendations for approval by the ESJGWA Board. The ESJGWA's responses to comments are provided in Appendix 1-J.

1.3.5 Inter-basin Coordination

As part of the SGMA process, stakeholder outreach includes inter-basin coordination efforts. To date, ESJGWA has participated in the San Joaquin Valley Point of Contacts (SJC POC) meetings hosted quarterly, as well as initial introductory meetings with its neighboring subbasins. Given that the ESJ Subbasin was the first of its neighbors to submit a plan, the majority of neighboring basins were not in a position to begin meaningful coordination until recently. There have been discussions about the establishment of annual meetings between representatives of the ESJGWA and the neighboring subbasins to begin a more formal coordination process. The purpose of these coordination meetings will be to share and discuss elements relevant to the subbasins, including water budget estimates, boundary flow assumptions, shared interconnected surface waters, and minimum thresholds.

A summary of the initial inter-basin coordination meetings with neighboring subbasins is below.

- Cosumnes Subbasin – April 15, 2019
- Tracy Subbasin – June 20, 2019
- Modesto Subbasin – July 10, 2019
- South American, Solano, and East Contra Costa Subbasins – July 19, 2019
- Tracy Subbasin – September 25, 2024

To establish these annual coordination meetings, the ESJGWA plans to reach out to neighboring subbasins as part of GSP implementation to set more formal coordination between neighboring subbasins.

1.3.6 Notice of Intent to Adopt the GSP

A Notice of Intent (NOI) to adopt a GSP was signed by the Plan Manager on behalf of the GSAs and distributed on July 24, 2024. The NOI was posted to the ESJGWA website homepage and hard copies were mailed cities and counties within the Subbasin, including the following:

- County of Calaveras
- County of Stanislaus
- County of San Joaquin
- City of Escalon

- City of Manteca
- City of Ripon
- City of Stockton

The signed NOI is provided in Appendix 1-K.

ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Basin Setting

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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Acronyms

µg/L	micrograms per liter
1,2,3-TCP	1,2,3-Trichloropropane
AEM	airborne electromagnetic
AF	acre-feet
AF/day	acre-feet per day
AF/year	acre-feet per year
B.P.	before present
bgs	below ground surface
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylenes
C2VSim-FG	California Central Valley Simulation Model – Fine Grid
CALSIMETAW	California Simulation of Evapotranspiration of Applied Water
CalTrans	California Department of Transportation
CASGEM	California Statewide Groundwater Elevation Monitoring
CC	climate change
CCR	California Code of Regulations
CCWD	Calaveras County Water District
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CGPF	CalSim II Generated Perturbation Factors
CGPS	continuous global positioning system
CNRA	California Natural Resources Agency
CSJWCD	Central San Joaquin Water Conservation District
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWC	California Water Code
DBCP	1,2-dibromo-3-chloropropane
DDW	Department of Drinking Water
Delta	Sacramento-San Joaquin River Delta
DOGGR	Division of Oil, Gas, and Geothermal Resources
DPC	Delta Protection Commission
DPW	San Joaquin County Department of Public Works
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
EDB	ethylene dibromide
ESJGWA	Eastern San Joaquin Groundwater Authority
ESJWRM	Eastern San Joaquin Water Resources Model
ETo	evapotranspiration
ft/mi	feet per mile
GAMA	Groundwater Ambient Monitoring and Assessment
GCM	global climate model
GDE	groundwater dependent ecosystem
GIS	Geographic Information System
gpd	gallons per day
gpm	gallons per minute
GSA	groundwater sustainability agency
GSP	Groundwater Sustainability Plan
HCM	Hydrogeologic Conceptual Model
IDW	inverse distance weighted

ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
ISW	interconnected surface water
IWFM	Integrated Water Flow Model
LOCA	local analogs
MAF	million acre-feet
MAR	managed aquifer recharge
MCL	maximum contaminant level
mg/L	milligrams per liter
MSL	mean sea level
MtBE	methyl tertiary-butyl ether
MWH	Montgomery Watson Harza
NAD 83	North American Datum of 1983
NAVD 88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NRCS	Natural Resource Conservation Service
NSJWCD	North San Joaquin Water Conservation District
OID	Oakdale Irrigation District
OSWCR	Online System for Well Completion Reports
PCBL	Projected Conditions Baseline
PCE	perchloroethylene
pdf	portable document format
PFOA	perfluorooctantoic acid
PFOS	perfluorooctanesulfonic acid
PMA	Projects and Management Actions
PRISM	Precipitation-Elevation Regressions on Independent Slopes Model
RCP	representative climate pathways
RL	Reporting Limit
RWQCB	Regional Water Quality Control Board
SAGBI	Soil Agricultural Groundwater Banking Index
SEWD	Stockton East Water District
SGMA	the Sustainable Groundwater Management Act
SJCFCWCD	San Joaquin County Flood Control and Water Conservation District
SJV	San Joaquin Valley
SMCL	secondary maximum contaminant levels
SOPAC	Scripps Orbit and Permanent Array Center
SS	specific storage
SSJID	South San Joaquin Irrigation District
SWRCB	State Water Resources Control Board
SY	specific yield
TAFY	thousand acre-feet per year
TCE	trichloroethene
TDS	total dissolved solids
TNC	The Nature Conservancy
UNAVCO	University Navstar Consortium
UNGL	University of Nevada Geodetic Laboratory
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

UWMPs	Urban Water Management Plans
VIC	Variable Infiltration Capacity
VOC	volatile organic compound
WDL	Water Data Library
WDR	waste discharge requirement
WID	Woodbridge Irrigation District
WRIMS	Water Resource Integrated Modeling System
WY	water year

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2. BASIN SETTING

This Basin Setting chapter contains three main sections as follows:

- Hydrogeologic Conceptual Model – Section 2.1 (Hydrogeologic Conceptual Model) provides the geologic information needed to understand the framework under which water moves through the Subbasin. It focuses on geologic formations, aquifers, structural features, and topography.
- Current and Historical Groundwater Conditions – Section 2.2 (Historical Groundwater Conditions) and Section 2.3 (Current Groundwater Conditions) describe and present groundwater trends, levels, hydrographs and level contour maps, estimated changes in groundwater in storage, identify groundwater quality issues, address land subsidence, and address surface water interconnection.
- Water Budgets – Section 2.4 (Water Budgets) describes the data used to develop the water budget. This section also discusses how the water budgets were calculated and provides water budget estimates for historical conditions, current conditions, and projected conditions.

2.1 HYDROGEOLOGIC CONCEPTUAL MODEL

2.1.1 Data Compilation

This section describes the hydrogeologic conceptual model (HCM) for the Eastern San Joaquin Subbasin (Subbasin), as was included in the 2020 Groundwater Sustainability Plan (GSP) and reconsidered during the 2024 Periodic Evaluation. The regulatory framework is based on the California Code of Regulations (CCR) Title 23 § 354.14. The HCM presents the physical characteristics used to define water movement throughout the Subbasin.

Data supporting development of the Eastern San Joaquin Subbasin HCM is available to the public from a variety of local, state, and federal agencies, as well as from non-governmental entities. The data presented herein were compiled from numerous studies conducted in the eastern portion of the San Joaquin Valley (SJV). Information from several online databases that support ongoing monitoring and development of the groundwater resources within the Eastern San Joaquin Subbasin and across California were amassed, digitized, evaluated, and reconfigured in support of the HCM. Most information was compiled during the development of the 2020 GSP. Where new data available between 2020 and 2024 provide additional information to the HCM, it has been incorporated into this chapter. New data support the original understanding of the Subbasin HCM and therefore, the original HCM remains in the 2024 GSP with additional detail incorporated where additional insights can be made.

To accomplish the data compilation task, software programs such as Microsoft Excel, ArcGIS, QGIS, CrossView, and Python[1] platforms for entering, storing, displaying, and evaluating the volume of data available were used. The following subsections describe the online programmatic databases from which much of the data were sourced and provide insight on the unique obstacles within each.

2.1.1.1 Groundwater Level Data

The California Statewide Groundwater Elevation Monitoring (CASGEM) and San Joaquin County monitoring well networks provided the basis for determining groundwater levels across the Eastern San Joaquin Subbasin in the 2020 GSP. CASGEM maintains a website that allows users to download site locations and groundwater level information. San Joaquin County's monitoring well data came from the San Joaquin County Flood Control and Water Conservation District (SJCFCWCD).

[1] Python version 3.11 was used as well as the Pandas, NumPy, Matplotlib, GeoPandas, Rasterio, Shapely, and cmocean packages

Since the 2020 GSP, all groundwater level data have been centralized in the California Department of Water Resource's (DWR) Water Data Library (WDL) database. Well information can be found in WDL, and all available historical data can be downloaded for each well.

There are approximately 1,000 unique wells across the Eastern San Joaquin Subbasin. Despite the large number of wells, horizontal and vertical data gaps still exist. Large areas of the Subbasin contain very few wells, particularly in the northwest and southeast portions of the Subbasin (see Figure 2-1).Substantial efforts have been made to fill these data gaps since the 2020 GSP. Section 7.1 describes what has been done as part of GSP implementation between 2020 and 2024 to address these gaps.

Figure 2-1: Depth of All Wells in Water Data Library

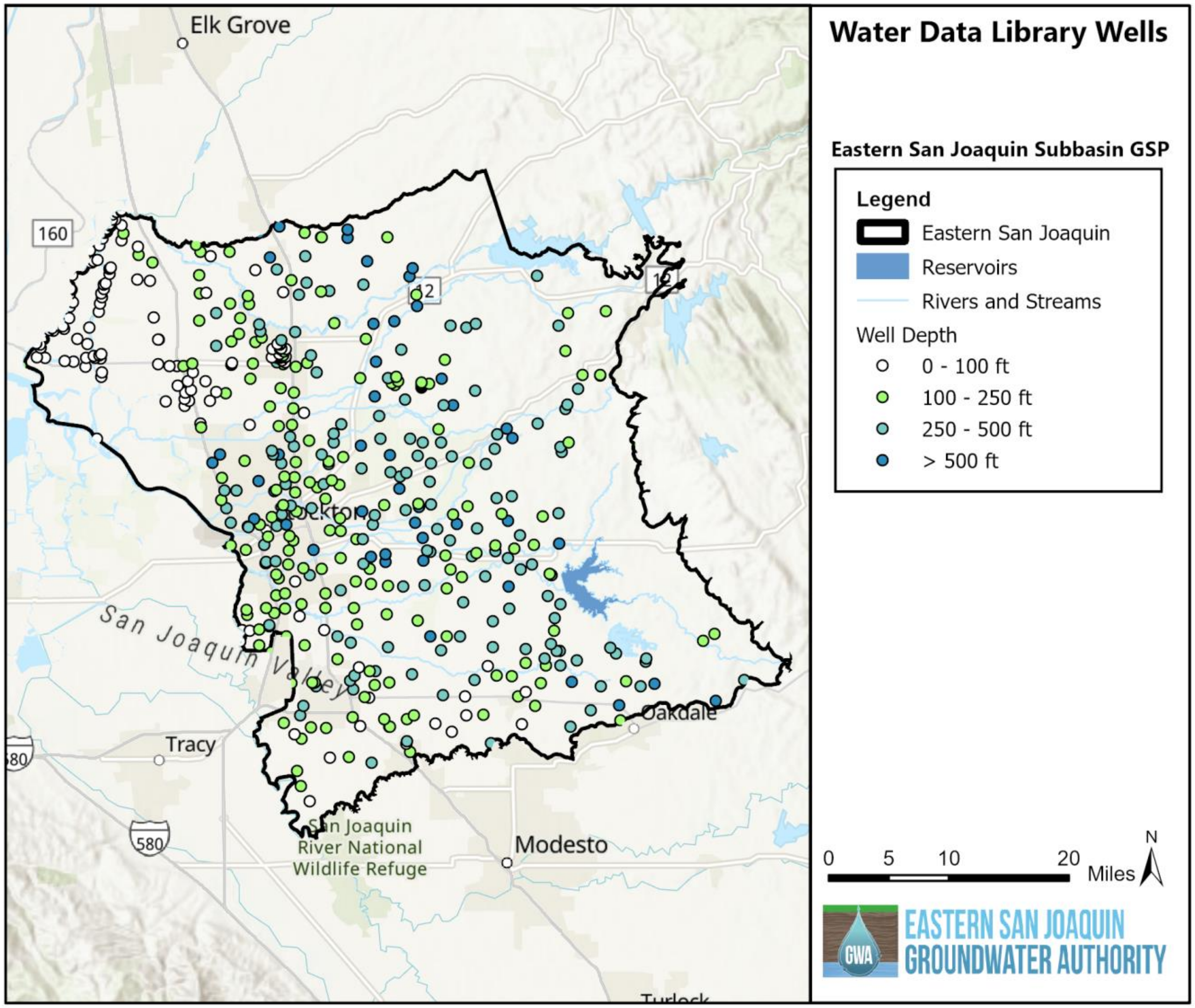
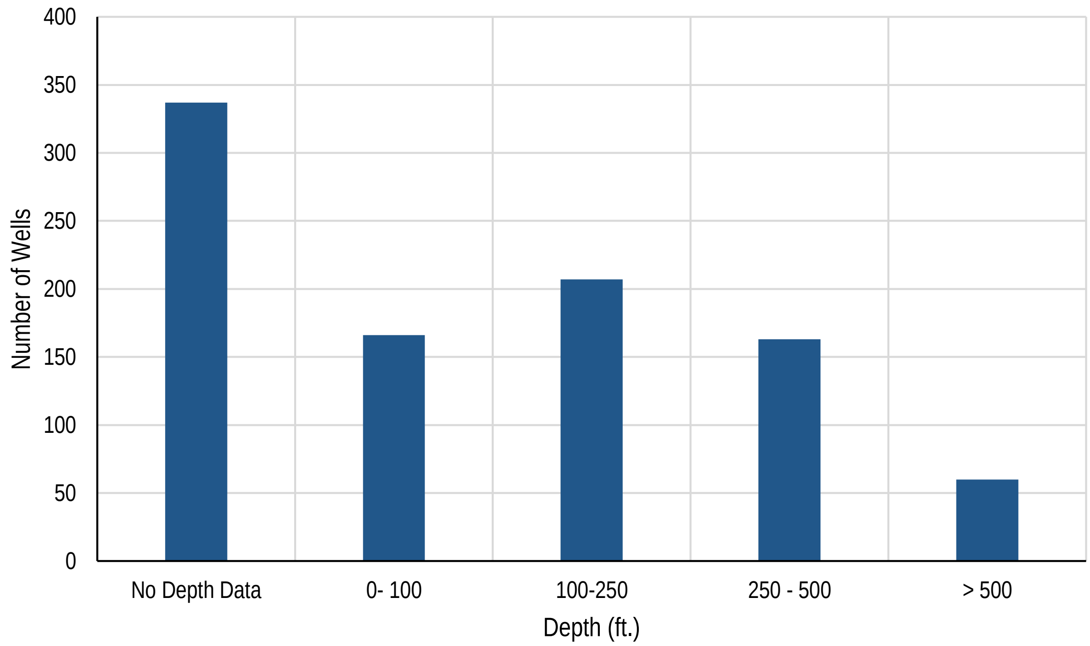


Figure 2-2 shows the distribution of well depths of WDL wells within the Subbasin, a large number of which do not have construction depth or screen interval information. This makes determining groundwater levels for depth-discrete aquifer intervals impossible. Groundwater elevation contour maps were prepared for the Subbasin's single principal aquifer, consistent with CCR Title 23 § 354.16 Groundwater Conditions requirements. Despite uncertainties due to limited construction information, this GSP presents maps that provide a useful description of groundwater conditions.

Figure 2-2: Depth Distribution of Wells in Water Data Library



2.1.1.2 Groundwater Quality Data

This GSP relies on groundwater quality data from the Groundwater Ambient Monitoring and Assessment (GAMA) Program. GAMA includes water quality data from numerous sources, such as United States Geological Survey (USGS) and DWR. The GAMA database contains approximately 6,800 well sites throughout the Eastern San Joaquin Subbasin with over 1.6 million water quality measurements (Figure 2-3).

Although GAMA provides data on many groundwater parameters and wells throughout the Eastern San Joaquin Subbasin, significant data gaps remain. For instance, there are inconsistencies in the parameters measured, as well as in the sampling periods. Some wells are sampled at regular intervals (i.e., quarterly or annually), while others are sampled irregularly. Such assorted schedules make analysis over a given period of time difficult. Data gaps are also apparent when looking at parameters over a longer timeframe. For example, chloride, an important and commonly measured groundwater quality parameter, is reported in only a small fraction of the total number of GAMA wells. As shown in Figure 2-4, out of the over 6,800 wells listed in GAMA for the Eastern San Joaquin Subbasin, no more than 700 chloride measurements were taken during any year since 2005.

No new groundwater quality sources have been identified since the development of the 2020 GSP that are as comprehensive as GAMA.

Figure 2-3: GAMA Monitoring Well Network

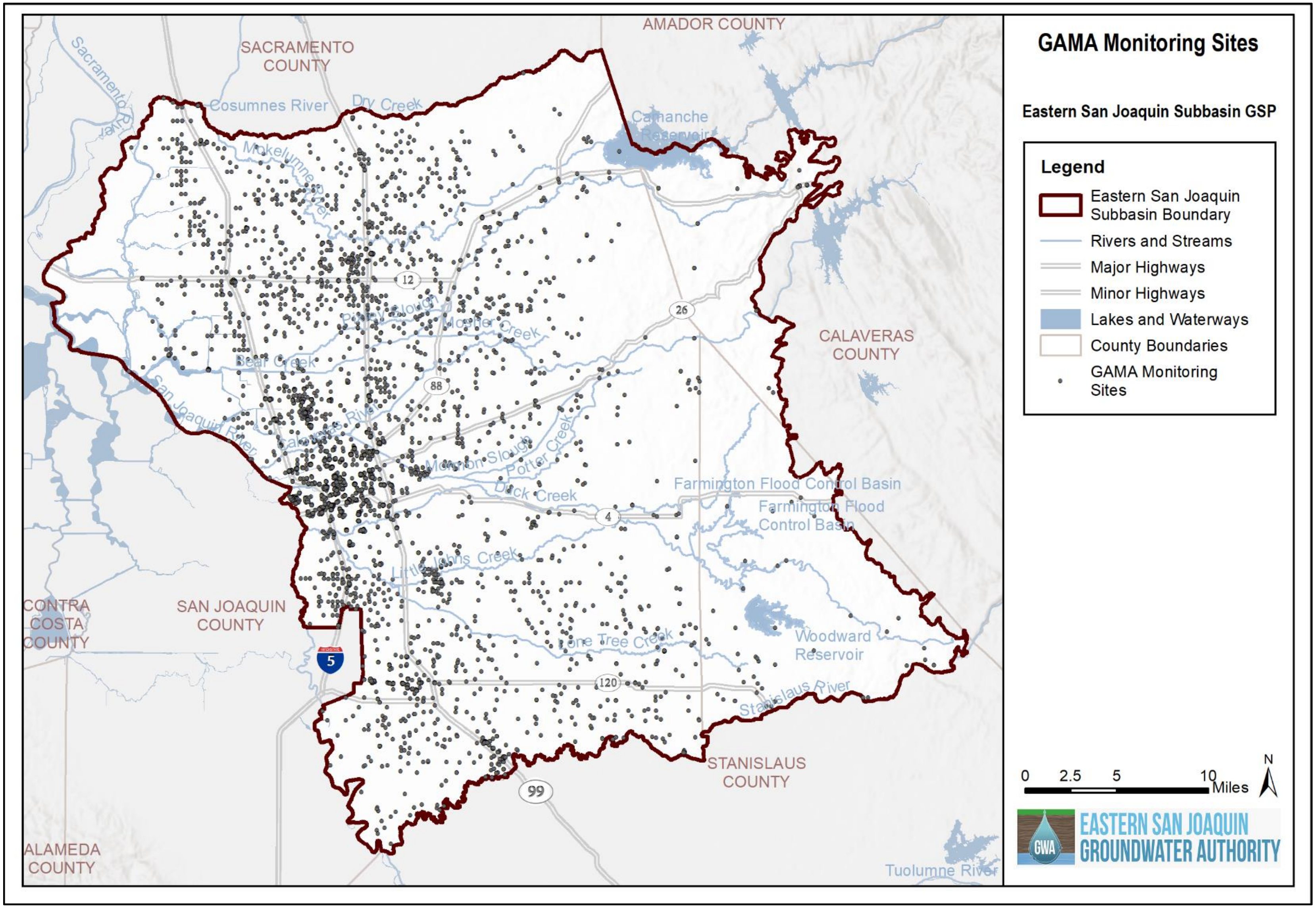
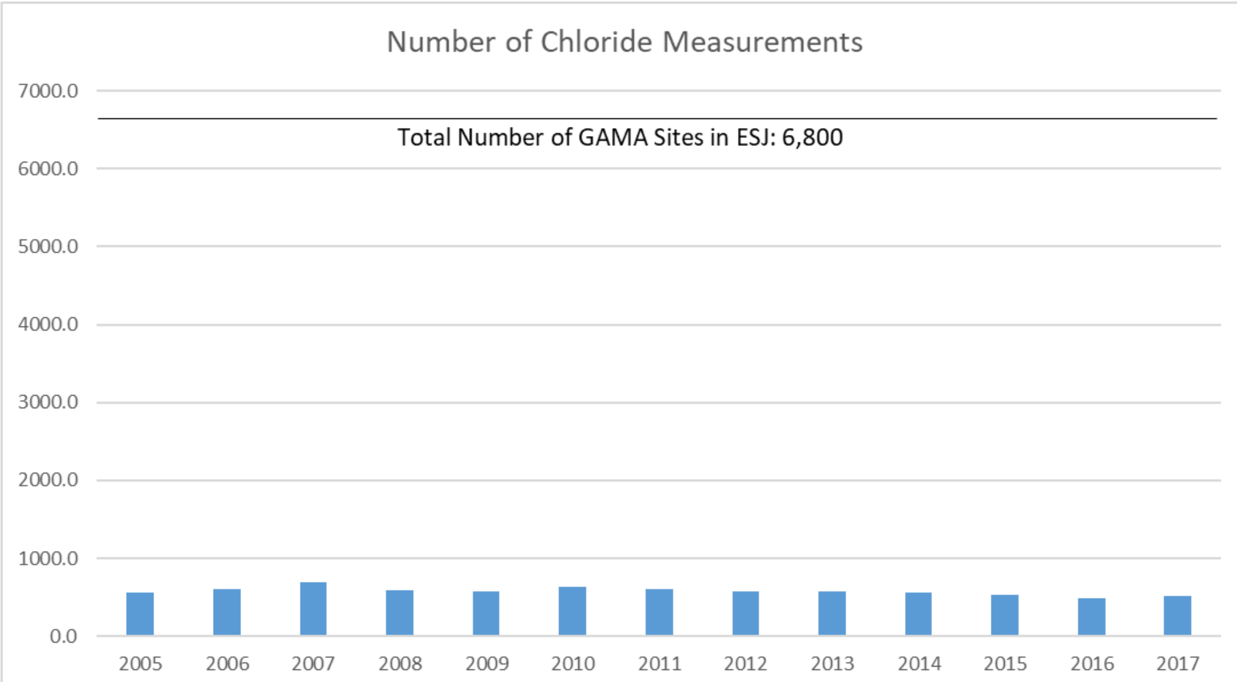


Figure 2-4: Number of Chloride Measurements Taken at GAMA Monitoring Sites (2005-2017)



Below is a list of attributes for each groundwater quality result in GAMA:

- Well ID
- Results
- Chemical
- Units
- Qualifier
- RL (Reporting Limit)
- Approximate Latitude
- Approximate Longitude
- Well Type
- Well Depth
- Top of Screen
- Screen Length
- Source
- Source Name
- Other Names

The attributes of each well in the GAMA database are not always complete or accurate. Well depths and screen interval data, where available, promote vertical analysis of groundwater quality data because these data can be correlated to depth-discrete aquifer zones. Additional depth-specific water quality monitoring is a focus of the monitoring network for this GSP, as discussed in Chapter 4 of this GSP.

2.1.1.3 Stratigraphic Data

The Online System for Well Completion Reports (OSWCR) provided a majority of the groundwater well logs used in developing the HCM. This online database, developed and maintained by DWR, is a compilation of well completion reports accessible to the public for viewing and downloading. Tables of water well records are also available which contain attributes such as construction depth and well type (e.g., domestic or agricultural). However, not every well record is complete within the tables or only a few attributes may be listed. None of the stratigraphic or geologic data are provided in the tables. Stratigraphic or geologic data must be obtained from the individual well completion reports, which are only available as scanned images downloadable in portable document format (pdf). Once the well completion reports are retrieved from the database, the geologic information can then be manually digitized into Microsoft Excel or other database software.

Critical information needed from the well completion reports are construction depth, screen interval, and borehole stratigraphy. The quality and completeness of the reports are, however, highly variable. Very few well logs contain all of the critical data; many more list only a few of the key attributes or none at all. Descriptions of the borehole stratigraphy also vary widely, from comprehensive geologic descriptions to single-word captions (e.g., sand, sandstone, or clay). Given the volume of wells in the Eastern San Joaquin Subbasin and the critical importance of the data being retrieved, great attention was paid to this aspect of the data compilation effort.

Once compiled, the well construction and stratigraphic data from OSWCR were correlated with well data available from the CASGEM and San Joaquin County monitoring well databases. To accomplish this task, individual well logs from OSWCR were assigned a unique location and then matched to a specific well within the CASGEM and San Joaquin County datasets (CA DWR, 2000).

Although the State ID format does not allow for matching between OSWCR, CASGEM, and San Joaquin County databases, well completion reports from OSWCR were correlated to wells in the other databases. This connection was made by plotting CASGEM/San Joaquin County well locations in Geographic Information System (GIS) software and correlating well completion reports to nearby wells with similar attributes. For instance, the State ID of the CASGEM/San Joaquin County wells and the modified State ID of the OSWCR were used to locate the features within the same Township/Range/Section. Well completion reports were matched to wells by attributes such as screen interval and seal depth or based on written location descriptions or hand-drawn sketches of the location.

To further support spatial analysis, well completion reports from OSWCR with no corresponding well in any database were added to the data set. Well completion reports for wells from other sources, including USGS nested wells and municipal wells, were also added. Well completion reports from OSWCR that did not correspond to wells in a different database were plotted using latitude and longitude coordinates listed in OSWCR. These coordinates are often approximations of the actual location; many latitude and longitude values are the geometric center of the section containing each well. All totaled, the borehole stratigraphy from approximately 330 groundwater wells was digitized to provide horizontal spatial coverage.

While groundwater wells provide valuable data in the shallower portion of the basin that are mostly accessed for groundwater use, the hydrostratigraphic units within the Eastern San Joaquin Subbasin are much deeper, reaching a maximum depth of approximately 1,000 feet. Data from the Division of Oil, Gas, and Geothermal Resources (DOGGR) were used to assess the geologic strata at the depths important to the HCM, as these wells are typically much deeper than groundwater wells.

Interpretation of geologic formations from the well completion reports and DOGGR well logs was undertaken after digitizing stratigraphic data from the various sources. This process relied heavily on the distinguishing features of each formation (Section 2.1.5), surficial geologic maps (Section 2.1.5), location and depth of borehole (Section 2.1.7), and professional judgement.

2.1.1.4 Airborne Electromagnetic (AEM) Surveys

Airborne Electromagnetic (AEM) surveys were completed across the state since the 2020 GSP. The data collected provides additional data to inform the HCM of the surveyed basins. Data are collected from a helicopter carrying geophysical equipment on a large hexagonal frame about 30 meters above the ground. This equipment sends a weak electromagnetic signal into the ground and measures the response received back. An electrical resistivity profile of the subsurface down to depths of as much as 300 meters can be developed using the received data. The Eastern San Joaquin Subbasin was included in Survey Area 6, which also included the Cosumnes, Tracy, and East Contra Costa Subbasins and Livermore Valley Groundwater Basin.

Figure 2-5 shows where the survey's flight lines were completed across the Subbasin (CA DWR, 2023 and CA DWR, 20024).

Aquifers are typically composed of sands and gravels that have high resistivities, while aquitards are composed of silt and clays that have low resistivities. The resistivity profiles help in mapping the overall dimensions and extent of the aquifer systems. The AEM survey data is analyzed in detail, correlated with data from nearby wells, and modeled to produce subsurface maps of the resistivity, lithology (the physical characteristics of rocks), and an initial hydrostratigraphic model (a description of the water-bearing and water-confining properties of rocks). Well lithology and oil and gas well geophysical logs located along the AEM flight lines were compiled to provide additional data to support the surveys. Groundwater levels and water quality data were also compiled.

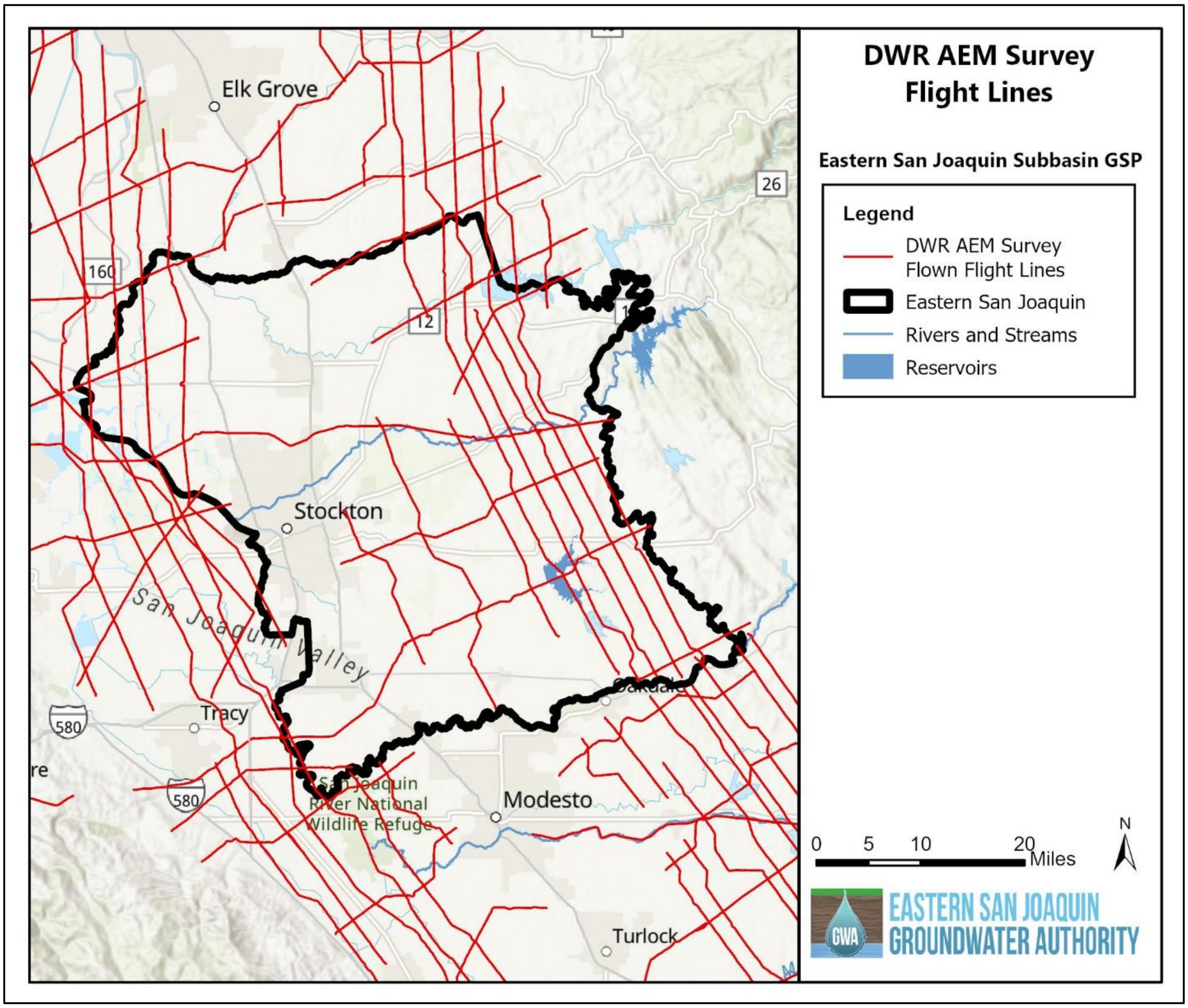
DWR processed the collected AEM data to filter out potential noise in the data and, if necessary, remove the data where interference is too great to effectively interpret. Resistivity models were produced that provide profiles indicative of areas with relatively coarser-grained (sands and gravels) and finer-grained (silts and clays) material, represented by areas of higher and lower resistivities, respectively. The resistivity data were then processed, combining the detailed high-quality well lithologic data with information on the spatial heterogeneity from the resistivity to provide an interpretation of lithology. The resistivity and coarse fraction data were combined to produce an initial hydrostratigraphic model for each subbasin, designating areas or layers of the subsurface having similar hydrogeologic properties (Department of Water Resources (CA DWR), 2023).

The resistivity data, and the texture interpretation DWR developed, are useful as an additional source of information to contribute to local understanding of the Subbasin's hydrogeology and structural features. These data were incorporated into the following pieces of the GSP:

- New cross-sections in the HCM
- Additional shallow subsurface texture map included in the HCM
- Refinements to the model stratigraphy in ESJWRM, described in detail in the ESJWRM Version 3.0 Model Documentation TM included in Appendix 2-C.

Python was used to process the data provided by DWR.

Figure 2-5: AEM Flight Lines across ESJ Subbasin



2.1.1.5 GIS Data

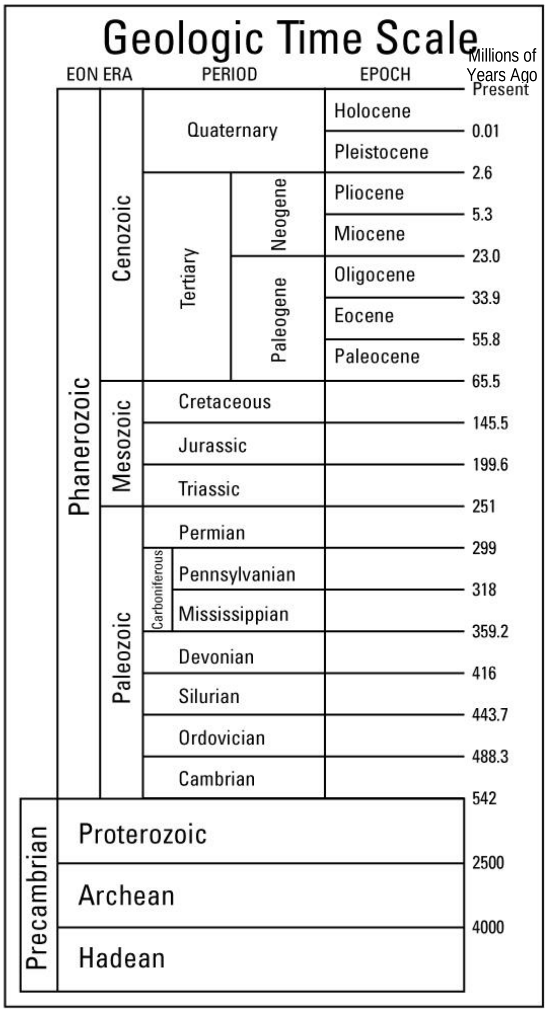
In accordance with CCR Title 23 §354.14, maps of various basin attributes are required as part of the HCM. To produce these maps, GIS software was used to store, manage, and analyze spatial and tabular data. GIS software was also used to extrapolate data through complex processes in cases where information or guidance was limited. For example, in accordance with CCR Title 23 §354.16, groundwater elevation contour maps are required based on the best available information. This requirement does not specify methods to use for producing the data, but the DWR Best Management Practice (BMP) for HCM suggests techniques used in Tonkin, M. and Larson, S. (2002), which uses geostatistical methods in conjunction with logical interpretations of groundwater level data to provide an adequate level of detail and accuracy.

Certain GIS software programs, including QGIS and ArcGIS, were relied on heavily. QGIS is a powerful open-source program, whereas ArcGIS is the industry standard. Both are capable of completing the required elements for the GSP. QGIS provided the graphical capabilities for final map production. ArcGIS was specifically utilized because of a third-party extension, CrossView, which is capable of generating hydrogeologic cross-sections that are presented in Section 2.1.7. The Universal Transverse Mercator (UTM) coordinate system and North American Datum of 1983 (NAD 83) were utilized along with the North American Vertical Datum of 1988 (NAVD 88) for all spatial data.

2.1.2 Regional Geologic and Structural Setting

The Eastern San Joaquin Subbasin lies within the San Joaquin Valley, which is part of the Central Valley of California. The Central Valley is a 400-mile-long, 50-mile-wide, northwestward trending asymmetrical structural trough filled with geologic units deposited over a long period of time. See Table 2-2 (Section 2.1.5) for the generalized stratigraphic column and Figure 2-6 below for the geologic time scale. The Sierra Nevada Mountain Range, east of the Central Valley, consists of pre-Tertiary igneous and metamorphic continental rocks. The Coast Range, to the west, consists of pre-Tertiary and Tertiary semi-consolidated to consolidated marine sedimentary and continental rocks. The material sources for the Central Valley continental deposits are the Coast Range and the Sierra Nevada, which are composed primarily of granite, related plutonic rocks, and metasedimentary and metavolcanic rocks from Late Jurassic to Ordovician age (Bertoldi et al., 1991).

Figure 2-6: Geologic Time Scale



2.1.3 Geologic History

The origin of geologic formations within the Eastern San Joaquin Subbasin varies in geologic time ranging from recent to Pre-Cretaceous bedrock or basement. Six to 10 miles of sediment have been deposited within the Central Valley and include both marine and continental deposits consisting of gravels, sands, silts, and clays. During the middle Cretaceous (~100 million years ago), parts of the Central Valley were inundated by the Pacific Ocean resulting in deposition of marine deposits. Marine conditions persisted through the middle to late Tertiary period (~3-30 million years ago) after which time sedimentation changed from marine to continental deposits due to the retreat of the sea and the regional rising of land mass previously inundated by the ocean. Intermittent volcanism dominated with the deposition of rhyolites and andesites (CA DWR, 1967).

2.1.4 Near-Surface Conditions

2.1.4.1 Topography

Ground surface elevations vary extensively across the Eastern San Joaquin Subbasin, from almost 1,000 feet above mean sea level (MSL) in the upland areas in the east to around sea level in the flat lying valley floor to the west. The Eastern San Joaquin Subbasin topographic map is provided as Figure 2-7.

The modern-day physiographic features are a direct result of the geologic history of the region. Surficial features on the valley floor in the Eastern San Joaquin Subbasin can be divided into physiographic units as described by DWR (1967) and Burow and others (2004): river flood plains, channels, and overflow lands; low alluvial plains and fluvial fans; and dissected uplands. The dissected uplands lie along the flanks of the valley between the Sierra Nevada to the east and the alluvial plains and fluvial fans to the west. Local relief ranges in excess of 100 feet in the form of dissected hills and gently rolling lands. The most extreme slopes are observed in Calaveras County, which are steeper than 25 percent. West of the dissected uplands is a belt of coalescing fluvial fans of low relief (less than 10 feet) that forms the low alluvial plains and fans that range in width from about 14 to 20 miles. These fans lie between the dissected uplands and the nearly flat surface of the valley trough. River floodplains and channels occur as narrow, disconnected strips along the channels of the major rivers. Overflow lands of the valley trough tributary to the San Joaquin River define the area inundated by rivers when floods are highest under natural conditions.

2.1.4.2 Major Hydrologic Features

The major hydrologic features within the Eastern San Joaquin Subbasin are shown in

Figure 2-8. The Subbasin is bounded on all sides except to the east by streams. Adjacent groundwater subbasins also share an interest in the impacts of the Sustainable Groundwater Management Act (SGMA) on these boundary streams.

In the Eastern San Joaquin Subbasin, the major rivers running east-west have headwaters high in the Sierra Nevada and flow west toward the axis of the valley (

Figure 2-8). Little deposition is taking place currently, and the rivers are cutting downward on the upper reaches of the fans where the river floodplains are commonly entrenched to depths of 50 to 80 feet. However, toward the lower ends of the fans where river gradients are low, many small streams and tributaries of the major rivers are actively aggrading their beds.

Figure 2-7: Topography

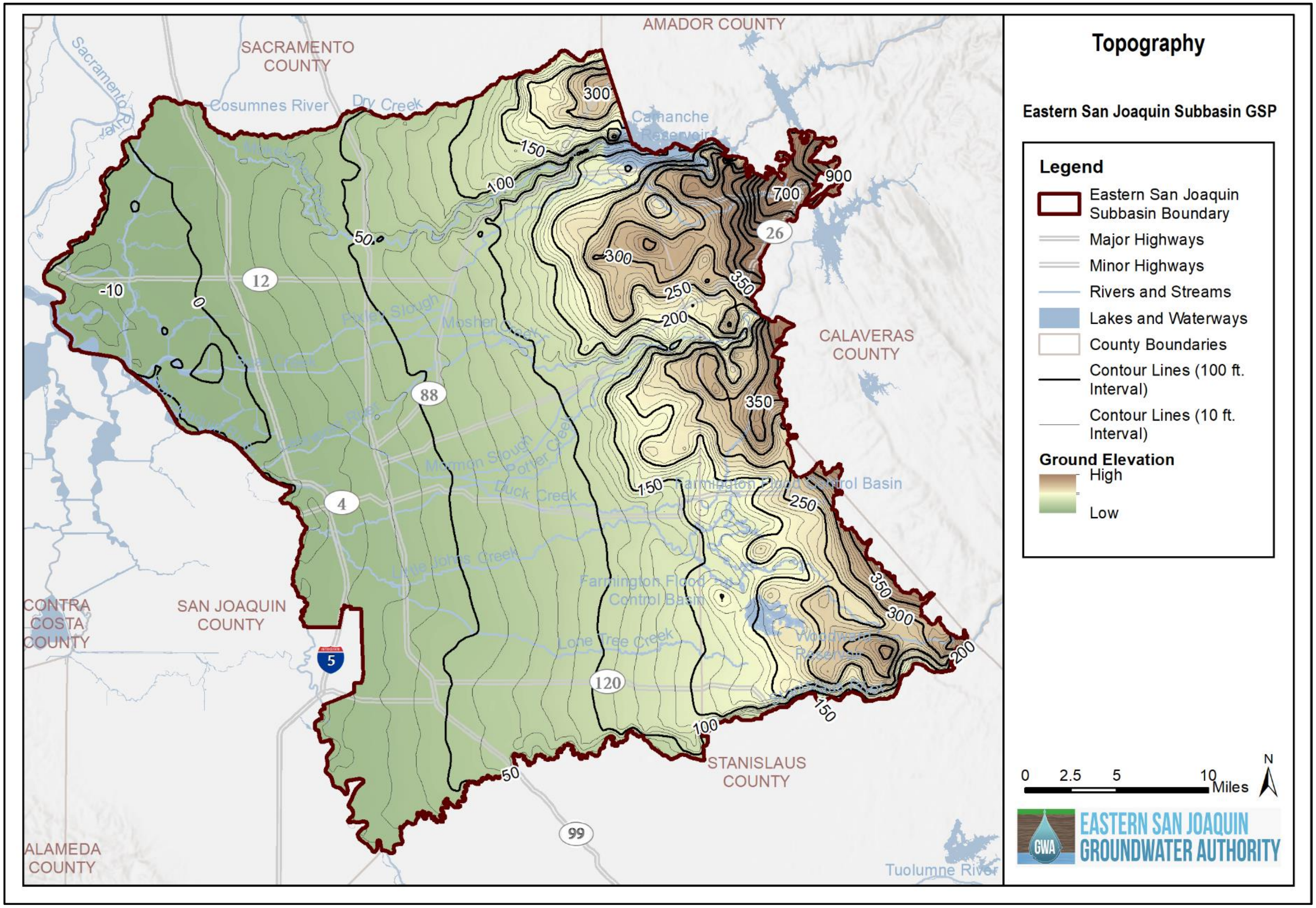
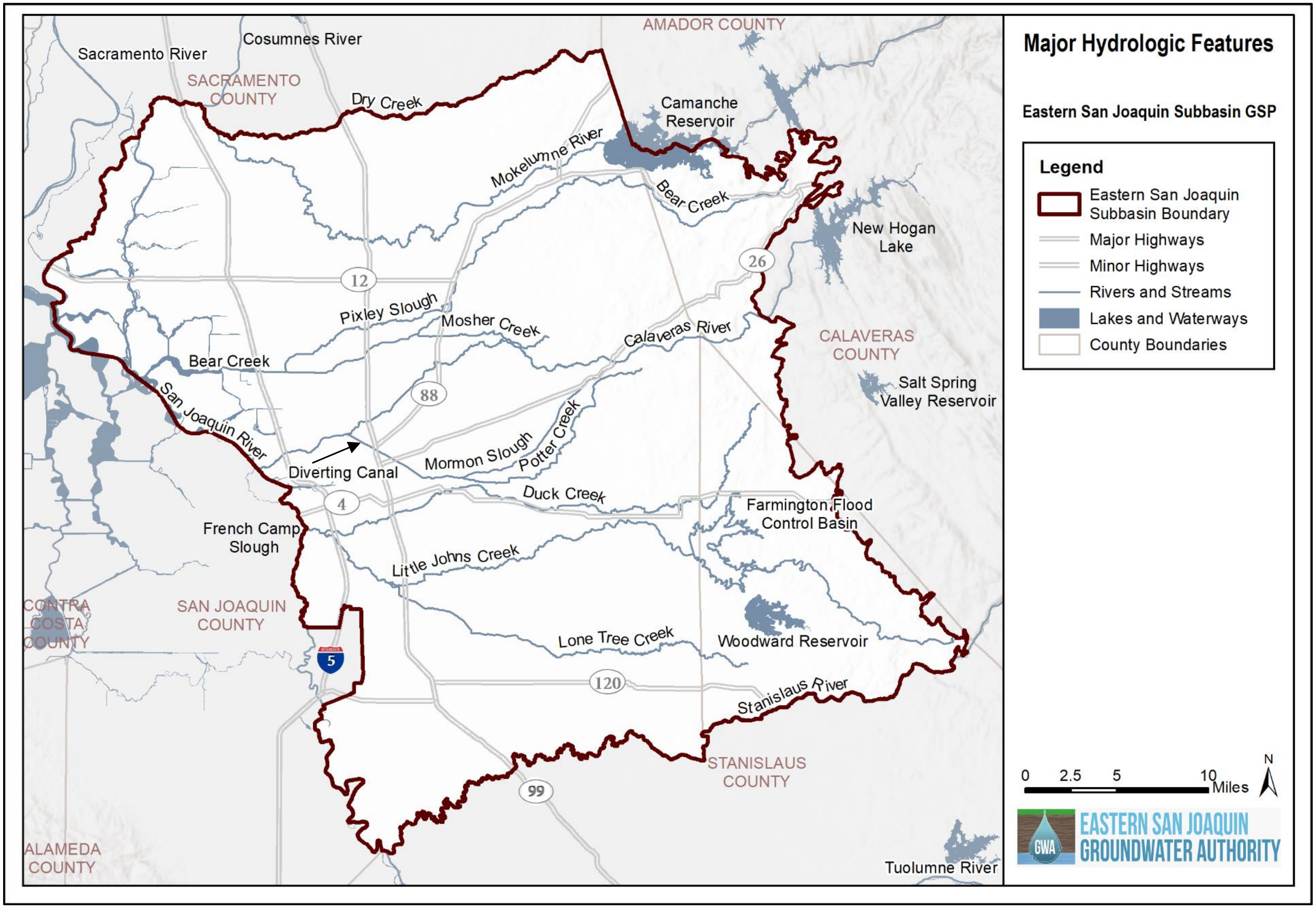


Figure 2-8: Major Hydrologic Features



The San Joaquin River is the principal drainage outlet of the northern San Joaquin Valley, flowing northward on the west margin of the Eastern San Joaquin Subbasin to its confluence with the Sacramento River in the Sacramento-San Joaquin River Delta (Delta) (Burow et al., 2004). Three major westerly flowing tributaries to the San Joaquin River within or adjacent to the Eastern San Joaquin Subbasin are the Stanislaus River (Subbasin south boundary), the Mokelumne River (north portion of Subbasin), and the Calaveras River (central portion of Subbasin).

The Stanislaus River drains a watershed of about 1,040 mi^2 (Burow et al., 2004) and flows through the dissected uplands between the communities of Knights Ferry and Oakdale, along the low alluvial plains and fans near the City of Riverbank to the confluence with the San Joaquin River near Vernalis (see Figure 2-9). Most of the watershed area falls within Modesto Subbasin. The flow in the Stanislaus River varies seasonally from less than 134 acre-feet per day (AF/day) during the dry season in early fall to over 16,400 AF/day during wet season in winter. These flows correlate to discharges from 68 to over 8,270 cubic feet per second (cfs) recorded at the Orange Blossom Bridge gauging station approximately one mile east of Oakdale and eight miles west of the Subbasin boundary along the river (CA DWR, 2019).

The Mokelumne River drains a watershed of about 5,550 km^2 (2,140 mi^2) and flows through the dissected uplands between the communities of Jackson and San Andreas into Pardee Reservoir where it is released to flow downstream into Camanche Reservoir and out along the alluvial plains and fans toward its confluence with the San Joaquin River near Isleton. On the north boundary of the Eastern San Joaquin Subbasin is Dry Creek and the Lower Dry Creek Watershed, the majority of which is within Cosumnes Subbasin. Dry Creek is mapped as an ephemeral drainage and is tributary to the Mokelumne River with its confluence near Thornton. Flow in the Mokelumne River below Camanche Reservoir varies seasonally and is dependent on discharges from the on-stream reservoir, from less than 200 AF/day during the dry season to 9,900 AF/day during the wet season. These flows correlate to discharges from as low as 100 to no more than 5,000 cfs reported by the USGS below the Camanche Dam. Major watersheds of the river are the Upper Mokelumne River (most of which is outside of the Subbasin to the east, with a small portion overlapping with Cosumnes Subbasin) and the Lower Mokelumne River (mostly contained in the Subbasin, with a small portion intersecting the South American and Solano Subbasins).

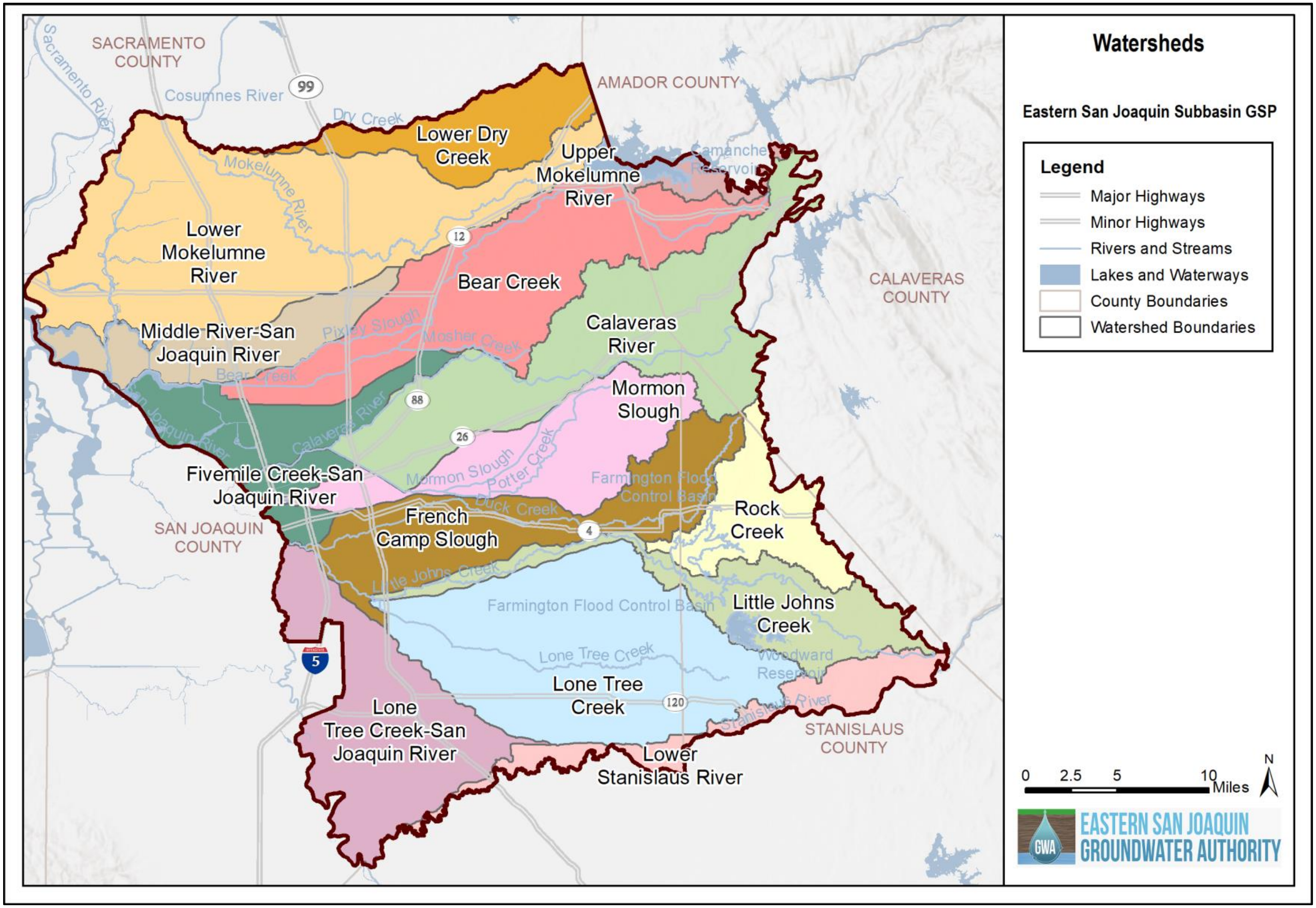
The Calaveras River, also with headwaters in the Sierra Nevada, drains a watershed of about 1,370 km^2 (530 mi^2) and flows into and across the Subbasin to its confluence with the San Joaquin River on the northwest side of Stockton. Flow in the Calaveras River below the New Hogan Reservoir varies seasonally from 608 AF/day to 19,800 AF/day and is dependent on discharges from the on-stream reservoir. These flows correlate to discharges from 223 to over 10,000 cfs reported by the USGS below the New Hogan Reservoir.

In addition to the Stanislaus, Mokelumne, and Calaveras Rivers, 10 watersheds extend into and across the Eastern San Joaquin Subbasin. Three of these watersheds extend beyond the western boundary of the Eastern San Joaquin Subbasin into the East Contra Costa or Tracy Subbasins: Middle River-San Joaquin, Five Mile Creek-San Joaquin, and Lone Tree Creek-San Joaquin. The Lone Tree Creek-San Joaquin watershed has its headwaters in the Coast Range foothills. Figure 2-9 depicts the Eastern San Joaquin Subbasin and the watersheds that overlie the Subbasin. Table 2-1 is a list of watersheds that overlie the Subbasin.

Table 2-1: Eastern San Joaquin Subbasin Watershed Details

Watershed Name	Total Area (square miles)	Area within Subbasin (square miles)	Percentage of Watershed within Subbasin
Lower Mokelumne River	223	202	91
Lower Dry Creek	88	47	53
French Camp Slough	88	88	100
Upper Mokelumne River	93	15	16
Lone Tree Creek	158	158	100
Little Johns Creek	122	63	52
Rock Creek	107	44	41
Calaveras River	224	133	60
Middle River-San Joaquin River	213	49	23
Mormon Slough	75	75	100
Lower Stanislaus River	218	37	17
Lone Tree Creek-San Joaquin River	169	98	58
Five Mile Creek-San Joaquin River	154	62	40
Bear Creek	127	127	100

Figure 2-9: Eastern San Joaquin Subbasin Watersheds



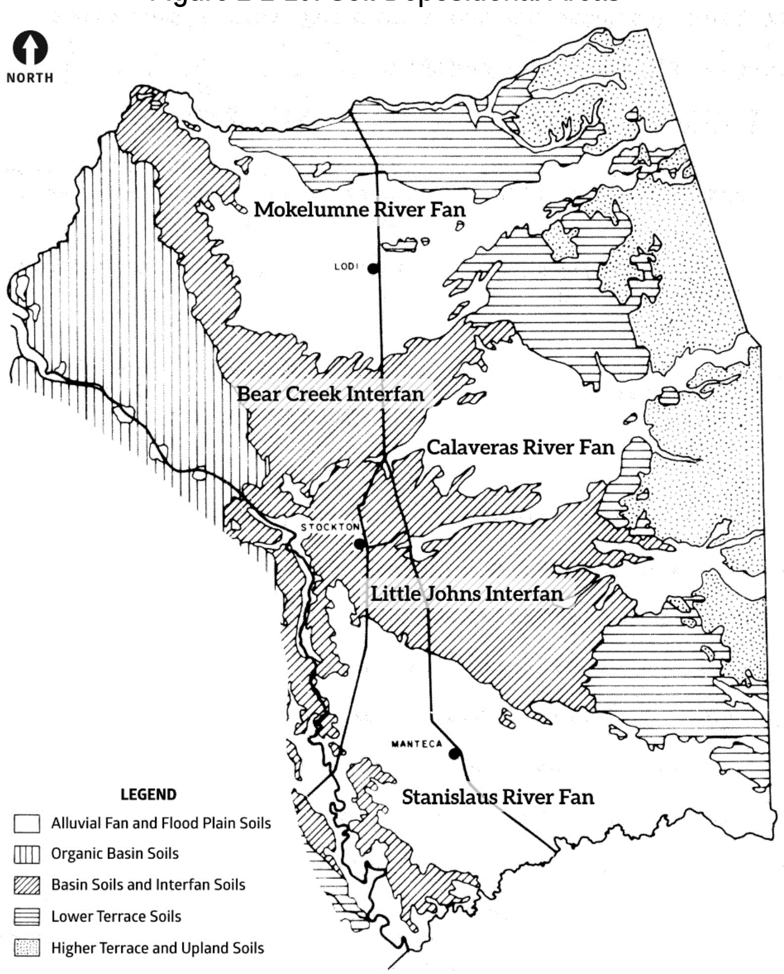
2.1.4.3 Surface Soils

Soils in the Eastern San Joaquin Subbasin are one of the primary controlling factors on surface water percolation rates through the vadose zone down to the groundwater table. As described in CA DWR (1967), soils in the region of the Eastern San Joaquin Subbasin can be grouped into five main categories:

1. Alluvial fan and flood plain soils
2. Organic basin soils
3. Basin soils
4. Lower terrace soils
5. Higher terrace and upland soils

These groupings coincide in part with the geologic formations in that the oldest soils are found on the nearly level high terraces and old fluvial fans in the eastern part of the area. The oldest soils typically have claypan or hardpan layers at depths of two feet or less. The youngest soils are forming on the recently deposited alluvium along stream bottoms and on recently exposed surfaces. These soils are generally deep and rich in nutrients. The soils at intermediate stages of development are on the low terraces. Figure 2-2-10 shows the areal distribution of the five soil types in San Joaquin County (CA DWR, 1967).

Figure 2-2-10: Soil Depositional Areas



Alluvial fan and floodplain deposits are present in three areas of the Eastern San Joaquin Subbasin bounding major east-west rivers: Mokelumne, Calaveras, and Stanislaus Rivers. Figure 2-2-10 depicts soil depositional areas within the Subbasin. These areas have the best infiltration rates, exclusive of the peat locales in the Delta (northwest portion adjacent to the Mokelumne River).

Soils of the Mokelumne and Stanislaus River fans have young soil profiles of sandy loam to loam. Infiltration rates of the soils are predominantly between 0.6 to 2 inches per hour. Areas of silt loam are also common especially in the floodplain and have a lower infiltration rate of less than 0.6 inches per hour. Soils in the alluvial fans tend to coarsen toward the apex of the fan. The soil types show little compaction and slight accumulation of lime or clay. Hardpan development, which would preclude infiltration, is minimal.

The soils of the Calaveras fan have deeper profiles of loam and clay loam with an infiltration rate of less than 0.6 inches per hour. These soils tend to be darker and heavier than the Stanislaus and Mokelumne River fan soils likely due to the source area being restricted to metamorphic or pre-Tertiary sedimentary material, whereas the Mokelumne and Stanislaus Rivers received large contributions from a granitic source (CA DWR, 1967).

The organic basin soils are restricted to the lower Delta portion of the Eastern San Joaquin Subbasin. Peat, muck, and clay loam are terms commonly applied to soils in this group. The organic basin soils have variable infiltration capacity. Where peat is the dominant soil constituent, infiltration is high (greater than 2 inches per hour); where clay loam or muck occurs, infiltration is low (less than 0.6 inches per hour) (CA DWR, 1967).

The interfan and basin soils lie between the Mokelumne, Calaveras, and Stanislaus River fans in a northwesterly trending belt and around the periphery of the organic basin soils. These soils generally have well-developed profiles, medium-to-heavy textures, and fairly well compacted subsoils. Locally, hardpan overlies silty to silty clay loams. Consequently, these soils have low infiltration rates (less than 0.6 inches per hour).

The terrace and upland soils have profiles containing moderately dense accumulation of clay and claypan, relatively near the surface. These layers are impervious barriers to the local downward movement of water, except where root holes and other breaks permit infiltration.

The Natural Resource Conservation Service (NRCS) categorizes soils by hydrologic soil groups. The hydrologic soil group is an estimation of the infiltration rate of the first five feet of soil based on depositional characteristics (mostly grain size and sorting) and secondary characteristics (compaction, lithification, and weathering). Hydrologic soil groups and their relative infiltration rates are listed below:

- A (high)
- B (medium)
- C (slow)
- D (very slow)

Figure 2-11 shows the distribution of soils mapped by hydrologic soil group across the Eastern San Joaquin Subbasin. The broad geologic features of the Eastern San Joaquin Subbasin reflecting the river drainage elevations, areas, and percent above snowline are also apparent in the map of soils distribution. The Stanislaus and Mokelumne River alluvial fans have the overall highest infiltration rate followed by the Calaveras River fan. The smaller foothill watersheds have the lowest average infiltration rates. The relatively high permeability of windblown sands on the Mokelumne and Stanislaus River fans and the recent alluvium of the current Mokelumne and Calaveras River floodplains are also recognizable (Figure 2-11).

Hardpan is a strongly cemented weathering profile that limits infiltration unless it is modified by ripping or excavating. Some hardpan is discontinuous and relatively shallow (located at a depth of five feet or less) and often is ripped with a bulldozer for agricultural purposes. However, in other areas, particularly in the older pre-Modesto formations, the hardpan is more continuous and extends to depths that cannot be reached by ripping methods.

The Farmington Groundwater Recharge/Seasonal Habitat Study Final Report, prepared by Montgomery Watson Harza (MWH) and dated August 2001 (MWH, 2001), overlaid the NRCS's interpretation of where hardpan soils would be found under natural conditions. The extent of the thickest hardpan is shown in Figure 2-12 in dark blue cross hatching.

Figure 2-11: Hydrologic Soil Groups

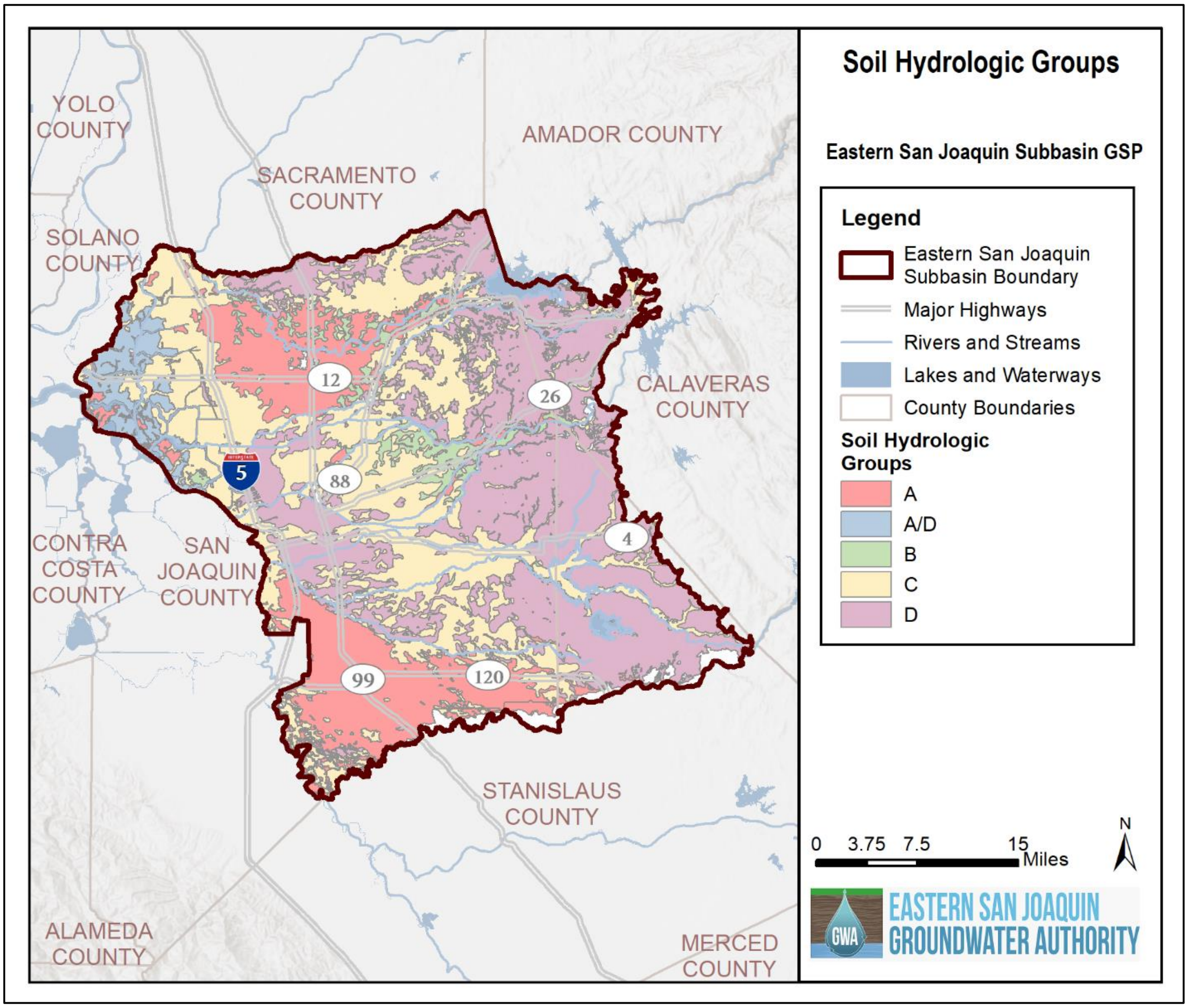
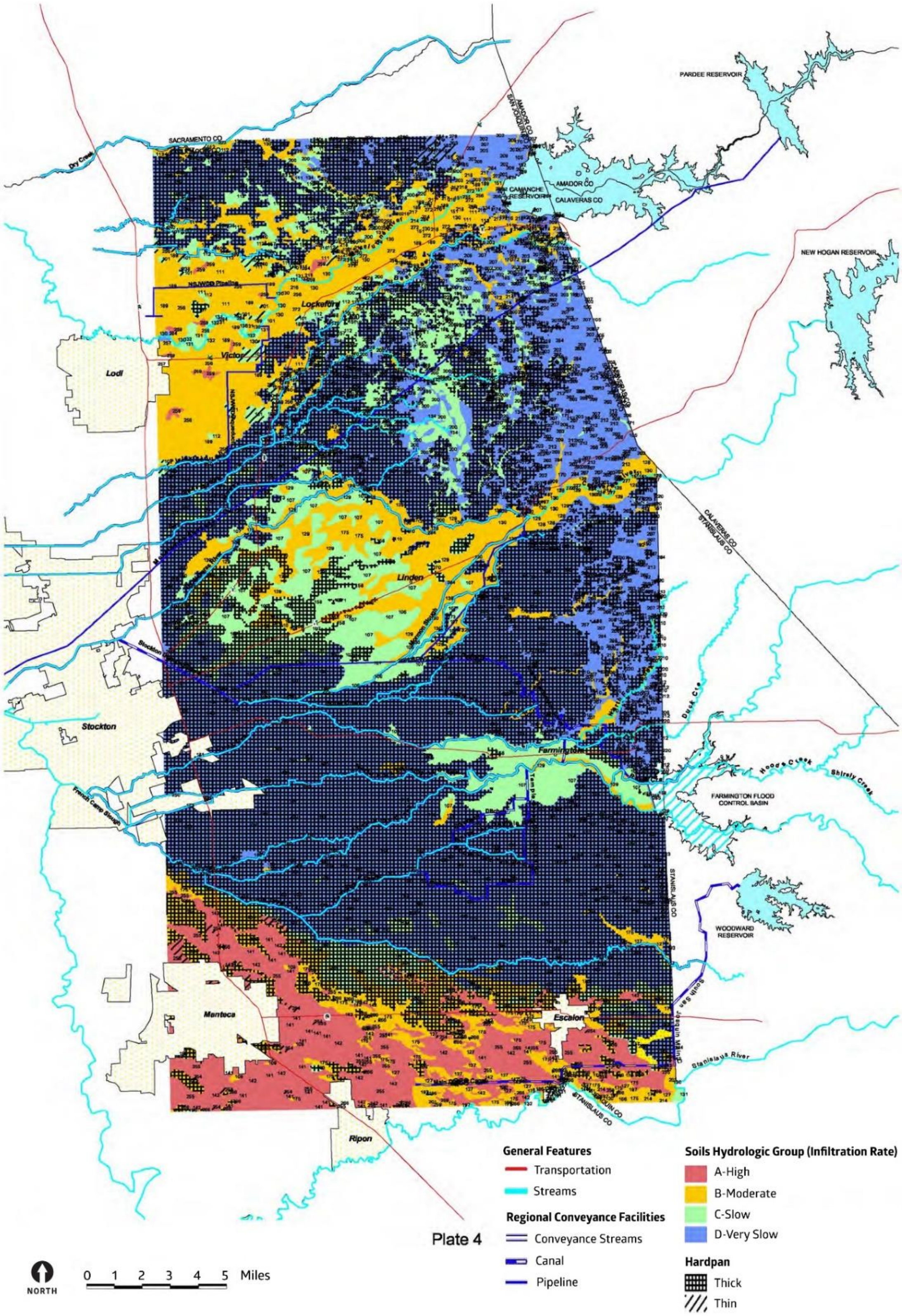


Figure 2-12: Occurrence of Hardpan within the Eastern San Joaquin Subbasin



2.1.4.4 Imported Water

The Eastern San Joaquin Subbasin does not rely on imported water supplies. All surface water used within the Subbasin originates from sources either within or directly tributary to the Subbasin. Several districts receive surface water from the Stanislaus River with a point of diversion approximately four miles upstream of the eastern boundary of the Subbasin (located in the Sierra Nevada foothills and not part of a Bulletin 118 groundwater basin). While this diversion point occurs outside of the Subbasin boundary, this water naturally enters the Subbasin by diversion or by surface-groundwater interaction.

2.1.4.5 Groundwater Recharge and Discharge Areas

Groundwater recharge and discharge is driven by both natural and anthropogenic (human-influenced) factors. Areas of recharge and discharge within the Eastern San Joaquin Subbasin are discussed below. Quantitative information about all natural and anthropogenic recharge and discharge is provided in Section 2.4.

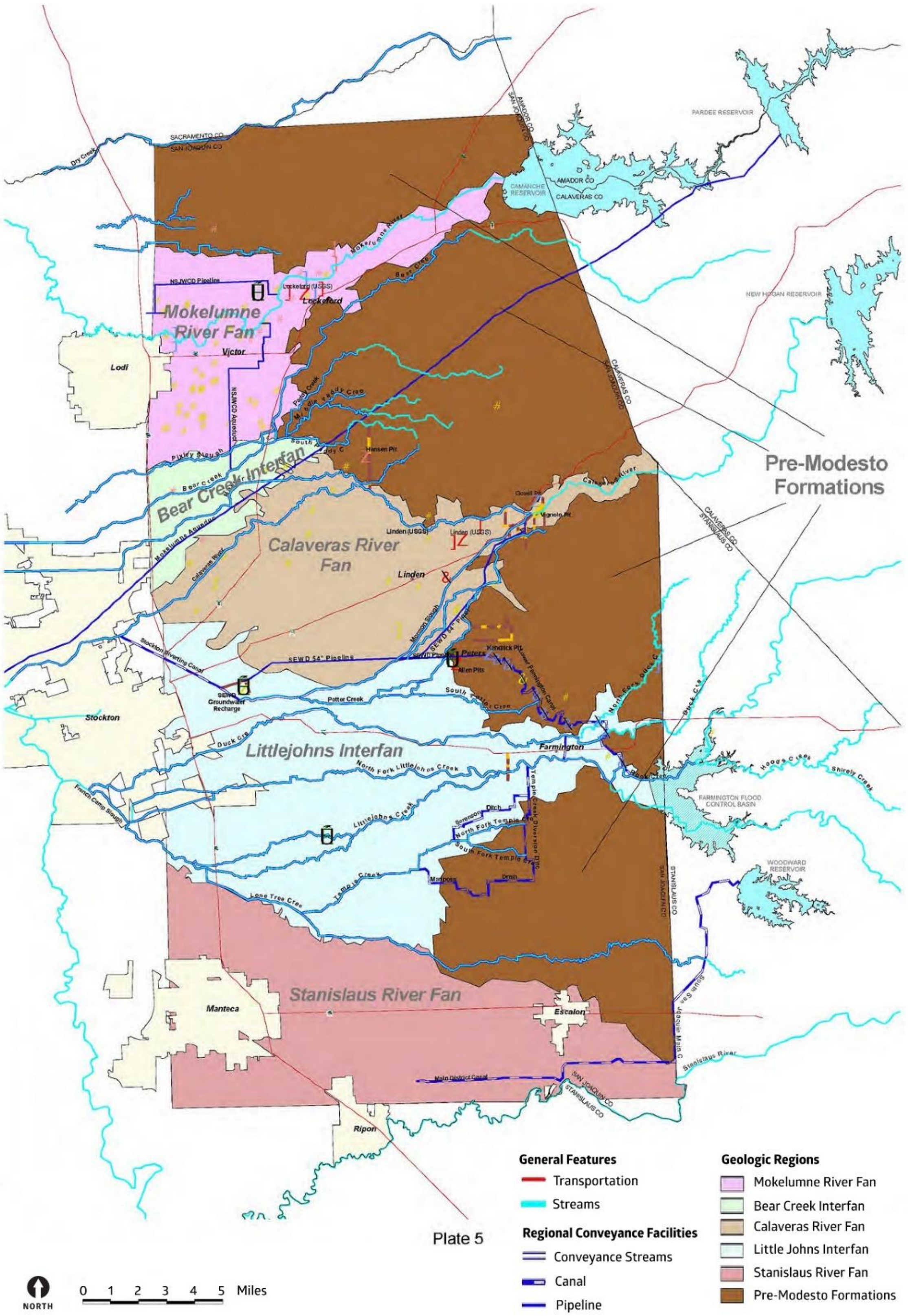
2.1.4.5.1 Description of Recharge Areas

The recharge potential of soils and formations encountered in the Eastern San Joaquin Subbasin varies considerably and is dependent on primary and secondary geologic effects. Primary geologic patterns that influence permeability relate to grain size and sorting as a result of depositional characteristics. Secondary geologic effects that influence soil recharge characteristics are associated with post-depositional events such as consolidation, lithification, and weathering, including the development of hardpan soils (MWH, 2001). Additional information on geologic formations is provided in Section 2.1.5.

The primary (original) geologic permeability of the pre-Modesto formations is variable depending on grain size, but in general is low due to secondary (post-depositional) effects including the development of hardpan soils. However, the units are heterogeneous (variable), and permeable channels are common beneath the hardpan. The primary permeability of the Modesto Formation varies both east-west and north-south due to grain size differences in the original depositional environments. On any given drainage, the alluvium is generally coarsest (and most permeable) in the east where the gradient is steepest, and the relatively high energy stream carries and deposits a high proportion of coarse bedload sand and gravel (the proximal fan). Suspended sediment (clay and silt) is generally not deposited until it is carried farther west to a lower energy environment (the distal fan). As a result, the average permeability, and thus the average recharge rates, of the alluvial fan decreases overall from east to west (MWH, 2001).

The grain size distribution produced from each watershed depends on several characteristics, including the type of geologic materials in the source area, the watershed's gradient and total area, and the portions of the watershed subject to rainfall and snowmelt runoff. During the Pleistocene Epoch when the Modesto and Riverbank formations were deposited (approximately 1 million to 10,000 years ago), a colder, wetter climate produced a lower snowline than at present, and coarse glacial outwash dominated the major streams originating in the interior of the Sierra Nevada (Mokelumne and Stanislaus River fans). Alluvium of the smaller foothill watersheds consists primarily of fine-grained material in interfan areas (Bear Creek and Little Johns/Rock Creek drainages). The Calaveras River drainage is intermediate between the two, forming a moderately coarse alluvial fan between the Calaveras River and Mormon Slough (MWH, 2001). Figure 2-13 depicts the aerial extents of the alluvial fans, interfan areas, and pre-Modesto formations.

Figure 2-13: Areal Extents of Alluvial Fans, Interfans, and Pre-Modesto Formations

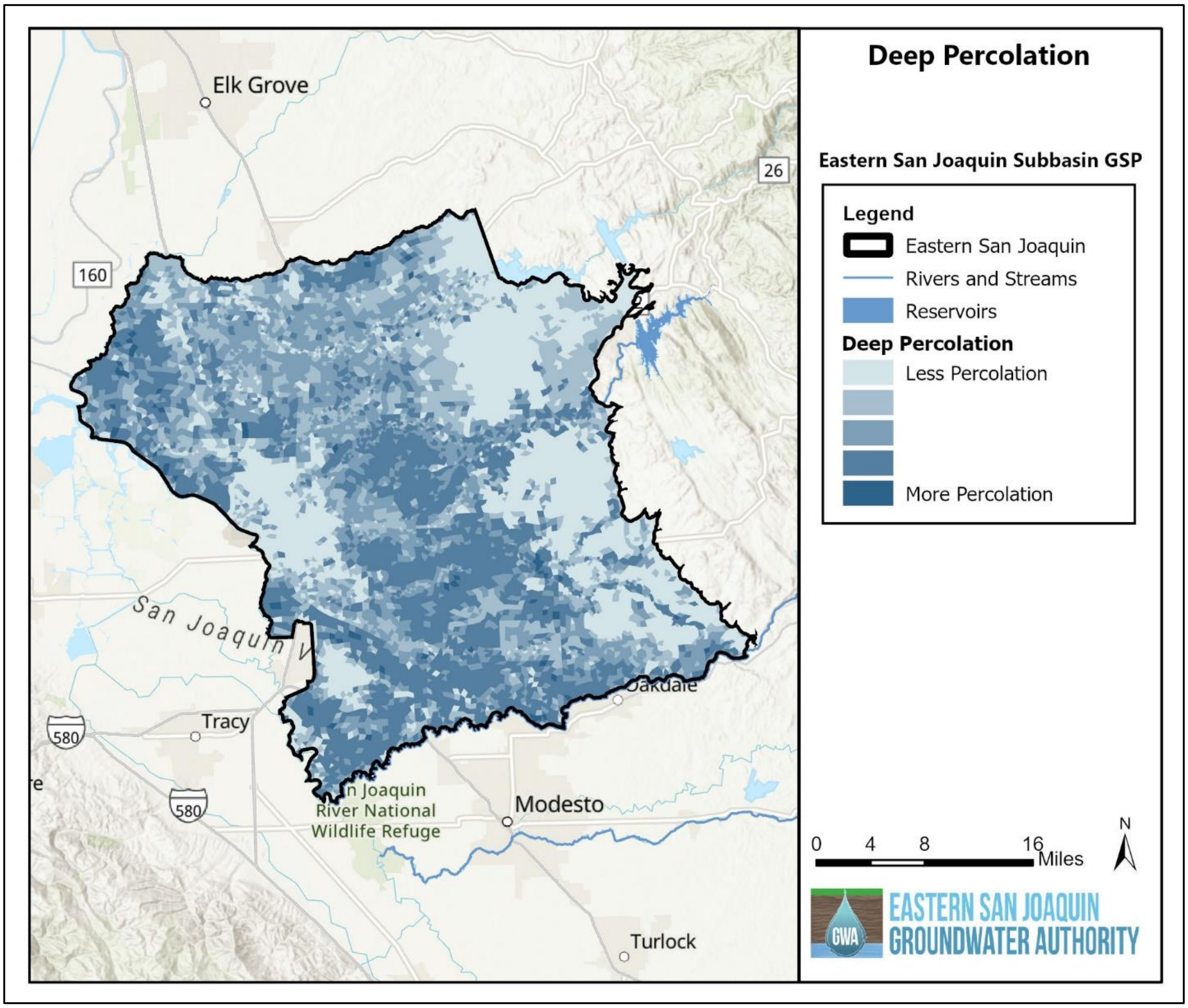


Within this overall framework, the alluvial fans of each drainage contain coarse-grained channel and levee deposits of relatively high permeability within finer-grained overbank and floodbasin deposits of low permeability. Stream channels migrate and abruptly jump to new locations over time in this depositional environment, creating deposits that are heterogeneous both laterally and vertically. As a result of this depositional environment, localized silt and clay lenses are common even in the alluvial fan areas. However, no regional clay layer is expected to exist that would severely reduce or inhibit vertical migration of water. The recent (Holocene) alluvium in the current incised river floodplains (Mokelumne and Calaveras Rivers) and windblown (eolian) sand deposits are of limited extent but relatively permeable (MWH, 2001). These present and historical alluvial depositional factors are useful in understanding rainfall percolation rates when the soil moisture deficit is zero and groundwater recharge occurs; groundwater system preferential vertical movement pathways through the principal aquifer and aquitards; and future groundwater management alternatives.

The Eastern San Joaquin Water Resources Model (ESJWRM) estimates the recharge that occurs in different areas of the Eastern San Joaquin Subbasin, largely due to the percolation of rainfall and applied irrigation water. Figure 2-14 shows the spatial distribution of percolation in the Subbasin, with generally less percolation occurring in finer soil areas (e.g., Hydrologic Soil Group D) and areas without extensive irrigation (i.e., native landscape). The higher percolation areas are those that substantially contribute to the replenishment and recharge in the Subbasin. Section 1.2.2.9 describes conjunctive use programs that were in place prior to the implementation of SGMA, and Figure 1-16, shown previously in Chapter 1: Agency Information, Plan Area, and Communication, maps direct recharge areas in the Subbasin.

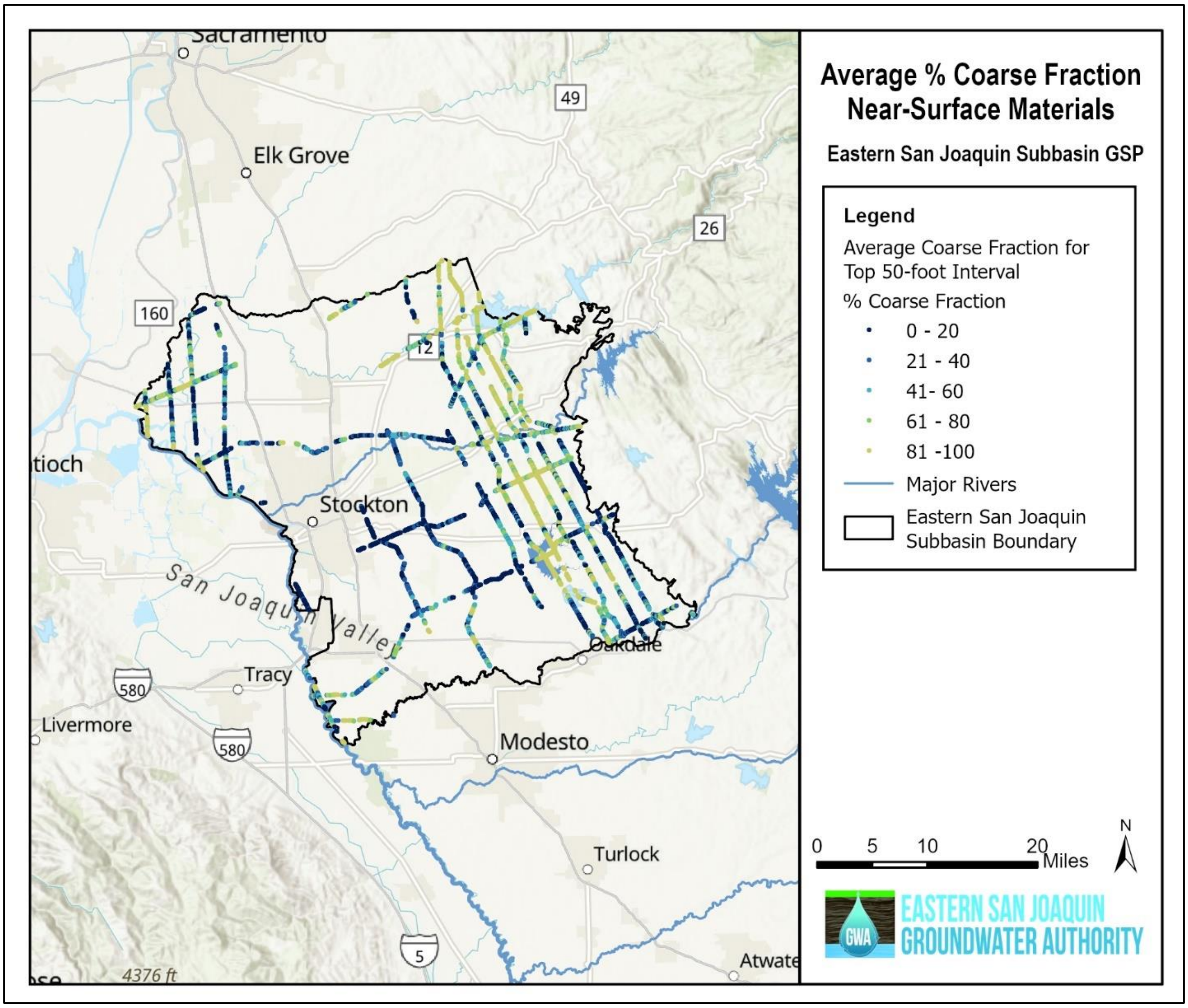
DWR's texture interpretation of the AEM data provided an additional data source for evaluating near-surface conditions in terms of percent coarseness of the material. Figure 2-15 shows the average percent coarseness (coarse fraction) in the top 50 ft of the subsurface along the survey flight lines. Darker blues represent finer material, while greens and yellows represent coarser material. On the eastern side of the Subbasin, where the alluvial fans identified in Figure 2-13 lie, the resistivity data indicate that the near-surface material is relatively coarser than in other areas of the Subbasin. This is consistent with general understanding of alluvial fan structure, where coarser materials are found further east where the gradient is higher. Increasingly to the west, the material becomes increasingly finer. Resistivity-based coarse fraction data complements ESJWRM model output, Hydrologic Soil Group mapping, Soil Agricultural Groundwater Banking Index (SAGBI) mapping, and geologic maps to identify areas in which natural groundwater recharge is occurring.

Figure 2-14: Existing Areas of Groundwater Recharge (ESJWRM Version 3.0)



Note: Figure shows the distribution of deep percolation of precipitation and applied water based on ESJWRM Version 3.0 model outputs. It does not include recharge from rivers and streams, boundary flows, or recharge projects.

Figure 2-15: Average Percent Coarse Fraction in Near-Surface Materials



2.1.4.5.2 Description of Discharge Areas

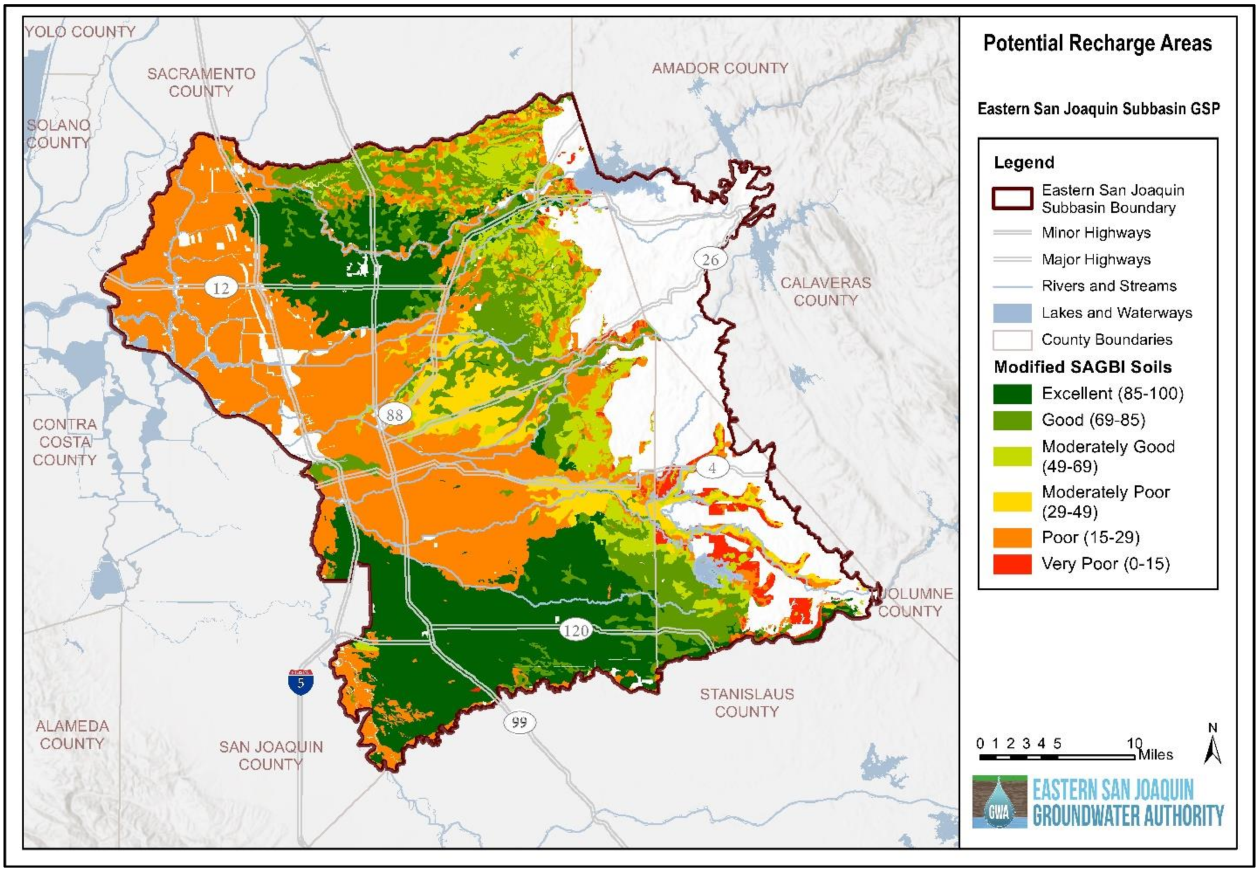
Groundwater discharge primarily occurs through groundwater production wells. Groundwater production in Eastern San Joaquin Subbasin is discussed further in Section 2.2. Groundwater also discharges to rivers and streams where groundwater elevations are higher than river stage. Other sources of groundwater discharge are evapotranspiration from riparian areas, phreatophyte woodlands, and other groundwater-dependent ecosystem (GDE) communities. Groundwater discharge to streams is described more in Section 2.2.6 and discusses analyses based on modeling results from the ESJWRM for approximately 1,700 stream nodes (locations along simulated streams where calculations are made related to stream flows and interaction with groundwater) in the Eastern San Joaquin Subbasin.

2.1.4.5.3 Description of Potential Recharge Areas

Figure 2-16 shows areas with their potential for groundwater recharge, as identified by the Soil Agricultural Groundwater Banking Index (SAGBI). SAGBI provides an index for the groundwater recharge for agricultural lands by considering deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition.

SAGBI data are derived from "modified" SAGBI data. "Modified" SAGBI data show higher potential for recharge than unmodified SAGBI data because the modified data assume that the soils have been or will be ripped to a depth of 6 feet, which can break up fine grained materials at the surface to improve percolation. Modified SAGBI data categorize 310,098 acres out of 610,890 acres (51 percent) of agricultural and grazing land within the Subbasin as moderately good, good, or excellent for groundwater recharge (University of California, Davis, 2018).

Figure 2-16: Potential Recharge Areas



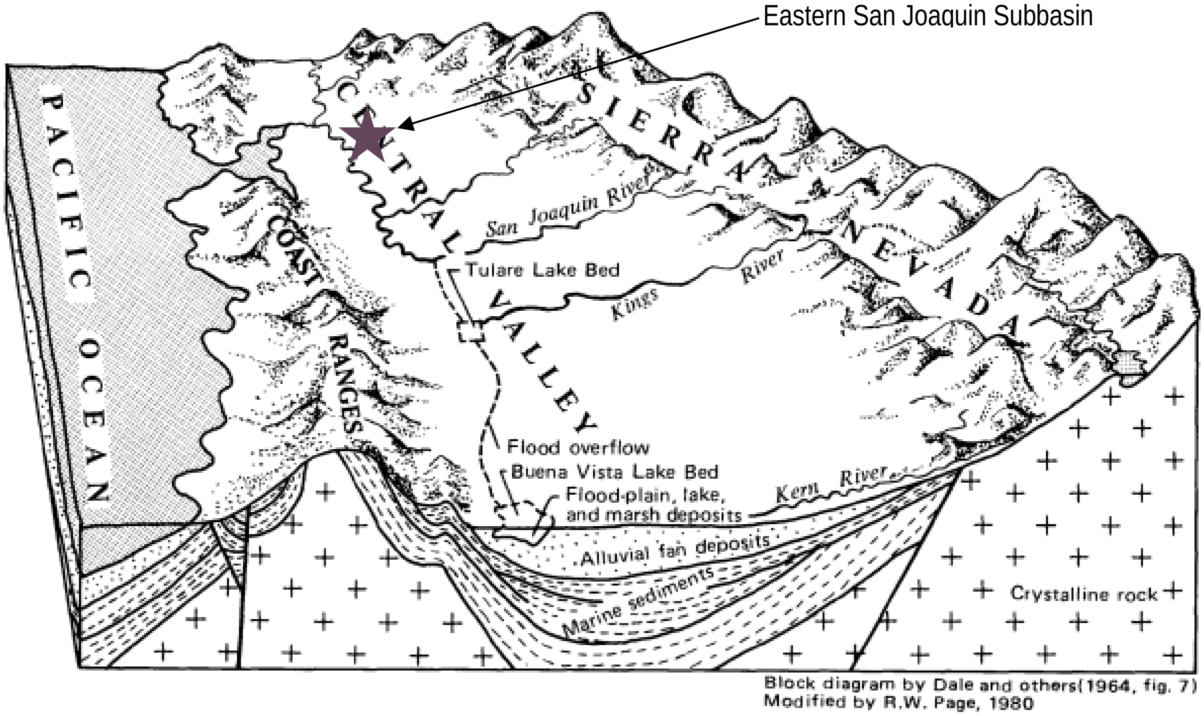
2.1.5 Geologic Formations and Stratigraphy

Geologic formations within the Central Valley and Eastern San Joaquin Subbasin are generally grouped as either eastside or westside formations based on their location relative to the San Joaquin River and the source of the sedimentary material of which they are composed. The Eastern San Joaquin Subbasin is located to the east of the San Joaquin River. Eastside continental formation material generally originates from deposits from the Sierra Nevada and westside continental formation material generally originates from the deposits of the Coast Range. Rising land masses contributed to the erosion and deposition of alluvial sands and fan deposits. Glaciation in the Pleistocene also contributed to the steepening of streams during melt water periods (CA DWR, 1967).

The block diagram of the Central Valley (Figure 2-17) provides a generalized geologic cross-sectional view of the geologic setting. The Eastern San Joaquin Subbasin is located in the foothills margin between the roughly horizontal alluvial sediments of the Central Valley geomorphic province, labeled "Central Valley" in Figure 2-17, and the granitic Sierra Nevada geomorphic province, labeled "Sierra Nevada" in Figure 2-17.

Sediment deposits can be subdivided into consolidated and unconsolidated deposits, with the consolidated sediments underlying the unconsolidated sediments. The most important fresh water-bearing formations in the Eastern San Joaquin Subbasin are the sands within the consolidated Mehrten and Laguna Formations and the unconsolidated younger alluvial deposits consisting of the Riverbank and Modesto Formations.

Figure 2-17: Generalized Geologic Section and Eastern San Joaquin Subbasin Setting



With depth, the stratigraphy of unconsolidated sediments consists initially of Recent to Pleistocene Age alluvial deposits of the Post-Modesto deposits and the Modesto and Riverbank Formations. The sediments of these units are typically unconsolidated sands and gravels interbedded with considerable silts and clays. These clays separate the upper sediments over the lower Late Plio-Pleistocene Age Laguna Formation and the older Eocene to Pliocene Age Mehrten Formation. The Laguna and Mehrten Formations are characterized by poorly consolidated sediments and are differentiated based on color and sand type. The Laguna Formation is typically light brown, and the differentiating characteristic of the Mehrten is black sands derived from volcanic detritus. The Valley Springs and Ione Formations are encountered below the Mehrten Formation. The formations have a distinct geologic dip and thickness to the west.

The geologic map shown in Figure 2-18 illustrates the surface deposits of the Pleistocene-aged Modesto Formation and Turlock Lake Formation largely within the valley floor (Wagner et al., 1981; Wagner et al., 1991). The knolls and ridges to the east represent outcrops of the Tertiary-aged Laguna, Mehrten, Valley Springs, and Ione Formations. The geologic stratigraphic column is provided on Table 2-2.

Figure 2-18: Geologic Map

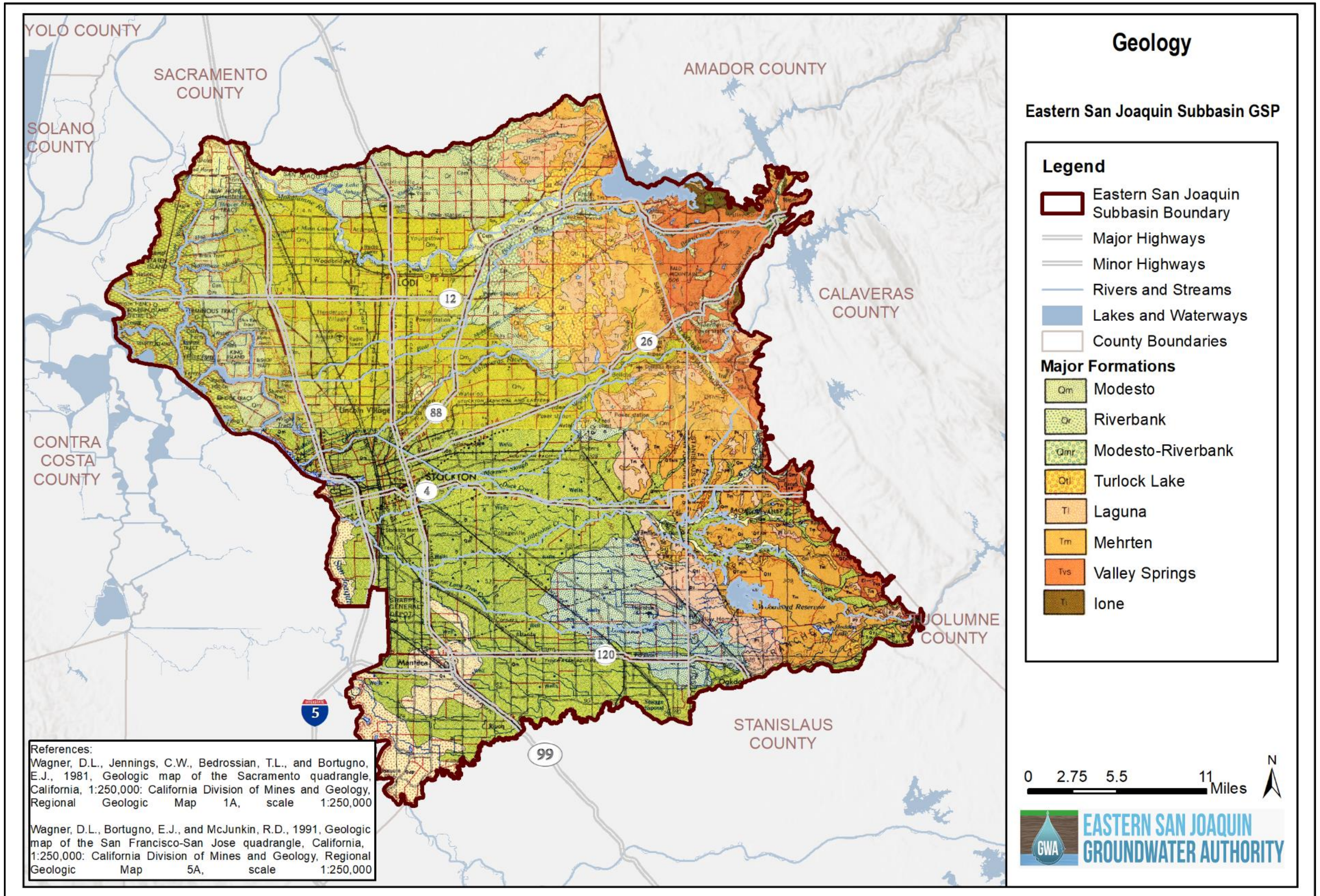


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Table 2-2: Generalized Stratigraphic Column, Formation Descriptions, and Water-Bearing Properties

Era*	Period*	Epoch*	Formation & Map Symbol	Thickness Maximum (feet)	Rock Characteristics and Environment	Water-Bearing Properties
CENOZOIC	Quaternary	Holocene	Stream Channel Deposits	50±	Continental unconsolidated gravel and coarse to medium sand deposited along present stream channels.	High permeability, significant avenue for percolation to underlying formations.
		Late Pliocene	Modesto (Qm)	65-130±	Continental fan and interfan material, locally some basin types, lenticular gravel, sand, silt, clay.	Moderate permeabilities. Unconfined aquifer.
		Pliocene	Riverbank (Qr)	150 to 250	Continental fan and interfan material, locally some basin types, lenticular gravel, sand, silt, clay. Reddish clay-rich duripan caps the unit.	Moderate permeabilities. Unconfined aquifer.
		Recent to Plio-Pleistocene	Flood Basin Deposits (Qb) Turlock Lake Formation (Qtl)	0-1,000±	Continental basinal equivalent of Laguna, Tulare & younger formations. Clay, silt & sand, organic in part.	Generally low permeabilities, saturated environment, unconfined to confined.
		Plio-Pleistocene	Laguna (Tl)	0-1000±	Continental, semi-to unconsolidated silt, sand & gravel, poorly sorted, includes Arroyo Seco Gravel pediment of Mokelumne R. area.	Moderate permeability, Unconfined to locally semi-confined. Restricted perched bodies in some areas.
	Tertiary	Mio-Pliocene	Mehrten (Tm)	0-600±	Continental andesitic derivatives of silt, sand and gravel & their indurated equivalents; tuff; breccia; agglomerate.	Moderate permeability to high where "black sands" occur. Confined to unconfined.
		Miocene	Valley Springs (Tvs)	0-500±	Continental rhyolitic ash, clay, sand & gravel and their indurated equivalent.	Low permeability. Not considered as significant in groundwater studies.
		Eocene	Ione (Tl)	0-500±	Light colored clay and sand. Marine shale, siltstone and sandstone	Contains saline waters except where flushed in outcrop areas.
MESOZOIC	Creta-ceous / Pre-Cretace-ous	Cretaceous Jurassic	Undifferentiated Bedrock		Igneous, metamorphics and ultramafics.	Contains saline waters. Not relevant to fresh water basin except as possible contaminant source.

Sources: CA DWR, 1967; Burow et al., 2004

* Figure 2-5 contains time scales corresponding to formations

2.1.5.1 Geologic Formation Descriptions

The Tertiary-age units that overlie the basement rocks and generally outcrop within the Eastern San Joaquin Subbasin are discussed in the following sections, from oldest to youngest.

2.1.5.1.1 Pre-Ione Eocene Rocks

The pre-Ione Eocene rocks, as described by Chapman and Bishop (1975), were deposited in a pre-Ione bedrock paleochannel system. Their composition includes sedimentary rocks of marine origin with biotite, chlorite, and muscovite. Feldspar is a significant component of this unit (Creely & Force, 2007). The thickness of this unit is highly variable in the foothill area as it is controlled by basement complex topography. The unit “wedges out” to the east and assumes a more uniform regional thickness to the west in the Central Valley Mesozoic-Cenozoic sediment pile (Creely & Force, 2007). Depictions and full geologic formation detail are provided in Table 2-2. The Tertiary volcanic and sedimentary rocks and terrace deposits are separated from the Jurassic volcanic/metamorphic basement by an angular unconformity from small-scale faulting. The Franciscan Group, Cretaceous, and Eocene Undifferentiated deposits have been impacted by the east-west Stockton Fault (CA DWR, 1967).

2.1.5.1.2 Ione Formation

The Eocene Age Ione Formation has been mapped along the eastern margin of the Eastern San Joaquin Subbasin and, as described by Loyd (1983), contains interbedded kaolinitic clay, quartz sand, sandy clay, and lignite. The Ione Formation is characteristically light in color, with color influenced by iron oxide, lignite, and carbonaceous mud rocks and shale (Creely & Force, 2007). Pask and Turner (1952) subdivided the Ione Formation into upper and lower members based on mineralogy. The upper and lower members contain kaolinite (anauxite) clays. Deposits can include coarse-grained sand (up to 2 mm diameter).

Ione sand is one of the most important sources of commercial clay and silica sand in the Ione Formation (Creely & Force, 2007). Ione sand has a white color with a pearly luster and appears massive; however, closer examination usually reveals cross stratification, heavy mineral laminae, and burrows (Creely & Force, 2007). Quartz is abundant with varying feldspar content in both members.

The lower member contains 8 to 10 percent feldspar, with the upper member containing 20 to 25 percent feldspar. The minerals biotite and chlorite are rare in the lower member and common in the upper member. Heavy mineral deposits vary. The lower member contains mature minerals like zircon and ilmenite. The upper member contains hornblende and epidote. Chromite is also commonly found in the Ione Formation. The upper member is largely absent north of Jackson Valley due to erosion and deposition during the development of the overlying Valley Springs Formation. The Ione Formation is deposited in both marine and fluvial continental environments (Creely & Force, 2007).

2.1.5.1.3 Valley Springs Formation

The Oligocene-Age Valley Springs Formation is described by Loyd (1983) as stream channel and alluvial deposits derived mainly from rhyolitic volcanic rocks, including some white, welded tuffs, and ash flows. The basal contact of the Valley Springs Formation is characterized, locally, by the presence of rhyolitic conglomerate. These tuffs may display alteration to clays, and, in extreme cases, only a claystone bed with relict tuffaceous texture remains. Pure deposits of rhyolitic ash exist in areas, while many sand and ash beds are present. In general, the clay beds of the Valley Springs Formation are greenish in color, may contain silt, sand, and large pumice fragments. The sandstones range in grain-size from fine to coarse and are typically well cemented. Predominantly composed of quartz and pre-Cretaceous material, the relatively sparse conglomerate lenses within the tuff, clay, and sandstone may also contain pumice fragments. In general, the Valley Springs Formation is predominantly fine-grained, containing less coarse-grained deposits. In the Central Valley, the Valley Springs Formation is considered to be largely non-water-bearing.

2.1.5.1.4 Mehrten Formation

Overlying the Valley Springs Formation is the Miocene Age Mehrten Formation, described as being stream channel, alluvial, and mudflow deposits derived mainly from andesitic volcanic rocks. The Mehrten Formation is considered the oldest significant fresh water-bearing formation within the Eastern San Joaquin Subbasin.

Bartow (1992) generally describes the Mehrten in the east-central portion of the Central Valley as being sandstone composed of amphiboles, pyroxenes, and pebbles (mostly volcanic) with lenticular bedding and gray to blue color. Bartow discusses a major change in regional volcanism as the rhyolitic pyroclastic deposits of the Late Oligocene and earliest Miocene were replaced near the end of the Early Miocene by reestablished andesitic arc volcanism in the northern Sierra Nevada. This andesitic volcanism provided the source materials for the Mehrten Formation.

Ferriz (2001) discusses how the Mehrten Formation outcrops discontinuously along the eastern flank of the Valley and was laid down in the Mokelumne area by streams carrying andesitic debris from the Sierra Nevada. The Mehrten thickens in the northeastern part of the San Joaquin Valley; generally, it can be more than 700 to 1,200 feet thick at depths ranging from more than 300 feet below ground on the east side of the valley to depths exceeding 1,400 feet along the central portion of the valley. The contact between the Mehrten Formation and underlying Valley Springs Formation is a non-distinct unconformity.

The Mehrten Formation is subdivided into upper and lower units. The upper unit contains finer grained deposits (black sands interbedded with brown-to-blue clay), and the lower unit consists of dense tuff breccia. Deep wells in the Stockton area indicate that the upper portion of the Mehrten Formation contains a high percentage of clay, suggesting that the upper portion of the unit may be finer grained than the middle or lower portions with resulting semi-confined conditions (CA DWR, 1967).

The black sands of the Mehrten Formation (black andesite detrital grains) generally have moderate to high permeability and yield large quantities of fresh water to wells, which makes them a preferred exploration target for groundwater supply in the eastern half of the Central Valley (Davis & Hall, 1959; CA DWR, 1967). East of Jack Tone Road, a large number of wells produce water from the relatively permeable “black sands” commonly described as hard sandstones (CA DWR, 1967).

2.1.5.1.5 Laguna Formation

The Pliocene to Pleistocene Laguna Formation is composed of discontinuous lenses of unconsolidated to semi-consolidated alluvial sands, gravels, and silts and is typically light brown. These poorly exposed stream-laid alluvial deposits form high terraces and are associated with the last major uplift in the Sierra Nevada.

The Laguna Formation outcrops in the northeastern part of San Joaquin County and dips at 90 feet per mile and reaches a maximum thickness of 1,000 feet, with the thickest areas (400 to 1000 feet) observed near the Mokelumne River in the Stockton Area (CA DWR, 1967). The Laguna Formation is moderately permeable with some reportedly highly permeable coarse-grained fresh water-bearing zones.

2.1.5.1.6 Turlock Lake Formation

The Turlock Lake Formation consists primarily of arkosic alluvium, mostly fine sand, silt, and in places clay, at the base grading upward into coarse sand and occasional coarse pebbly sand or gravel (Marchand & Allwardt, 1981). The age of the Turlock Lake Formation is about 600,000 to greater than 730,000 years old, but younger than about 1 million years. The Turlock Lake commonly stands topographically above the younger fans and terraces throughout the northeastern San Joaquin Valley, in a broad band between the Merhten, Laguna, and the younger Riverbank and Modesto alluvial fans to the west. A buried soil separates the Turlock Lake Formation into two units (upper and lower) in the northeastern San Joaquin Valley. The thickness of the Turlock Lake is variable and appears to increase toward the east. Estimates of thickness in the subbasins to the south range from 295 to 850 feet for eastern Stanislaus County, 1,000 feet for northern Merced County, and 160 to 720 feet in the Chowchilla area.

The Turlock Lake Formation is differentiated from the west to east by its Corcoran Clay member that is present in the southwest corner of the Subbasin near Manteca, and dominates the area west of Highway 99 south of the Eastern San Joaquin Subbasin. The Corcoran Clay becomes interbedded with the sands and silt of the upper Turlock Lake Formation and is not found in the central and northern portions of the Subbasin. The Corcoran Clay is found ranging in thickness from a feather edge to 160 feet beneath the present bed of Tulare Lake. The Turlock Lake Formation is dominant within the basins to the south.

2.1.5.1.7 Riverbank Formation

The Riverbank Formation consists primarily of arkosic sediment derived mainly from the interior Sierra Nevada, which forms at least three sets of terraces and coalescing alluvial fans along the eastern San Joaquin Valley (Marchand & Allwardt, 1981). The Riverbank Formation is about 130,000 to 450,000 years old. The Riverbank, as exposed in the northeastern San Joaquin Valley, is primarily sand, containing some scattered pebbles, gravel lenses, and some interbedded fine sand and silt. The Riverbank unconformably overlies the Laguna Formation, and its terraces and fans truncate or are cut into Turlock Lake alluvium or fill post-Turlock Lake gullies and ravines, which, in turn, are cut and filled near the foothills by terraces of the lower member of the Modesto Formation. The Riverbank Formation is informally subdivided into three units (lower, middle, and upper) which appear to coarsen upward, like those of the older Turlock Lake Formation. The Riverbank Formation also shows a variable thickness that tends to increase toward the major river channels; 150 to 200 feet is reported in northern Merced and eastern Stanislaus Counties, 260 feet along the Merced River, and about 65 feet along the Chowchilla River.

2.1.5.1.8 Modesto Formation

The Modesto Formation is composed of mainstream arkosic sediments and associated deposits of local derivation laid down during the last major series of aggradation events in the eastern San Joaquin Valley (Marchand & Allwardt, 1981). Gravel, sand, and silt were deposited as a series of coalescing alluvial fans extending continuously from the Kern River drainage on the south to the Sacramento River tributaries in the north. They occur in a wide band immediately east of the San Joaquin Valley axis and to the west of the Riverbank and older fan remnants. Radiocarbon dating estimates the age of the Modesto Formation to be older than 9,000 years before present (B.P.) to 42,000 years B.P. Most of the prime agricultural land and many of the major cities are located in the young alluvial soils associated with the undissected Modesto terrace and fan surfaces. Modesto deposits overlie late Riverbank alluvium and older units and are locally incised or covered along modern channels by post-Modesto deposits.

The materials of the Modesto Formation are virtually identical to those of the Laguna, Turlock Lake, and Riverbank Formations, but their association with low terraces and young fans and their moderate to slight degree of erosional modification and soil profile development clearly differentiate them from older alluvium. The total thickness of the Modesto deposits is reported to be 50 to 100 feet in eastern Stanislaus County, 130 feet along the Merced River, and about 65 feet along the Chowchilla River fan. The Modesto Formation also thickens toward each river channel and toward the south; there is significant evidence of local facies changes laterally. Exposed sections differ substantially from exposures near the foothills and from exposures along the westward draining rivers.

2.1.5.1.9 Post-Modesto Deposits – Recent Alluvium and Basin Deposits

In general, these younger units are less consolidated and sedimentary in nature, representing a sequence of young alluvial fills including alluvial fans, channel, point bar, levee, crevasse splay, interdistributary, and floodbasin alluvium. The alluvial fan deposits are much smaller than the late Modesto fans. The age of these deposits ranges from 9,000 years B.P to modern time. Lacustrine, swamp, and marsh deposits are presently accumulating in poorly drained areas on the alluvial fan toes. In oxbow lakes on river flood plains, near the edge of the Delta where Holocene sea level rise caused alluviation of the lower Mokelumne and Cosumnes Rivers, lakes and swamps have formed where tributary gullies have been blocked by mainstream aggradation (Marchand and Allwardt, 1981).

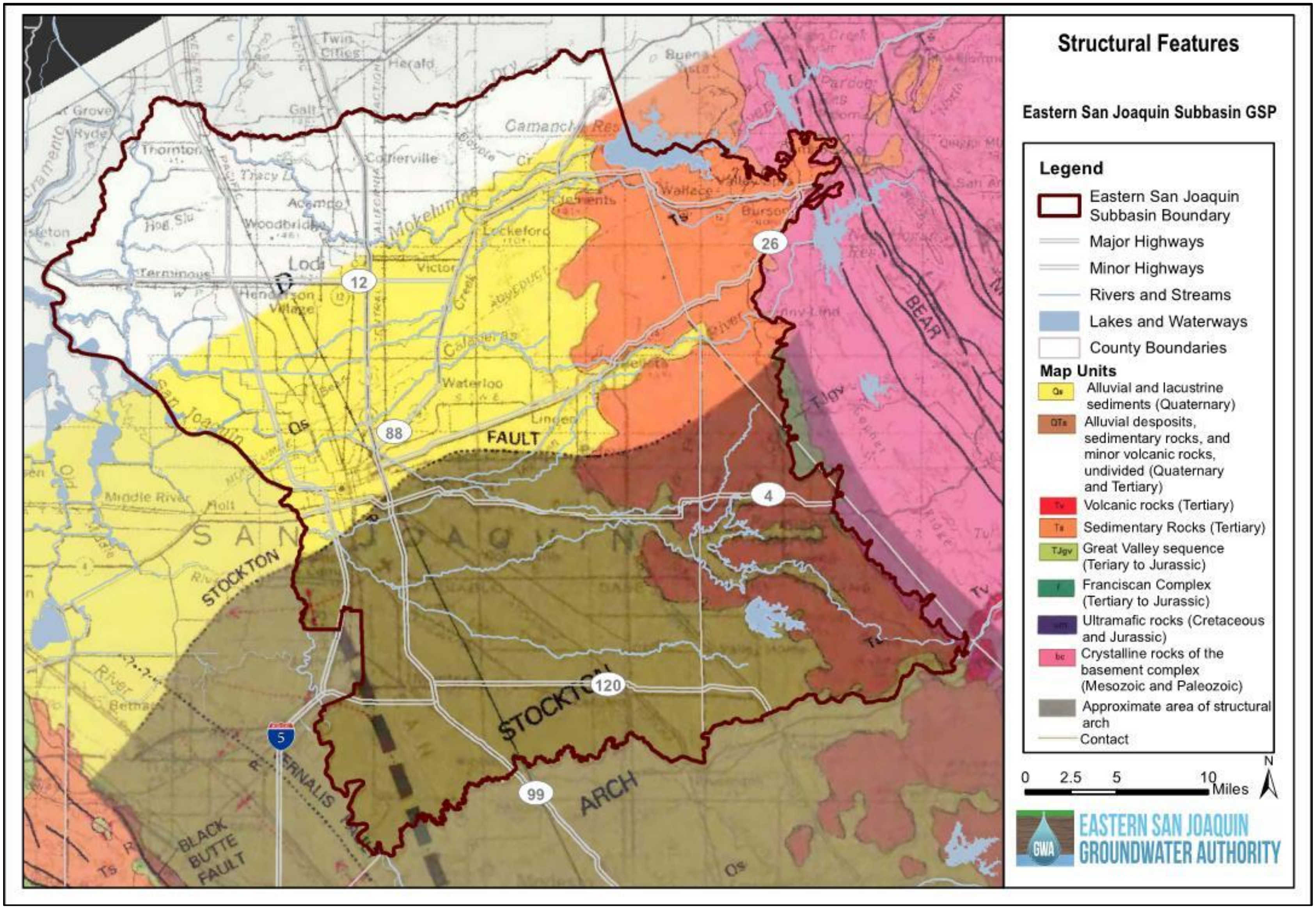
2.1.6 Faults and Structural Features

The Stockton Fault – The Stockton Fault is the largest fault in the Eastern San Joaquin Subbasin, shown in Figure 2-19. It is a large reverse fault with displacements of up to 3,600 feet (1,100 m) that trends transverse to the regional structure and bounds the Stockton Arch on the north. Bartow (1985) shows relative movement along the fault as north-side-down. The timing of the vertical movement is predominantly post-Eocene (Hoffman, 1964), and the latest movements appear to have been subsequent to deposition of the basal part of the Valley Springs Formation, probably during Miocene time.

The Vernalis Fault – The Vernalis Fault is a reverse fault with northwest-southeast trend that bounds the Tracy-Vernalis anticlinal trend that is mapped outside of the west boundary of the Eastern San Joaquin Subbasin. East-side-down movement of as much as 1,500 feet (460 m) probably took place at the same time as the major movements on the Stockton Fault (Bartow, 1985). The relative thickness of sediments can be inferred from the elevations of the base of the freshwater aquifer system shown in Figure 2-20. The freshwater aquifer system on the north side of the Stockton Fault extends approximately 600 feet deeper than the aquifer system south of the fault. Relative movement along the fault is north-side-down, thus allowing for greater accumulation of the continental Tertiary sediments and deepening of the aquifer materials in this area.

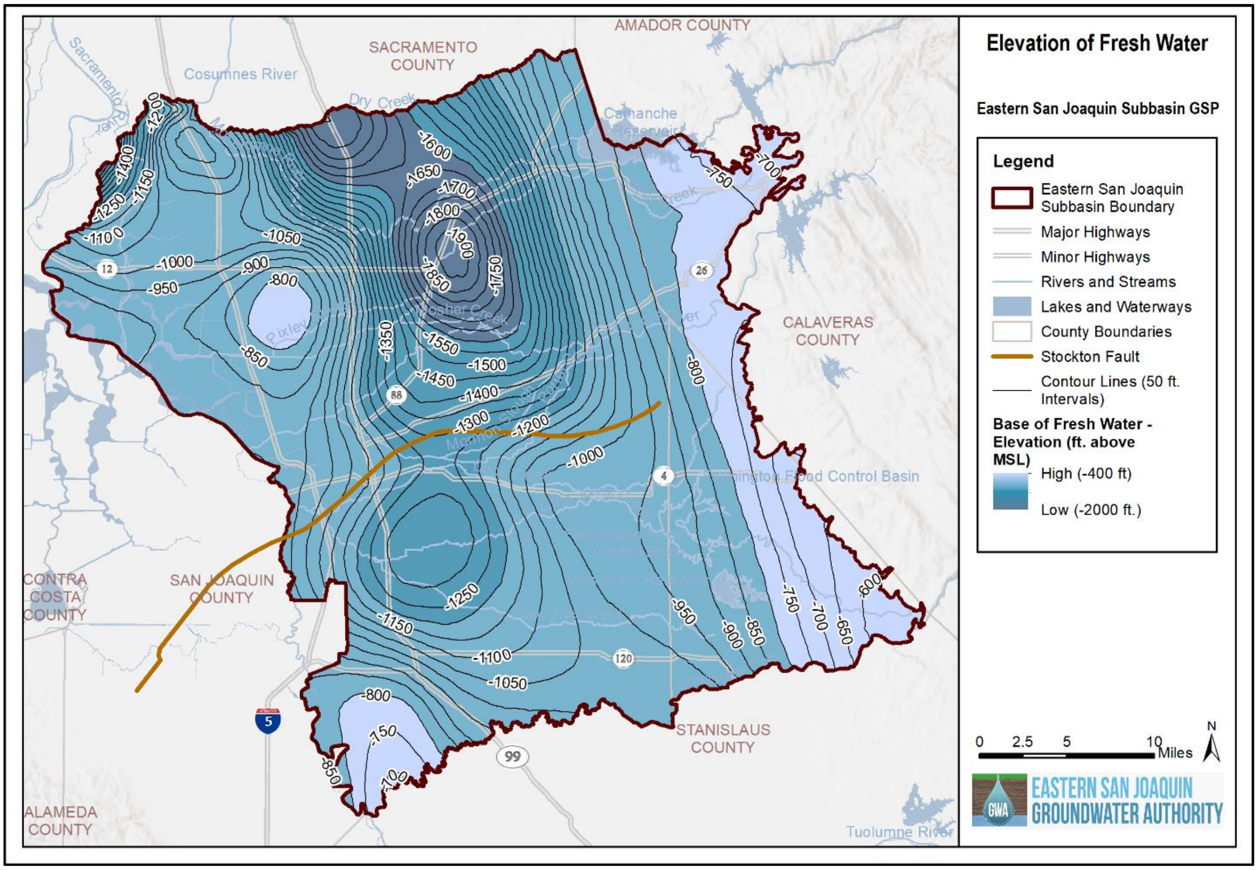
Stockton Arch – The Stockton Arch is a broad transverse structure that underlies the southern half of the Eastern San Joaquin Subbasin. The arch is bounded on the north by the Stockton Fault, and the southern limit is the line of truncation of Paleogene strata south of Modesto (Bartow, 1985). Indications of northward-shallowing marine facies in the lower Paleogene sequence suggests that the arch was present by Paleocene time. Erosion during the Oligocene time apparently reduced whatever physiographic expression the arch may have had and left a nearly flat plain prior to deposition of the later Tertiary units.

Figure 2-19: Faults and Structural Features



As a result of the north-side-down movement along the Stockton Fault, the Tertiary sediments are thicker north of the fault and thinner south of the fault. This feature also influences the location, depth, and thickness of the "base of the fresh water," as shown below in Figure 2-20. The base of fresh water is discussed further in Sections 2.1.7 and 2.1.8.2.

Figure 2-20: Base of Fresh Water Elevation and Stockton Fault



Angular unconformities – There are a series of angular unconformities formed during the Cenozoic-related to uplift of the Sierra Nevada to the east (Bartow, 1985). The Cenozoic history of the Sierra Nevada is one of progressive westward tilting, perhaps episodic, with an increasing rate in the late Cenozoic. The subtle angular unconformities that separate the Tertiary units are evidence of this progressive tilting. The Tertiary units rarely have dips of more than 2 degrees; the difference in dip between the Ione and the Valley Springs Formations, for example, may be less than 1 degree. The discordances are most apparent in terms of gradients of depositional surfaces measured in distances of several miles. The largest discordances are between the Ione Formation (about 1,500 feet/mile) and the Valley Springs Formation (94 - 120 feet/mile), between the Mehrten Formation (99 - 131 feet/mile) and the Laguna Formation (52 - 79 feet/mile), and between the Laguna Formation and the Quaternary deposits (less than 18 feet/mile). The Ione-Valley Springs unconformity represents the Oligocene regression that affected most of central and southern California, and the Mehrten-Laguna unconformity probably marks the accelerated uplift of the Sierra Nevada beginning 3 to 5 million years ago (Huber, 1981) in the central part of the range. The Sierra Nevada was relatively stable through the Miocene with only a minor discordance between the Valley Springs and Mehrten Formations; their lithological difference reflects primarily a change from rhyolitic to andesitic volcanism in the source area. Uplift of the Sierra Nevada continued through the Quaternary, but the record is complicated by Quaternary climatic events (e.g., glaciation) which were the principal controlling factor in Quaternary sedimentation for the east side of the Great Valley.

2.1.7 Geologic Cross-Sections

Five geologic cross-sections (A-A', B-B', C-C', D-D', and E-E') were developed for the Eastern San Joaquin Subbasin based on the stratigraphic information amassed as part of the data compilation efforts. A geologic cross-section is an interpretive diagram of the lateral and vertical subsurface relationships of geologic formations. A cross-section location map with locations of groundwater and oil and gas wells reviewed in the development process is provided as Figure 2-21. Three of the cross-sections (A-A' through C-C') are along east-west transects in the north, central, and southern portion of the Subbasin, respectively; two of the cross-sections (D-D' and E-E') are generally along north-south transects. Cross-section D-D' generally transects the cities of Lodi, Stockton, and Manteca in the west portion of the Subbasin, and cross-section E-E' transects the Eastern San Joaquin Subbasin along the alignment of Jack Tone Road from the northeast to the southwest portion of the Subbasin. Each of the five geologic cross-sections are provided in Figure 2-22, Figure 2-23, and Figure 2-24.

Four additional cross-sections (F-F', G-G', H-H', and I-I') were added as part of the 2024 Amended GSP, following the release of DWR's AEM data. To supplement the existing cross-sections by geologic formation, these additional cross-sections show an estimate of percent coarseness of the subsurface material. Percent coarseness estimations were developed by DWR, derived from AEM resistivity data through a comprehensive translation process in which texture characteristics of the subsurface are related to the collected resistivity measurements. Cross-sections by coarse fraction represent multiple flown survey lines stitched together to show a continuous line. Darker brown areas represent relatively finer materials (lower coarse fraction) and lighter yellow areas represent coarser materials (higher coarse fraction). Lithology logs used by DWR to generate the texture interpretation of the resistivity data are included on each cross-section. Figure 2-25 shows the locations of these four additional cross-sections. Cross-sections F-F', G-G', H-H', and I-I' are included in Figure 2-26, Figure 2-27, Figure 2-28, Figure 2-29, respectively.

Figure 2-21: Cross-Section, by Formation, Location Map

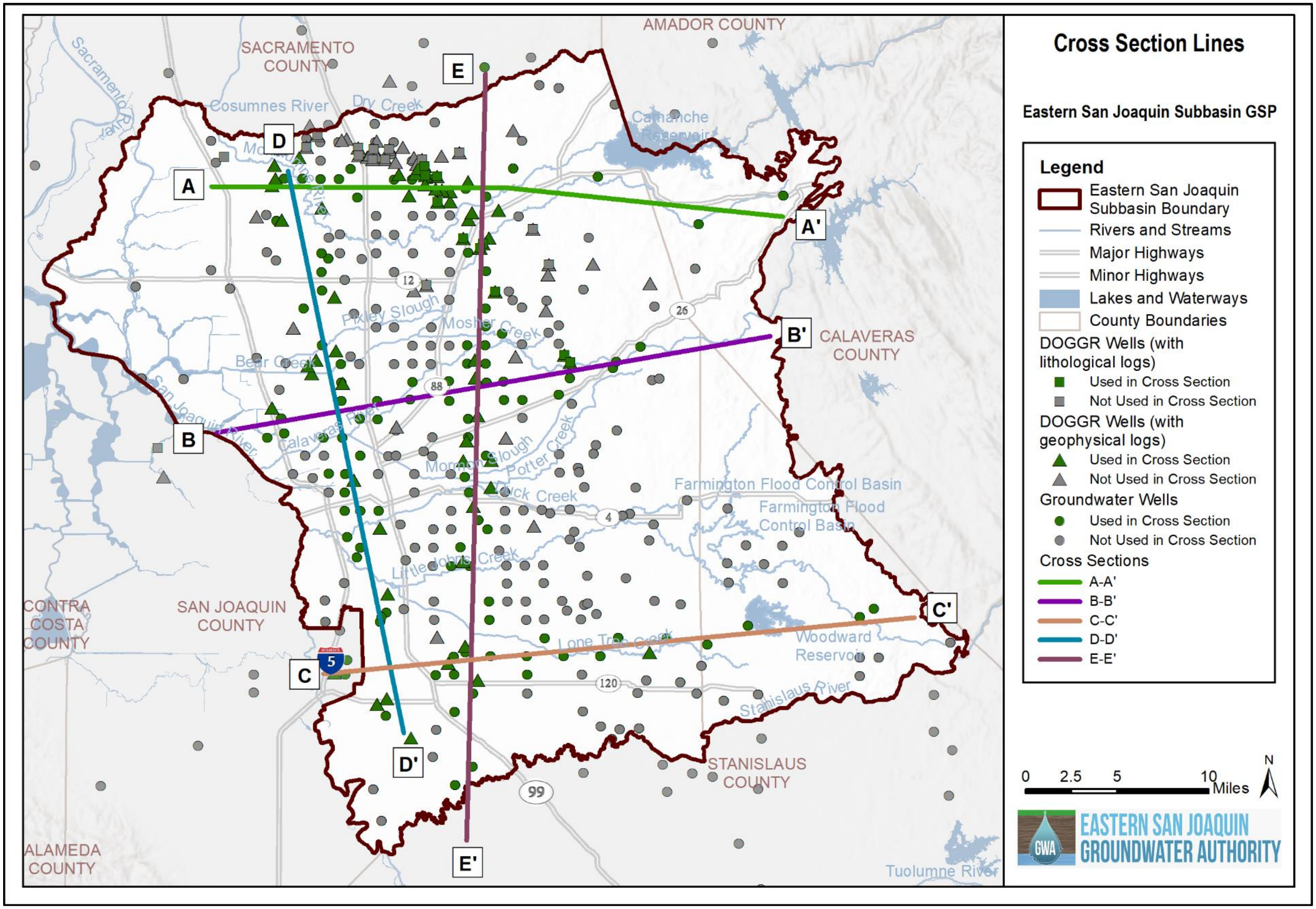


Figure 2-22: Hydrogeologic Cross-sections A-A' and B-B'

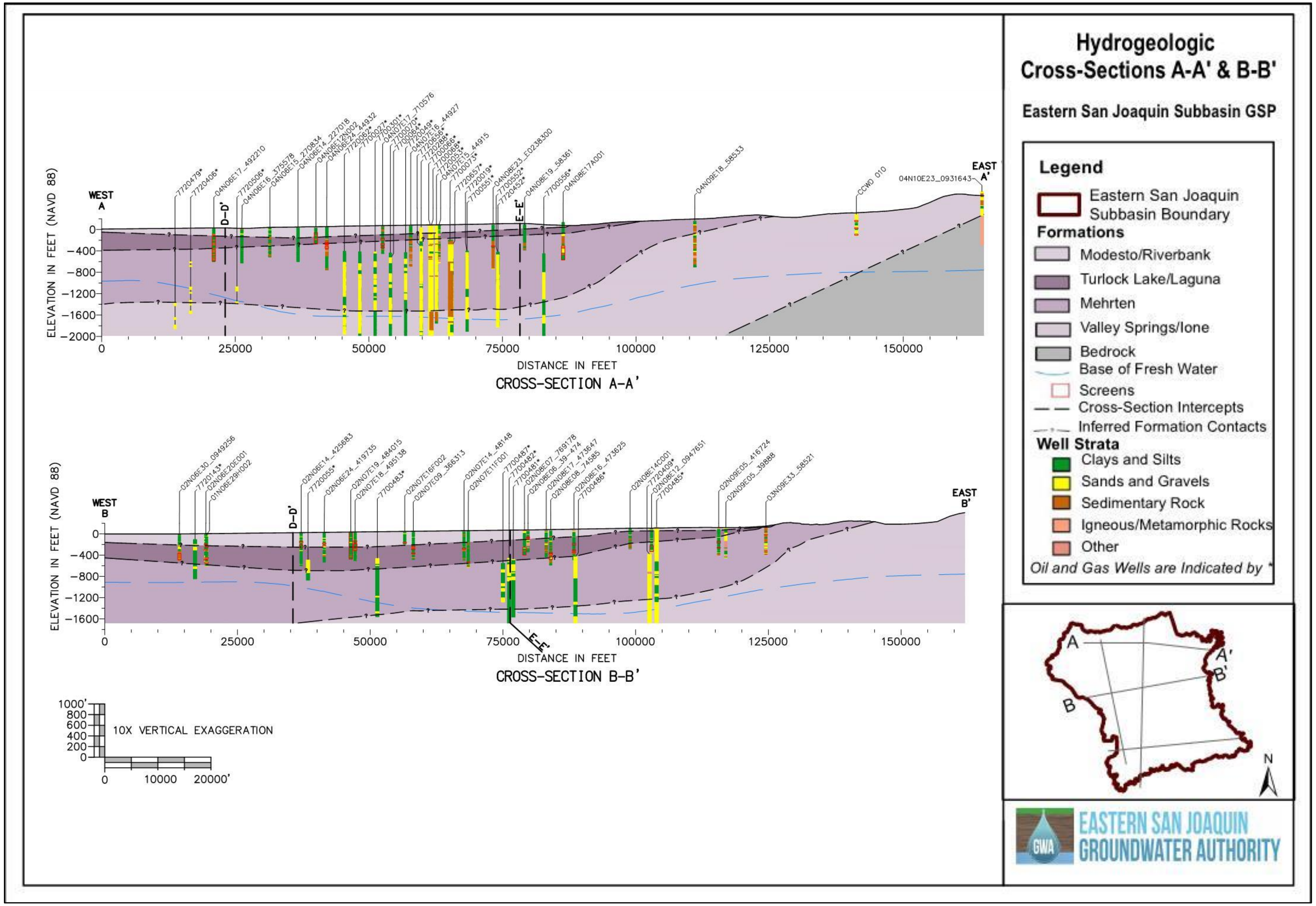


Figure 2-23: Hydrogeologic Cross-sections C-C' and D-D'

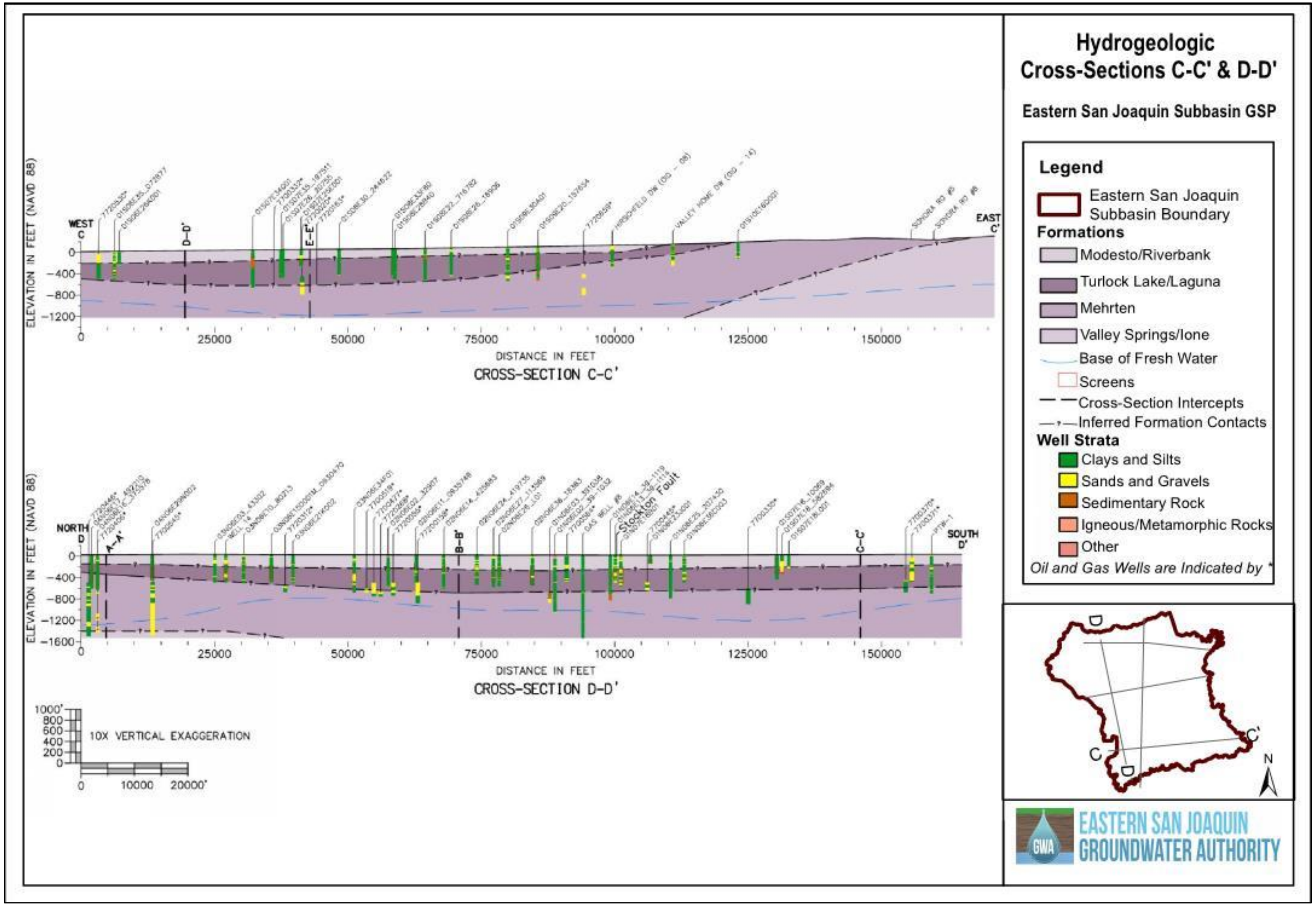


Figure 2-24: Hydrogeologic Cross- section E-E'

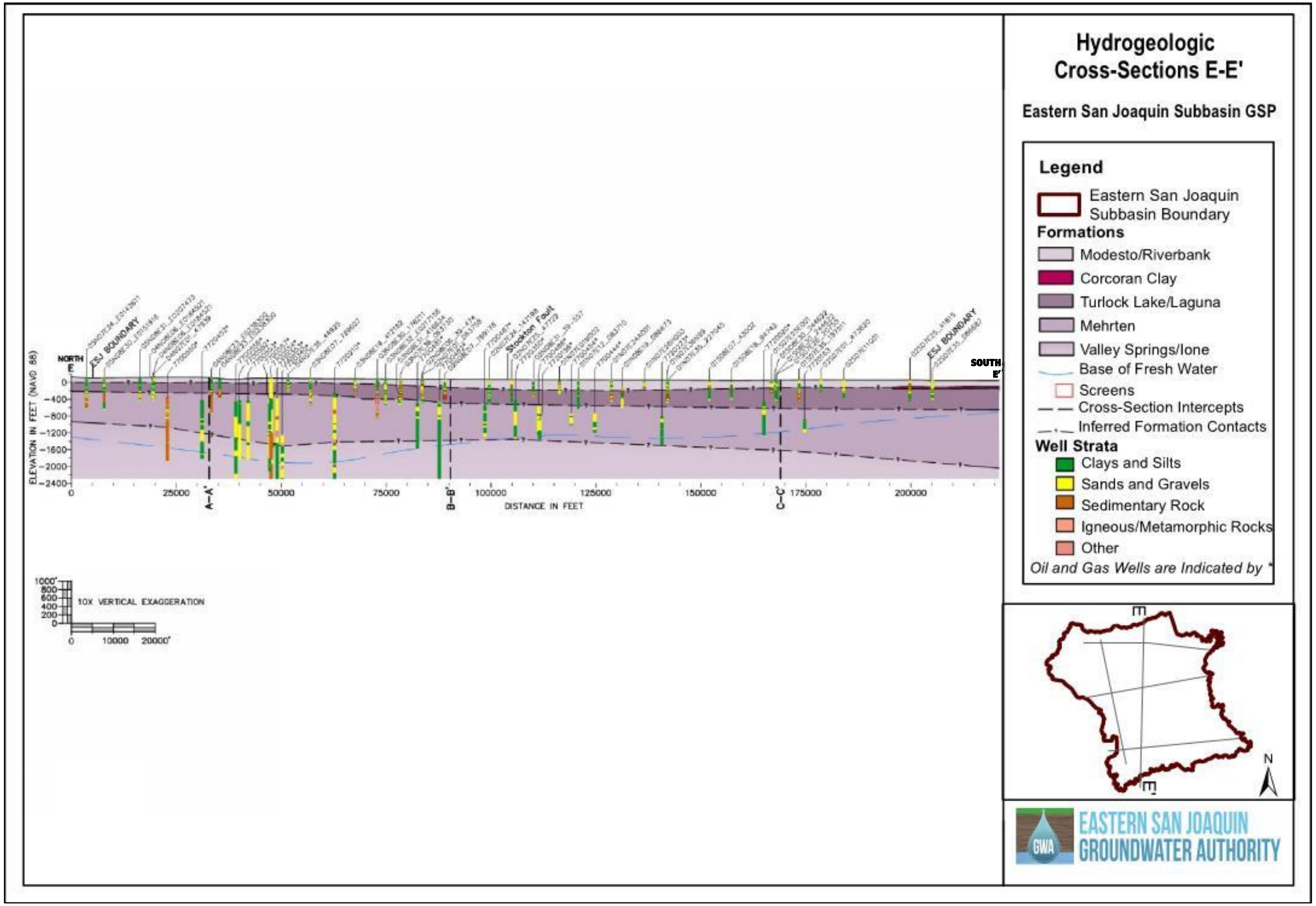


Figure 2-25: Cross-Section, by Percent Coarseness, Location Map

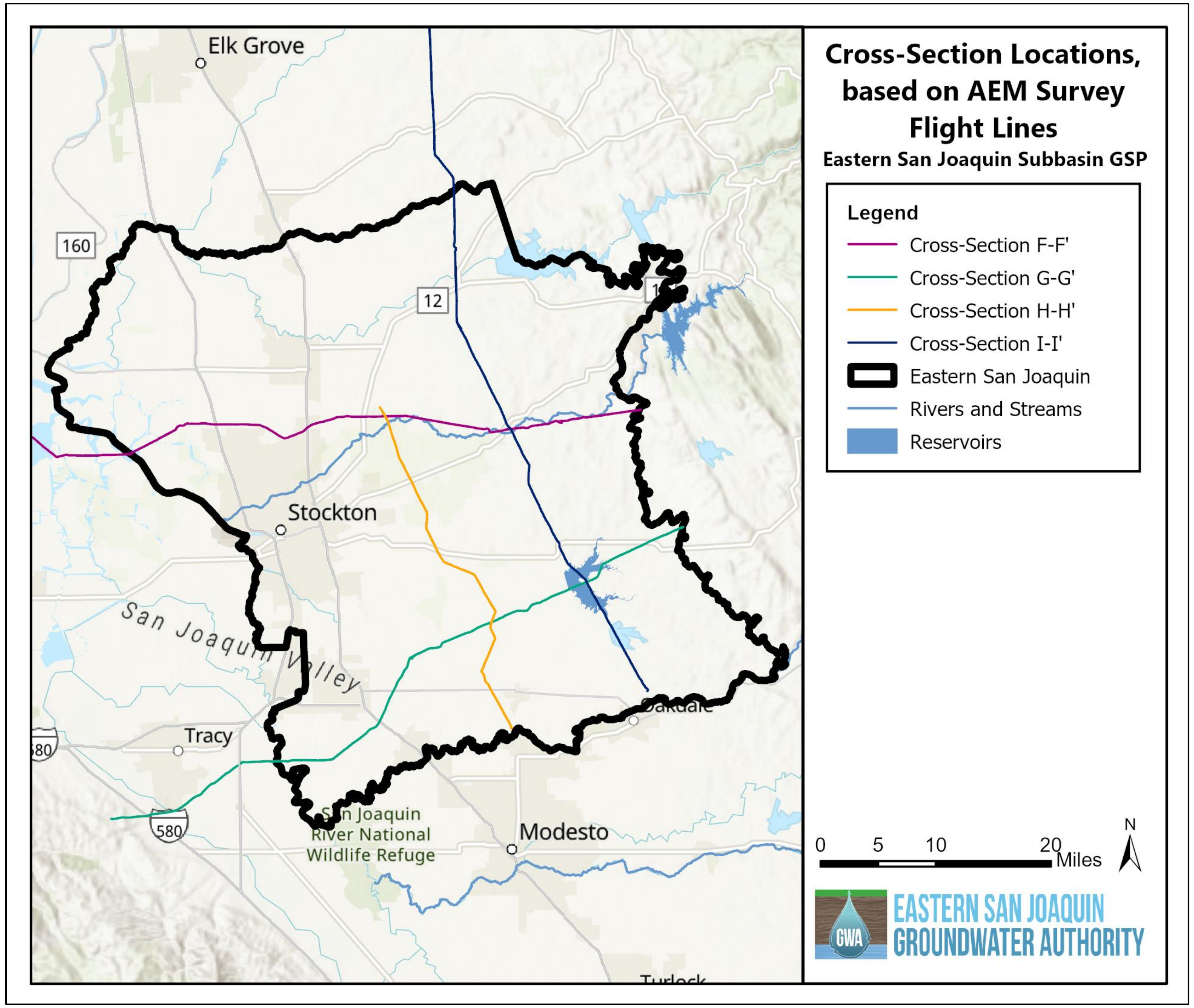


Figure 2-26: Percent Coarse Cross-Section F-F'

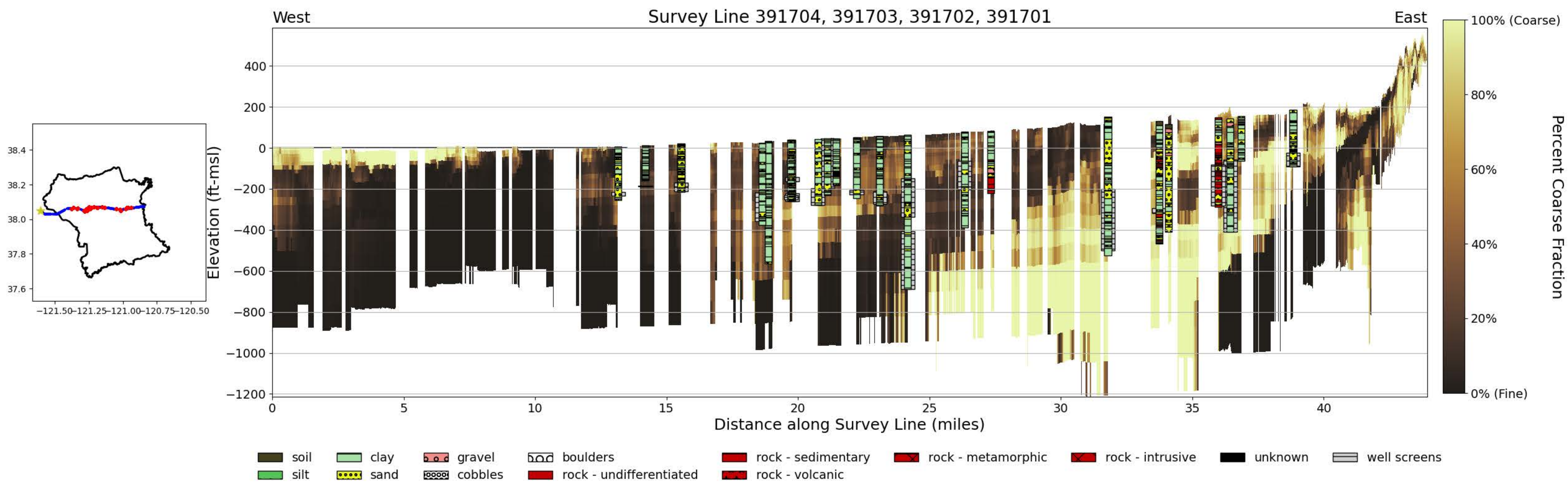


Figure 2-27: Percent Coarse Cross-Section G-G'

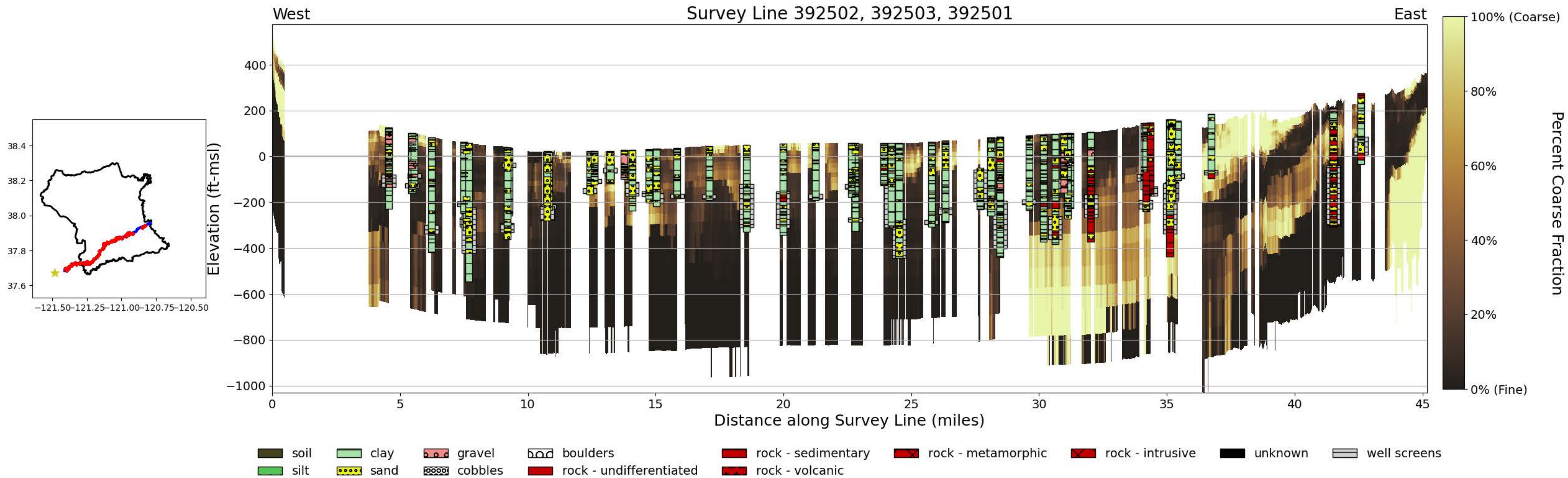


Figure 2-28: Percent Coarse Cross-Section H-H'

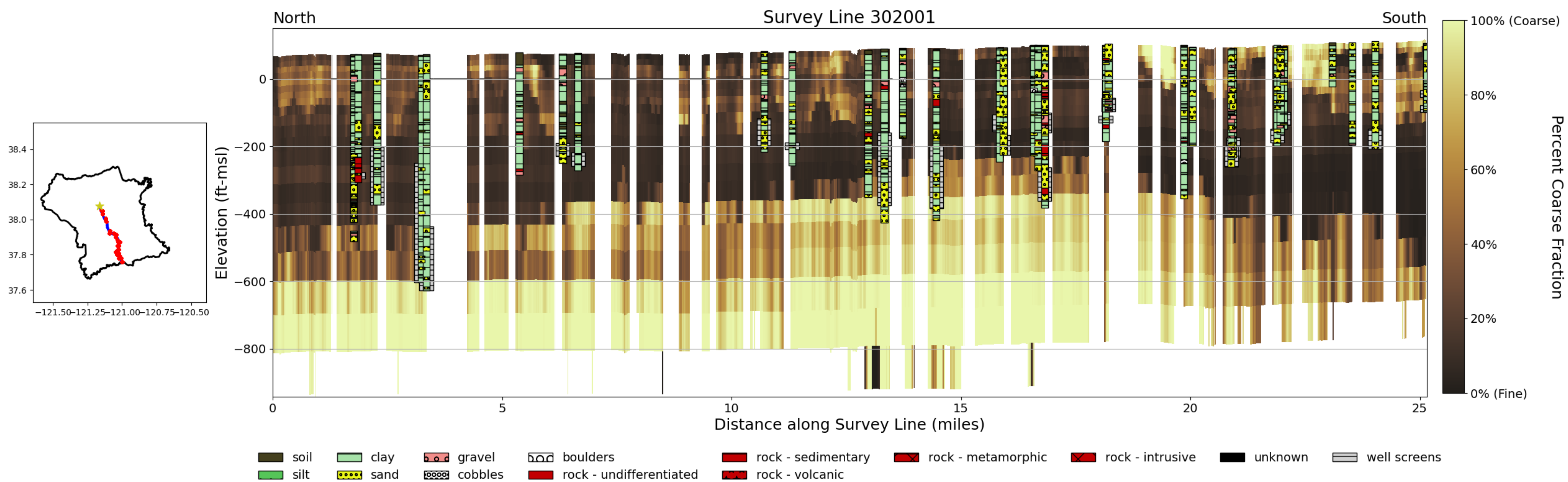
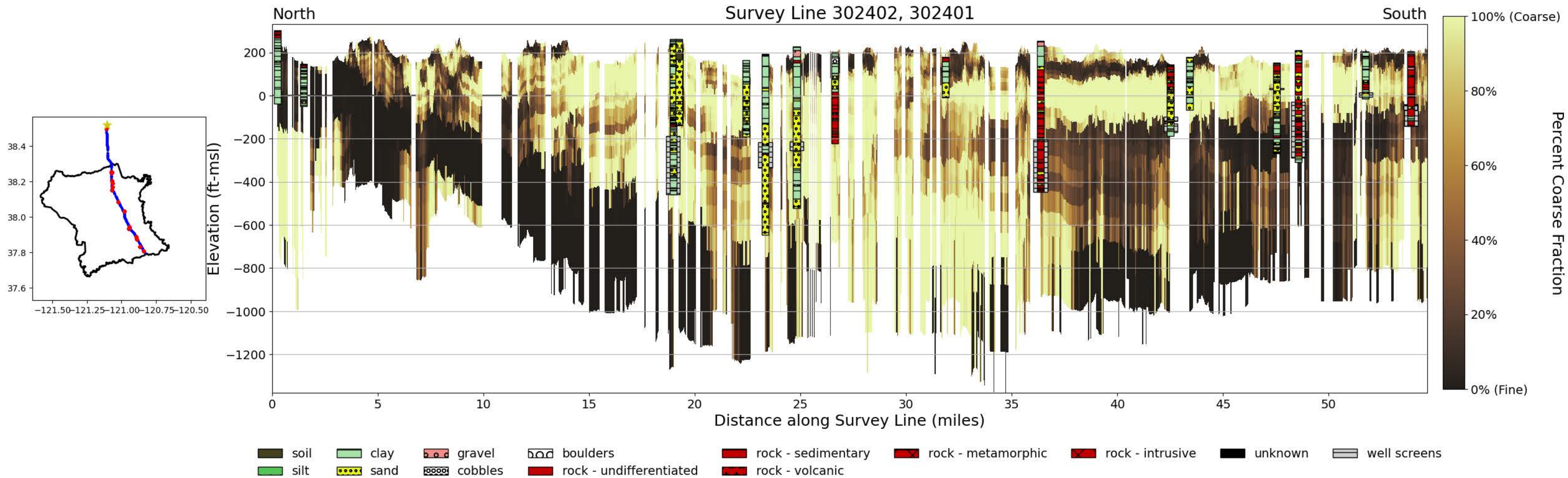


Figure 2-29: Percent Coarse Cross-section I-I'



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Stratigraphic data from well completion reports of hundreds of water wells and oil and gas wells (indicated by an asterisk on the cross-sections) were used to develop the geologic cross-sections. Stratigraphy (e.g., clays and silts, sands and gravels, sedimentary rock, metamorphic and igneous rock) is presented directly on the cross-sections along with the well screen interval (shown in red). The deeper oil and gas wells are shown extending to the bottom depth of the cross-sections, but many extend several hundred to thousands of feet beyond the depictions provided.

The analysis interpreted geologic formations from the borehole data after digitizing stratigraphic data from the various well log sources. This process relied heavily on the distinguishing features of each formation. Particularly, the black sands prevalent in the Mehrten Formation and evidence of shells noted in the descriptions that likely indicated a change to marine sediments of the Ione Formation were often mentioned in well logs. The analysis used surficial geology, location, and depth of the borehole to determine geologic formations. The analysis inferred formation contacts in places where data were limited, including areas on the east and west limbs of the cross-sections, as well as vertically throughout.

As evident on the east-west geologic cross-section transects, the oldest formations are present on the east side of the Eastern San Joaquin Subbasin, shown overlapping the older sedimentary and/or basement rocks of the Sierra Nevada (A-A'), with progressively younger formations present to the west and vertically occupying shallower depth intervals. The east-west depictions also show the contacts of the formations steeply dipping in the east and nearly flat lying or at low gradients to the west. The northwest-southeast trending cross-section D-D' shows the formations in their relatively flat-lying positions, with oldest formations on the bottom and progressively younger formations above. This cross-section transect is essentially normal to the dip of the beds. In slight contrast to D-D', the transect of cross-section E-E' is somewhat oblique to the dip of the beds, thus there is an apparent down-dip toward the south. This effect is seen because the transect is moving into younger materials from the south toward the north.

The base of fresh water is superimposed on the cross-sections as supported by works from Page (1974) and Williamson (1989), as represented in Figure 2-20. The base of the fresh water represents the vertical extent of fresh non-saline groundwater within the Eastern San Joaquin Subbasin principal aquifer. The sands of the Mehrten Formation are thickest in the northeast portion of the basin and there is a corresponding deepening of the freshwater aquifer on the north side of the Stockton Fault, as shown on cross-sections A-A' and B-B'. The depth of the base of fresh water is shallower south of the Stockton Fault in the southern portion of the Eastern San Joaquin Subbasin. Further discussion of the principal aquifer is provided in Section 2.1.9.

Well depths generally decrease in total depth from north to south across the Subbasin and locally within proximity of the major surface water drainages. In general, coarser sands are found at shallower depths within the lower unit of the Laguna Formation and upper Mehrten Formation (C-C') in the area of the Stanislaus River Drainage. Similarly, shallow well completions evident on cross-section D-D' and the southern portion of E-E' are indicative of the sandier nature of the recent alluvial deposits, the Turlock Lake Formation, and the Laguna Formation near the San Joaquin River.

2.1.8 Basin Boundaries

2.1.8.1 Lateral Boundaries and Boundaries with Neighboring Subbasins

The Eastern San Joaquin Subbasin is within the larger San Joaquin Valley, which comprises the southernmost portion of the Great Valley Geomorphic Province of California. Groundwater subbasins bounding the Eastern San Joaquin Subbasin are shown in Figure 1-5 and include:

- Cosumnes Subbasin to the north of Dry Creek
- Modesto Subbasin to the south of the Stanislaus River
- South American Subbasin to the northwest of the Mokelumne River
- Solano Subbasin to the northwest of the Mokelumne River

- East Contra Costa Subbasin to the west of the San Joaquin River
- Tracy Subbasin to the west of the San Joaquin River

Foothill and bedrock highs are to the east within Calaveras and Amador Counties.

2.1.8.2 Definable Bottom of the Basin

The base of the fresh water defines the bottom of the basin, the maximum vertical extent of fresh non-saline groundwater within the Eastern San Joaquin Subbasin. While water-bearing materials exist below this depth, the saline nature of the groundwater, in addition to the depth itself, generally makes accessing deeper groundwater not economically viable.

Because of the extreme depths to the base of fresh water shown in Figure 2-20, efforts by the USGS have been used to define the "base of fresh water" through the interpretation of the California DOGGR well logs and deep oil well geophysical logs as depicted on maps and cross-sections above. Base of fresh water (encountered saline) has been observed as shallow as 650 feet below ground surface (bgs) in the eastern part of the basin to over 2,000 feet bgs in the northern part of the basin as depicted on the surface contour map and supported by work completed by Williamson (1989).

2.1.9Principal Aquifer

The Eastern San Joaquin Subbasin HCM has one principal aquifer that provides water for domestic, irrigation, and municipal water supply and that is composed of three water production zones. The zones have favorable aquifer characteristics that deliver a reliable water resource because of their basin location and sand thickness.

The zones are:

- Shallow Zone that consists of the alluvial sands and gravels of the Modesto, Riverbank, and Upper Turlock Lake Formations
- Intermediate Zone that consists of the Lower Turlock Lake and Laguna Formations
- Deep Zone that consists of the consolidated sands and gravels of the Mehrten Formation

Details on the formations are provided in Section 2.1.5.

2.1.9.1 Zones within Principal Aquifer

Zones within the principal aquifer are based on the compilation of five hydrogeologic cross-sections (see Figure 2-22 through Figure 2-24). Cross-sections were based on over 330 well logs in the Subbasin. From these data, well depths for municipal and irrigation wells range from 75 to over 800 feet bgs, with an average depth of 350 feet bgs. Well logs were reviewed for the following information used in preparing the cross-sections:

- Depth of water table
- Depth and thickness of saturated fine to coarse grained sand and gravel layers
- Depth and thickness of discrete layers of sands
- Depth and thickness of discrete clay or silt layers that locally confine groundwater
- Depth of water-bearing aquifer materials (e.g., sands and gravels) down to the base of fresh water and deeper, where available

Analyses identified significant permeable zones with high production rates and good water quality at relatively shallow depths (less than 700 feet bgs) due to the following conditions:

- The relatively shallow depths of production wells had high specific capacity that met the water supply demand and reduced the cost associated with drilling deeper
- The base of fresh groundwater is deep; ranging from depths of 700 to 1,900 feet bgs
- Deeper water is saline and not considered suitable for potable or agricultural use

These results were cross-checked with the AEM data to validate the texture of shallow deposits, such as alluvial fans and sediments that interact with streams, and were used in updates to the hydrogeological conceptual model and the ESJWRM model stratigraphy. See Appendix 2-C for more detail on how AEM texture data were incorporated into the representation of Subbasin hydrostratigraphy.

Figure 2-30 and Figure 2-31 depict the wells used during this hydrogeologic characterization effort. Information compiled was used to detail the three permeable water-bearing zones described from surface downward in the following sections.

Figure 2-30: Bottom Elevation of Water-Bearing Zones (Shallow)

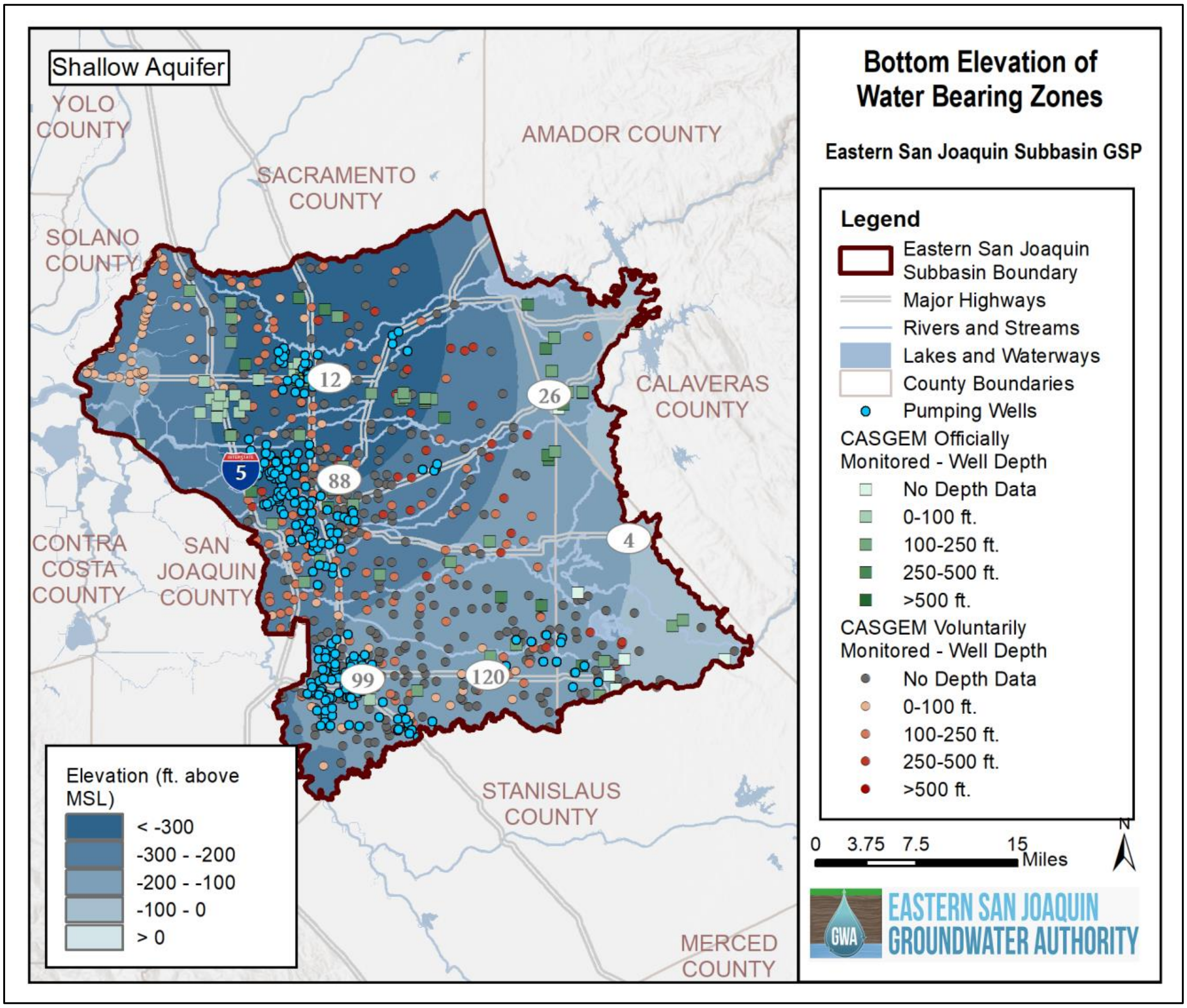
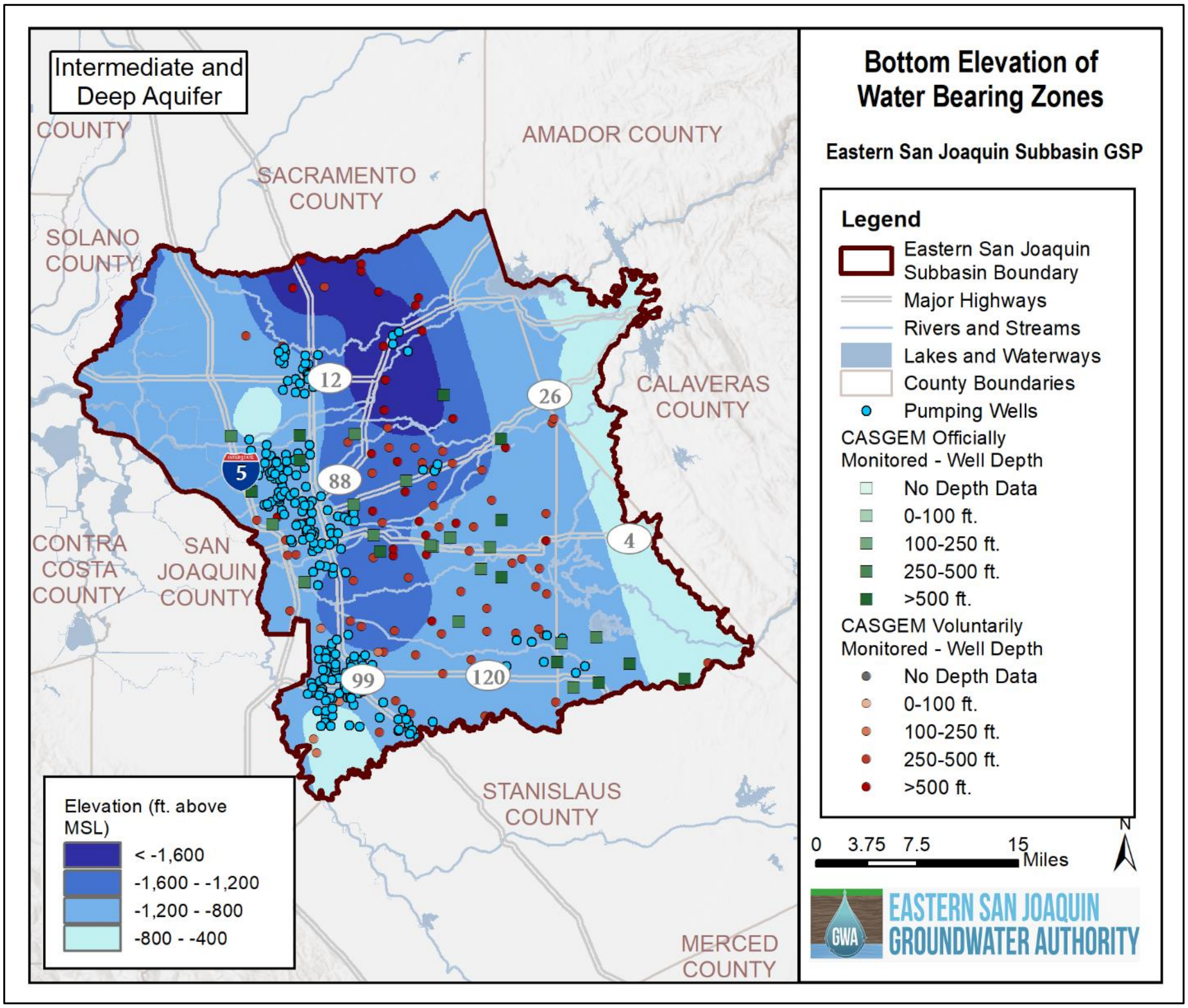


Figure 2-31: Bottom Elevation of Water-Bearing Zones (Deep and Intermediate)



2.1.9.1.1 Shallow Zone

The shallow water-bearing zone is composed of permeable sediments from recent alluvium, Modesto/Riverbank Formations, and the upper unit of the Turlock Lake Formation that are present west of the older geologic formations and extend across the majority of the Eastern San Joaquin Subbasin. This zone is generally unconfined above the aquitards (clays/silts, including Corcoran clay, and old soil horizons/hardpan layers).

The depositional structure on the eastern side of the valley trough is depicted on the hydrogeologic cross-sections A-A' through E-E' (see Figure 2-22, Figure 2-23, and Figure 2-24). This structure results in the groundwater flow that follows both the dip of the beds and hydraulic head differentials. Erosional and depositional features dominate aquifer characteristics. The cross-sections also depict the aquifer thickness from 30 feet to greater than 300 feet.

The Shallow Zone characteristics are supported by the sand thickness information detailed below along with review of basin aquifer parameters and AEM texture data. This zone has high yielding wells. Aquifer characteristic values range as follows (CA DWR, 1967; Burow et al., 2004):

- Transmissivities up to 90,000 gpd/feet

- Specific yields up to 17 percent
- Vertical permeability estimates up to 0.1 feet/day

2.1.9.1.2 Intermediate Zone

As depicted on the hydrogeologic cross-sections A-A' through E-E' (see Figure 2-22, Figure 2-23, and Figure 2-24), sands, typically from 10 to over 60 feet thick, are found below the low permeable clay layers or aquitards. The sands and gravels are developed with one relatively continuous sand unit at 350 feet bgs, within the top of the lower unit of the Turlock Lake Formation and Laguna Formation, thinning out at topographic highs to the east. Eastern basin depositional structure shows a pinching, wedging, and combination water-bearing zones with the surficial alluvium.

The aquifer characteristics are supported by the sand thickness information detailed herein for the principal aquifer. The eastern distribution of this water-bearing zone near the surface suggests unconfined groundwater conditions. Typically, this zone is found under semi-confined conditions with high yielding wells and is considered the current primary production zone. Area groundwater numerical models support the CA DWR (1967) and Burow and others (2004) aquifer characteristic values range as follows:

- Transmissivities up to 59,500 gallons per day (gpd)/feet
- Storage coefficients typically 0.00001 (unitless)
- Vertical permeability estimates up to of 0.07 feet/day

2.1.9.1.3 Deep Zone

The water-bearing "black sands" of the semi-consolidated Mehrten Formation are considered a significant source of water for Eastern San Joaquin Subbasin production wells. The formation is thick in the west, with a limited number of deep wells that penetrate the entire depth of this unit as depicted on the hydrogeologic cross-sections A-A' through E-E' (see Figure 2-22, Figure 2-23, and Figure 2-24). This water-bearing zone is confined due to the thick overlying clay units, consolidation, and basin location. Semi-confined conditions are more likely to the east because of the dipping of beds and stratigraphic layer thinning and erosion of clay/silt beds. The beds of the Mehrten Formation dip are at a steeper slope of 90 to 180 feet per mile westward. Consolidated sediments of the Mehrten and Valley Springs Formations are at valley bottom depth and exposed on the eastern foothills. Recharge to these aquifer formations occurs because of the high topographic setting with increased rainfall and exposure of weathered surface and runoff from the adjacent fractured Sierran bedrock.

As depicted on the hydrogeologic cross-sections A-A' through E-E' (see Figure 2-22, Figure 2-23, and Figure 2-24), boring logs indicate a significant 30-foot thick gravel encountered at a depth from 140 to 170 feet. Thickly bedded sands were found to exceed 250 feet. At the eastern margins of the basin, consolidated portions of the Mehrten, Valley Spring, and Ione Formations are important for low-yielding bedrock wells and are considered aquifer recharge sources for the Eastern San Joaquin Subbasin. The relatively low permeability and consolidated nature of the Valley Springs and Ione Formations act as the bottom of the Deep Zone (Burow et al., 2004).

The aquifer characteristics are supported by the sand thickness information. The well yields are high in this zone, over 1,000 gallons per minute (gpm). Area groundwater numerical models support the CA DWR (1967) and Burow and others (2004) aquifer characteristic values range as follows:

- Transmissivities up to 250,000 gpd/feet
- Storage coefficients that are typically 0.0001
- Vertical permeability estimates up to of 0.05 feet/day

2.1.9.1.4 Limited Aquitards

The Corcoran Clay member of the Turlock Lake Formation and other interbedded clay/silts are aquitards that inhibit groundwater flow. The Corcoran Clay (found at the base of the upper unit of the Turlock Formation) is present at a depth of about 200 feet bgs. The Corcoran Clay has a limited distribution in the extreme southwestern extent of the Subbasin, southwest of the City of Manteca. The clay is typically 20 to over 100 feet thick and is locally eroded and interfingered with coarser materials at its margin. Groundwater below the Corcoran Clay is confined. The Corcoran Clay is found more significantly in subbasins to the south where it is a significant vertical barrier to flow.

Thick clay and silt layers are found within the Laguna and Mehrten Formations. These two formations each have two documented upward coarsening alluvial sequences (Burow et al., 2004). Significant clay and paleosols divide the water-bearing zones at the base of each sequence. The cross-sections (Figure 2-22, Figure 2-23, and Figure 2-24) show both the clay and silt horizons range in thickness from less than 10 feet to over 150 feet. The vertical permeability estimates range from 0.01 to 0.007 feet per day (Burow et al., 2004).

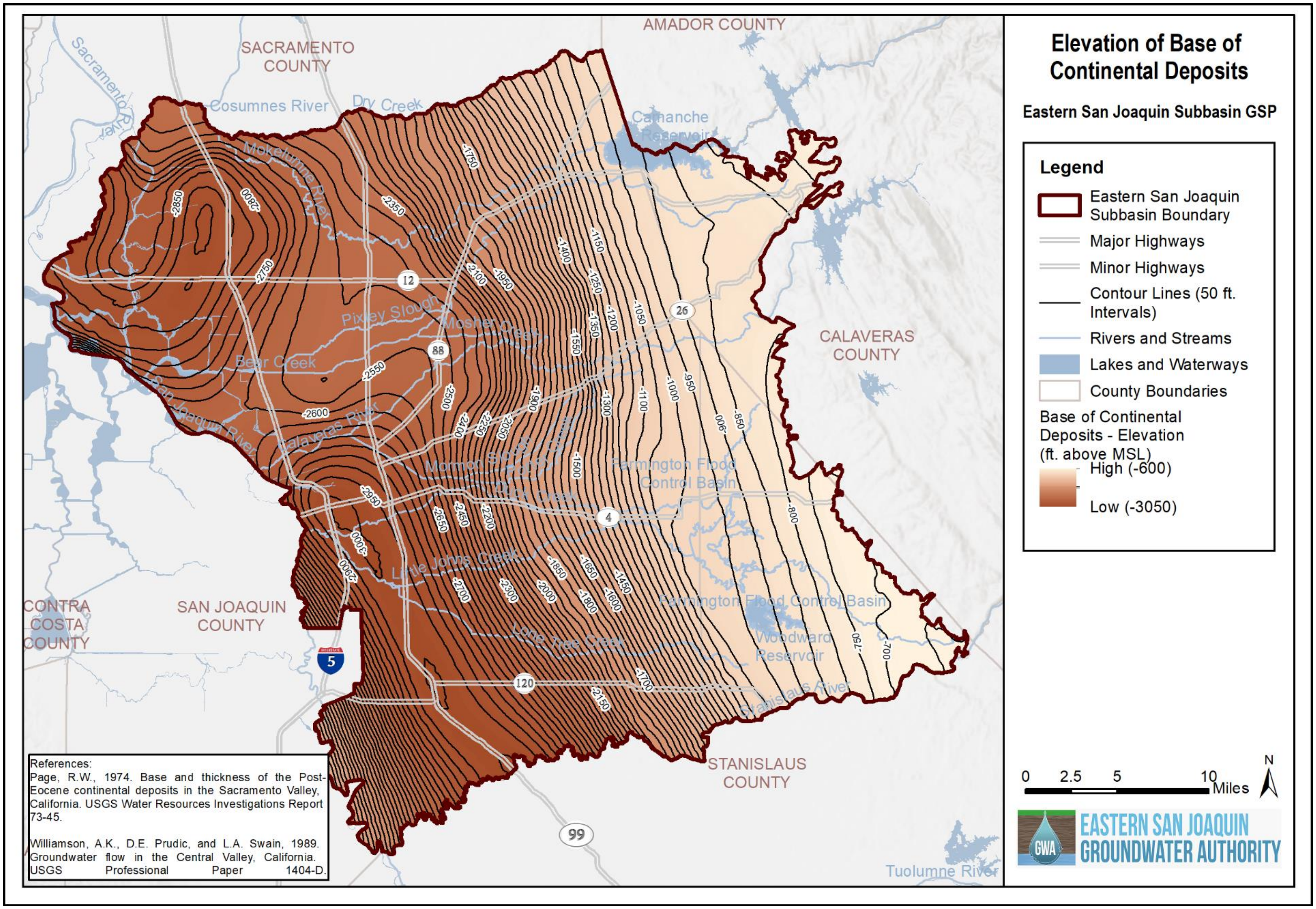
Discontinuous clay horizons have been eroded significantly by the movement of the ancestral rivers. As depicted on the cross-sections, thickest sequences of uppermost permeable units and overbank fines below these layers have been observed. The general thickness and depth are supported by a southeast to northwest movement of river channels to the existing channel location.

Hydraulic connection for the entire depth of the principal aquifer is supported by cross-section depictions that indicate the laterally extensive interbeds of high and low permeable layered deposits. The historical erosional and depositional history supports the referenced hydraulic interconnection. This observation is consistent with the possible thinning and wedging out of the regional clay units due to reworking or ancestral erosion (Davis et al., 1959). In addition to the natural connectivity, the number of water wells drilled through these zones also indicates additional hydraulic connection because of the construction of long well gravel packs that connect the water-bearing zones.

2.1.9.1.5 Deep Saline Groundwater

Connate or saline water occurs from the base of fresh water (shown in Figure 2-20 or Figure 2-31) to the base of continental deposits (shown in Figure 2-32), forming a saline layer that ranges in thickness from 50 to 2,250 feet from the east to the west across the Subbasin. The deep saline layer is not currently a water production zone for consumption or land application. Information used in developing the thickness of the saline water above continental deposits is from Page's 1974 *Base and Thickness of the Post Eocene Continental Deposits in the Sacramento Valley* and the thickness of the aquifer developed by Williamson and others (1989).

Figure 2-32: Elevation of Base of Continental Deposits



2.1.9.2 Aquifer Characteristics and Groundwater Quality

Because of the horizontal and vertical distribution of sediments and hydraulic connection between the water-bearing zones, one Principal Aquifer is defined.

An important step in aquifer characterization includes the completion of sand and gravel thickness (isopach) maps. An isopach map illustrates thickness variations within a tabular layer or stratum. Isopachs are contour lines of equal thickness over an area. The combined isopach map for the principal aquifer is depicted on Figure 2-33. The isopach map details are as follows:

- Over 313 water supply well logs with depths to 1,000 feet were used, with an average depth of 540 feet bgs.
- Average sand and gravel thickness is 140 feet.
- The thickest sand and gravel sequences ranged from 500 to 700 feet near the Stanislaus River, south of Woodward Reservoir and northeast of Oakdale.
- Thicknesses from 200 to 400 feet were observed west of Morada along Bear Creek and toward the Delta.
- The 200 to 500 feet thickness contours were observed near Stockton along the Duck Creek historical drainage.

Recognizing the sand and gravel thickness and the relative hydraulic conductivity of these permeable units, a more comprehensive understanding of the aquifer transmissivity can be made as detailed in Section 2.1.9.2.1.

As discussed in Section 2.1.4.3, soils facilitate rainfall and applied water infiltration, which is a significant recharge source for the Shallow Zone. Other recharge takes place through infiltration and percolation of surface water bodies and via groundwater flow from upgradient areas to the zones within the entire principal aquifer and potentially from flow between subbasins from the north, south, and west. The Intermediate and Deep Zones are recharged via infiltration near sand and gravel layers that are typically thicker near historical riverbeds. Vertical movement of water through sand deposits is more rapid compared to the confining clay deposits. In the high topographic areas along the east margin of the Subbasin, water-bearing zone sediments are exposed at the surface and considered significant to recharge.

2.1.9.2.1 Aquifer Parameters and Production Zone Well Capacities

The GSP uses several sources to summarize the field-tested aquifer characteristics and production zone well capacity information for the principal aquifer.

For depiction purposes, Table 2-3 includes four investigation areas encompassing the entire Subbasin: Calaveras County, Farmington, Manteca, and near the Stanislaus Triangle Area (Riverbank). For these examples, the maximum well yields range from greater than 100 to 2,800 gpm. The range in specific capacity is 27 to 90 gpm/ft of drawdown. These numbers relate to the testing of individual well capacities and the anticipated pumping water level related to the pumping rate. Transmissivity and storage values relate to the aquifer character anticipated at a distance away from a pumping well. Specific yield (SY) is defined as a unit volume of water released from an aquifer per unit decline in water table. Specific storage (SS) of a saturated aquifer is defined as the amount of water released from storage per unit decline in hydraulic head (Freeze and Cherry, 1979).

Figure 2-33: Sand and Gravel Isopach Map

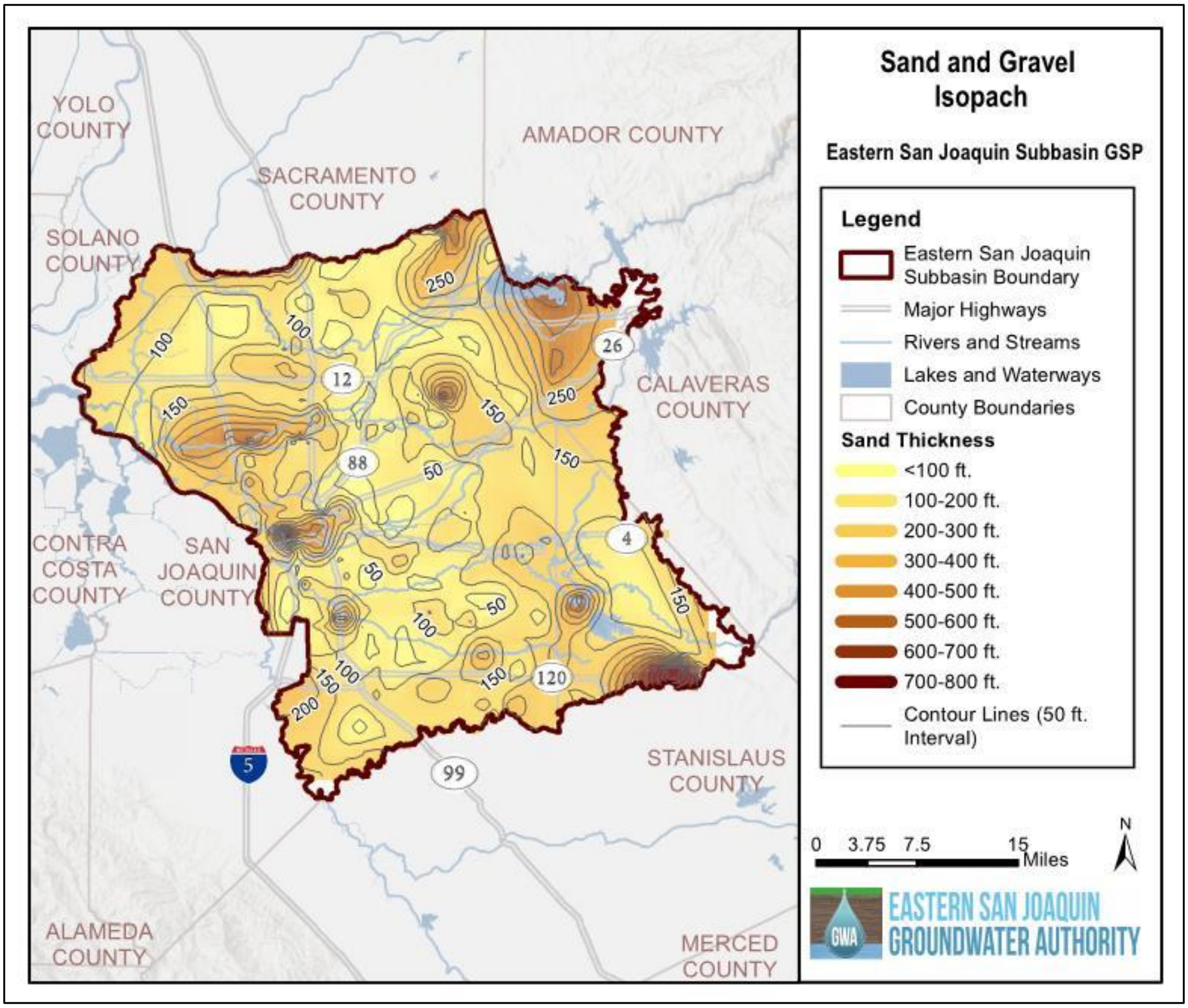


Table 2-3: Production Zone Capacities

Sources/Well Information	Maximum Well Yield (gpm)	Maximum Well Specific Capacity (gpm/ft drawdown)	Maximum Transmissivity (gpd/ft)	Maximum Specific Yield (Unconfined [%])	Specific Storage (Confined [Unitless])	Sand and Gravel Thickness	Encountered Mehrten Depth, (feet)
Entire Eastern San Joaquin Subbasin (CA DWR, 2006)	1,500	n/a	n/a	7.3 %		>150	400-600
Calaveras County (WRIME, 2003)	>100	>10	>35,000	>6 %		>120	At Surface
Farmington (DE, 2012)	800	27	19,600	>5 %	0.001	>110	230
Manteca (NV5, 2017)	2,500	90	61,000	>10 %	0.0001	>130	350
Stanislaus Triangle (Bookman-Edmonston, 2005)	>2,800	>40 (DE, 2007)	35,000	17 %	0.001	>150	Dip to the West

Using the basic physical properties of groundwater flow, a confined aquifer transmissivity is defined by:

$$T = Kb$$

Where: T is transmissivity
K is the hydraulic conductivity (rate of flow under a unit hydraulic gradient through a unit cross-sectional area)
b is the aquifer thickness.

Using a typical clean sand hydraulic conductivity value of 500 gpd/feet^2 and a thickness of 120 feet, the aquifer transmissivity averages approximately 60,000 gpd/feet, which is similar to the documented values reported above (Freeze and Cherry, 1979). For additional comparison, data for the five layers of the ESJWRM were provided in the ESJWRM Model Report and Version 3.0 Model Documentation Updates TM (see Appendix 2-A and Appendix 2-C, respectively)

The distribution of production wells and monitoring wells is provided on Figure 2-30 and Figure 2-31. Table 2-4 provides descriptors for the three water-bearing zones:

- Number of wells for each zone
- Well depths
- Wells used on the cross-sections

Additional aquifer parameter confirmation is provided by the ESJWRM as follows (Woodard & Curran, 2018):

- Horizontal Hydraulic Conductivity – The horizontal hydraulic conductivity varies across the non-saline model layers ranging from 1.1 ft/day to 72.7 feet/day or 0.148 to 10 gal/day/feet^2.
- Specific Storage and Yield – SS and SY are used to represent the available storage at nodes in confined and unconfined aquifers. SS values range from 4.18 x 10^{-6} to 2.05 x 10^{-4}. SY values range from 4 to 10 percent.

Table 2-4: Wells within Water-Bearing Zones

All Wells			
Water-Bearing Zone	Number of Wells	Average Construction Depth (feet bgs)	Average Construction Bottom Elevation (feet MSL)
Shallow	452	165	-82
Intermediate and Deep	201	539	-411

Pumping Wells			
Water-Bearing Zone	Number of Wells	Average Bottom of Screen Depth (feet bgs)	Average Bottom of Screen Elevation (feet MSL)
Shallow	148	270	-238
Intermediate and Deep	113	369	-300

Groundwater Wells Used in Cross-Sections, by Formation			
Water-Bearing Zone	Number of Wells	Average Bottom of Borehole Depth (feet bgs)	Average Bottom of Borehole Elevation (feet MSL)
Shallow	39	234	-144
Intermediate and Deep	273	672	-566

2.1.9.2.2 Regional Historical Groundwater Flow and Surface Water Interaction

The horizontal groundwater flow direction for the Eastern San Joaquin Subbasin is typically towards areas of lower groundwater near the center of the Subbasin. The flow generally mirrors topography and is relatively consistent over time. The flow direction follows the overall west dipping gradient of the geologic formations in the eastern portions of the Subbasin. Higher groundwater elevations are in the foothills on the east side of the Subbasin, and the elevations decrease following the topography. In the western portion of the Subbasin, groundwater flows east toward areas with relatively lower groundwater elevation. Horizontal groundwater flow is further discussed in Section 2.2.

The GSP evaluates vertical groundwater gradients using the USGS nested wells in the Eastern San Joaquin Subbasin. Clark and others (2012) drilled and assessed several nested wells or multiple well sites in the Eastern San Joaquin Subbasin. These nested well sites include three to five monitoring wells per borehole with screen intervals at depths of approximately 100 to 900 feet (Clark et al., 2012). Groundwater elevation in these monitoring wells, measured from 2006 to 2008, usually indicate the same trend. Groundwater elevation is typically lower in monitoring wells with deeper screen placement, suggesting a downward flow of groundwater. The difference in groundwater elevations from the shallowest to deepest monitoring wells within each borehole is typically between 5 and 20 feet (Clark et al., 2012). Additional discussion regarding differences and distribution across the Subbasin is provided in Section 2.2.

Historical groundwater-surface water interaction in the context of the twenty-seven years of the historical model (ESJWRM) is discussed in Section 2.2.6.

2.1.9.2.3 General Groundwater Quality

2.1.9.2.3.1 Geologic Formation Groundwater Quality

The USGS and other government agencies completed several major studies concerning groundwater quality in the Central Valley of California, which includes the Eastern San Joaquin Subbasin. Repeatedly mentioned in these studies is the natural geochemical effects on groundwater quality that is specific to geologic formations (Creely & Force, 2007; Faunt, 2009; CA DWR, 1967). This natural effect is of great interest for the GSP implementation because groundwater level fluctuations from overdraft and recharge may result in water quality changes that is specific to geologic formations.

Natural geochemical reactions can be highly variable, even from well to well, as reactions depend on a number of factors, including the amount of 1) reactive surface area of the formation sediments; 2) available oxygen in the formation as affected by fluctuations in groundwater elevation, depth to groundwater, and oxygenated near-surface recharge; and 3) potentially inorganic-oxidizing bacteria.

For the Eastern San Joaquin Subbasin, igneous and metamorphic rocks of the Sierra Nevada Mountains underlie the upstream drainages. These rocks predominately contain oxygen, silicon, aluminum, iron, calcium, sodium, potassium, and magnesium (Creely & Force, 2007). Rivers draining areas of granitic rocks typically have better water quality than metamorphic or volcanic rocks (CA DWR, 1967). For example, the Mokelumne River drains areas of granitic origin and has a lower salt content than the Calaveras River, which drains an area of primarily metamorphic rocks (CA DWR, 1967). Streams originating from either igneous or metamorphic rocks have relatively low amounts of dissolved solids, compared to marine sedimentary rocks that make up the Coast Range west of the Subbasin (Faunt, 2009). However, marine formations also underlie continental deposits in the Eastern San Joaquin Subbasin and have considerable amounts of chlorine, sulfur, bromine, and boron from connate water (Creely & Force, 2007). Connate water originates from fluids that are trapped in the pores of the sedimentary rocks as they are deposited and can contain many mineral components as ions in solution. Above these marine formations are continental deposits described in Section 2.1.5.

Groundwater quality in wells in Calaveras County is characterized by Metzger and others in a 2012 study, *Test Drilling and Data Collection in the Calaveras County Portion of the Eastern San Joaquin Groundwater Subbasin, California, December 2009 – June 2011* (Metzger et al., 2012). These wells are in the eastern portion of the Eastern San Joaquin Subbasin, in an area underlain by the Ione and Valley Springs Formations. This study assessed groundwater samples and identified three water types present: calcium-magnesium-bicarbonate, sodium-bicarbonate, and mixed cation-mixed anion water. The mixed cation-mixed anion group consisted mostly of sodium and chloride. These groundwater samples also showed high levels of arsenic, which were attributed to pH level variation or redox potential (Metzger et al., 2012). The Ione Formation, for instance, is known to have high sulfate levels in groundwater related to the pH influence on pyrite-sulfide rich coal deposits.

Arsenic is of particular concern because it is naturally occurring in the Eastern San Joaquin Subbasin and is hazardous to human health. Izbicki and other's (2008) study, *Source, Distribution, and Management of Arsenic in Water from Wells, Eastern San Joaquin Groundwater Subbasin, California*, assesses the concentration and sources of arsenic in various wells. Arsenic was detected mostly in San Joaquin County, and the largest concentrations were in the western portion of the Subbasin (Izbicki et al., 2008). The surficial geology in this area consists of the Modesto and Riverbank Formations, which are underlain by the Turlock Lake and Laguna Formations (see Figure 2-18, Figure 2-22, Figure 2-23, and Figure 2-24). Sources of arsenic include weathering of minerals containing arsenic, desorption of arsenic under certain pH values, and release of arsenic in redox conditions (Izbicki et al., 2008).

Another element of great importance is nitrogen as it is included in many compounds that are by-products of agriculture, which heavily dominates the landscape of the Eastern San Joaquin Subbasin. Elevated levels of nitrate can typically occur as a result of fertilizer application, manure and septic waste, and natural sources. Extensive work by Holloway and others (1998) showed the Mokelumne River watershed contained significant quantities of nitrogen from bedrock lithology. The upper part of the watershed, outside the Eastern San Joaquin Subbasin, is underlain by igneous and metamorphic rock, but the metasedimentary and metavolcanic rocks contained the highest levels of nitrogen (Holloway et al., 1998).

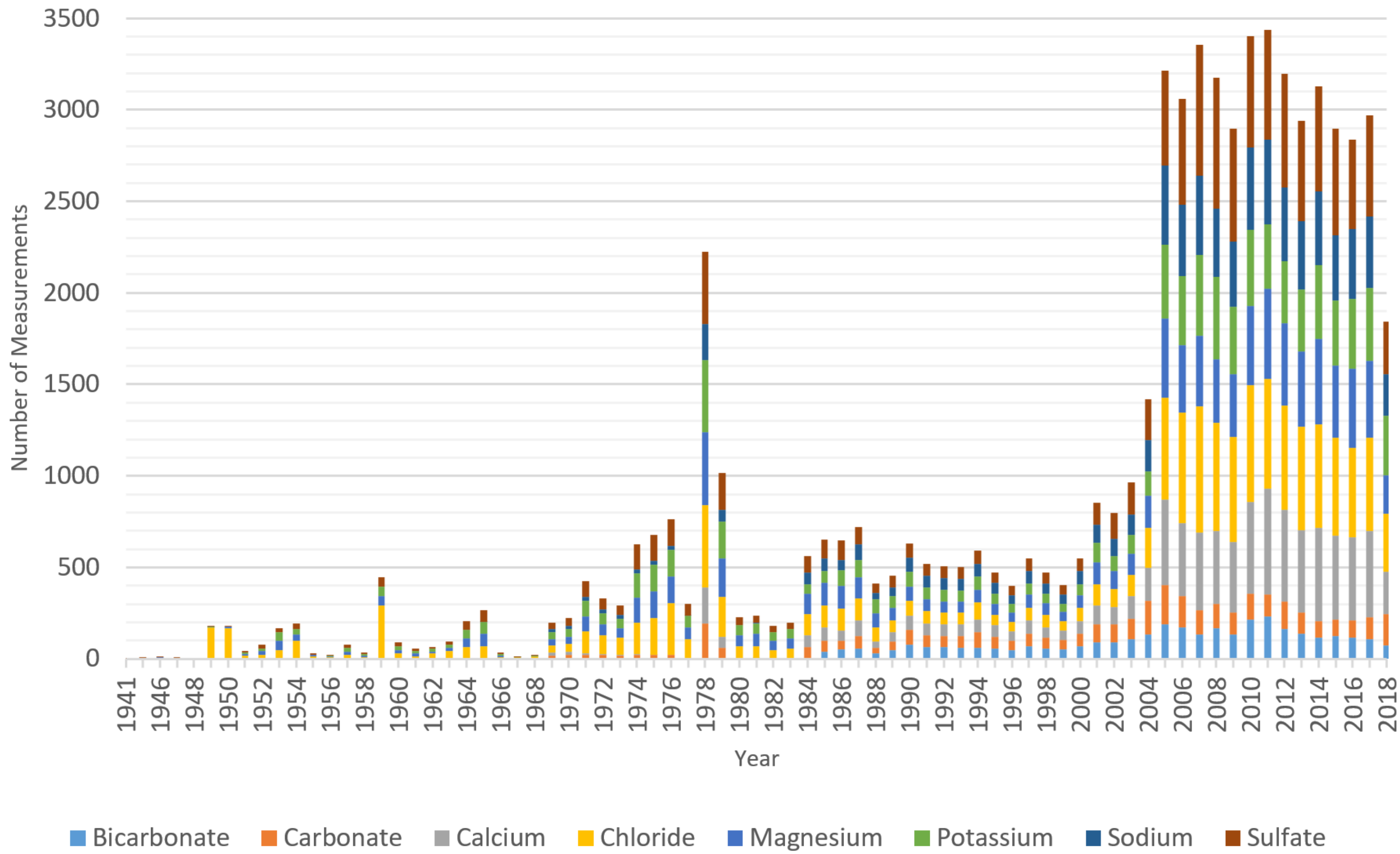
General water quality of principal aquifers is summarized in the following sections, as required by CCR Title 23 §354.14. General water quality can be determined by assessing commonly measured inorganic parameters as indicators of change. Evaluating these inorganic parameters involves looking at historical trends and comparing results to certain thresholds, as well as determining water types. These parameters include major cations and anions, listed below:

Anions	Cations
Bicarbonate	Calcium
Carbonate	Magnesium
Chloride	Potassium
Sulfate	Sodium

2.1.9.2.3.2 Ion Composition

Evaluating the historical trends of these parameters is not straightforward. GAMA records include some groundwater quality results for the Eastern San Joaquin Subbasin going back to the 1940s. However, a thorough analysis requires a large amount of data on all the major cations and anions mentioned above. A large number of measurements of this kind were taken from 2005 to 2017, as shown in Figure 2-34. This analysis was not updated as part of this GSP amendment as basic groundwater chemistry reflects the geology of origin, which has not varied considerably since the preparation of the 2020 GSP.

Figure 2-34: Total Number of Cation/Anion Measurements in the Eastern San Joaquin Subbasin

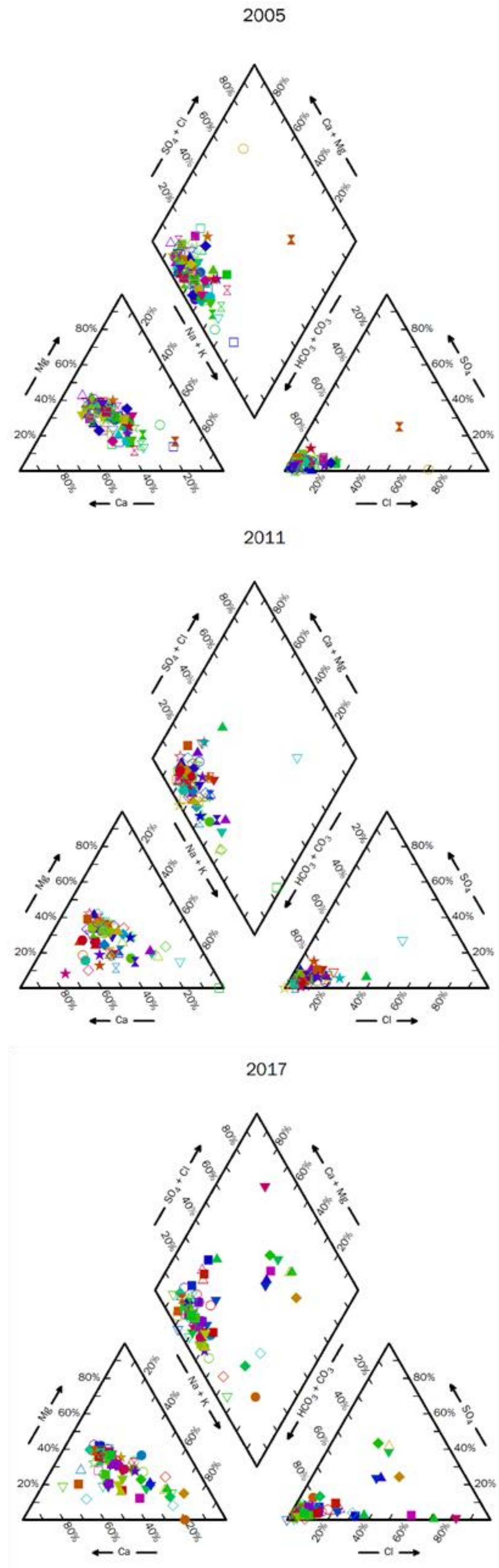


General water quality of the Subbasin can be determined by assessing water type over specific years, in this case, within the time frame of 2005 to 2017. Evaluating the years 2005, 2011, and 2017 provides an even spread over the selected time frame and gives an idea of possible water type trends. Trilinear diagrams for each of these years show relative concentrations of the major cations and anions (see Figure 2-35). Each symbol in the diagram represents a water sample collected. Water samples, represented by the same symbol, are plotted in the two lower triangle diagrams for each year based on their relative cation (left) and anion (right) concentrations. The top diagram represents a projection of the two ternary diagrams for easier comparison.

Due to the difference in sampling locations, the years 2005 and 2011 show carbonate and bicarbonate-rich waters, and 2017 displays increased chloride and sulfate concentrations in some wells. These dates correlate to both data size increases and heavier rainfall periods. Chloride concentrations in 2017 are generally less than 150 milligrams per liter (mg/L), with some higher measurements reaching 2,000 mg/L. Sulfate concentrations in 2017 are mostly under 300 mg/L, but a few extremely high levels up to 100,000 mg/L exist near the City of Manteca.

GAMA groundwater quality data in the northern portion of the San Joaquin Valley Groundwater Basin were assessed by Bennett et al. in 2006. Groundwater samples were compared to thresholds such as the U.S. Environmental Protection Agency (USEPA) secondary maximum contaminant levels (SMCL). None of the major cations and anions measured in the Eastern San Joaquin Subbasin resulted in exceedances of the SMCLs (Bennett et al., 2006). These measurements took place in December 2004 to February 2005. Additional parameters were sampled in this study and are discussed further in Section 2.2 (Historical Groundwater Conditions).

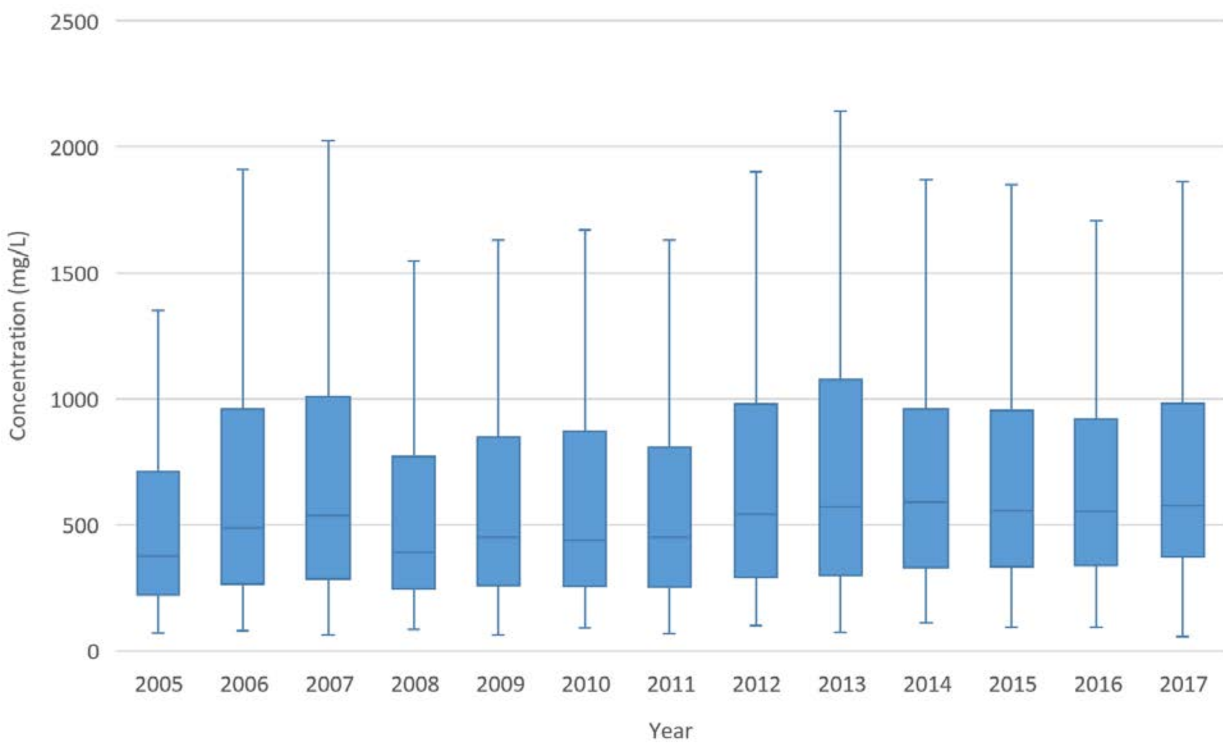
Figure 2-35: Trilinear Diagrams



2.1.9.2.3.3 Total Dissolved Solids

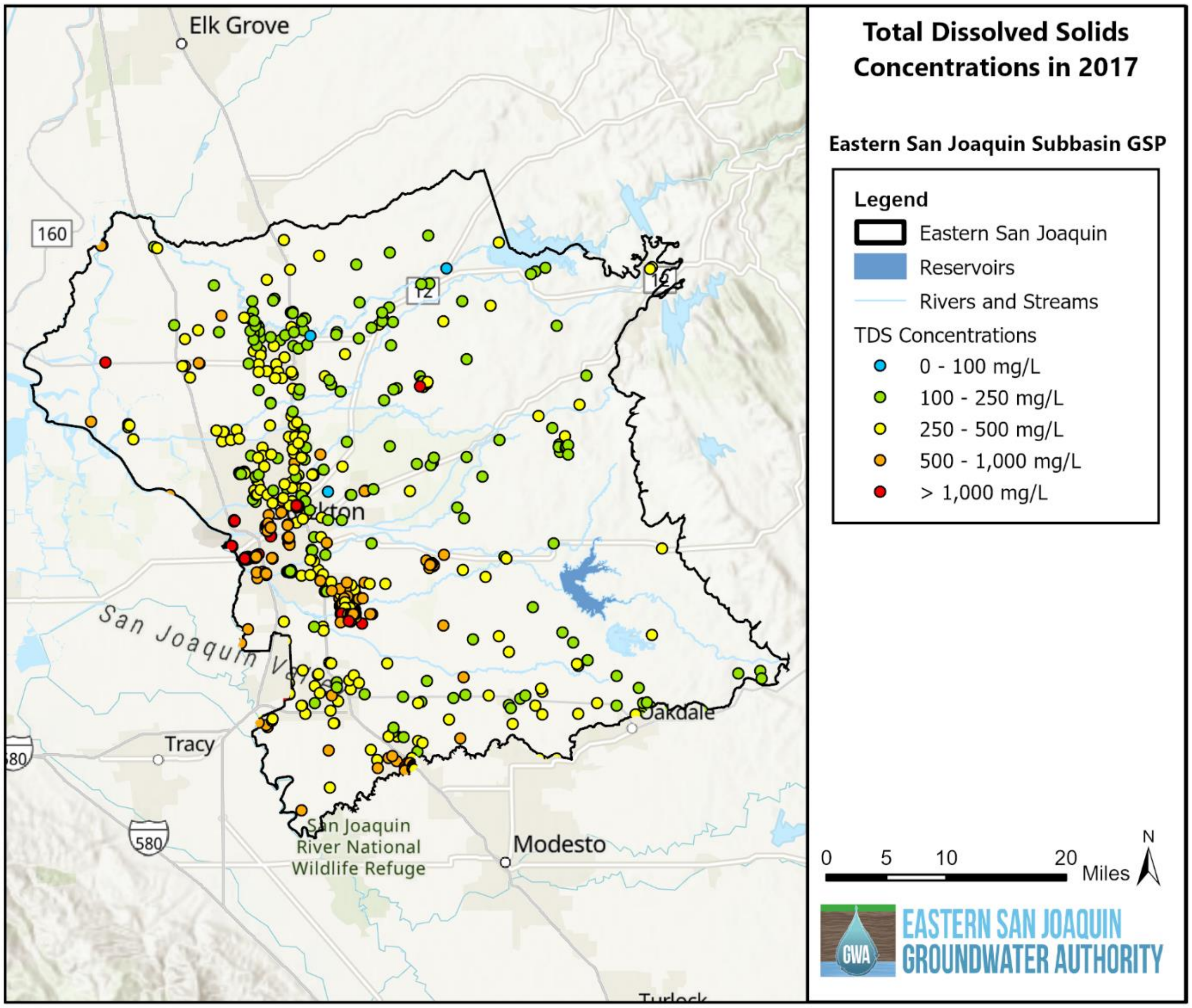
A wide range of total dissolved solids (TDS) values exist in the Eastern San Joaquin Subbasin. Based on data in the GAMA database from 2005 to 2017, TDS values generally varied from 100 to 2,000 mg/L (Figure 2-36), with a median value of 520 mg/L. Over the 13-year period shown in Figure 2-36, the median concentration of TDS has steadily increased from approximately 400 mg/L in 2005 to approximately 600 mg/L in 2017. Figure 2-37 shows the variation of TDS concentrations across the basin in 2017. Sources of TDS in the Subbasin include Delta sediments, deep deposits, and irrigation return water, as discussed in Section 2.2.4.1. Additional details on TDS concentrations are provided in Section 2.2 (Historical Groundwater Conditions).

Figure 2-36: TDS Annual Variation



Note: This Box-and-Whisker plot represents a summary of five different statistic values of the distribution. Minimum and maximum values are represented by the end points of the extended lines. The center line indicates the median. The top and bottom of the rectangle indicate the first quartile (25th percentile) and third quartile (75th percentile) of the distribution, respectively.

Figure 2-37: TDS Concentrations in 2017

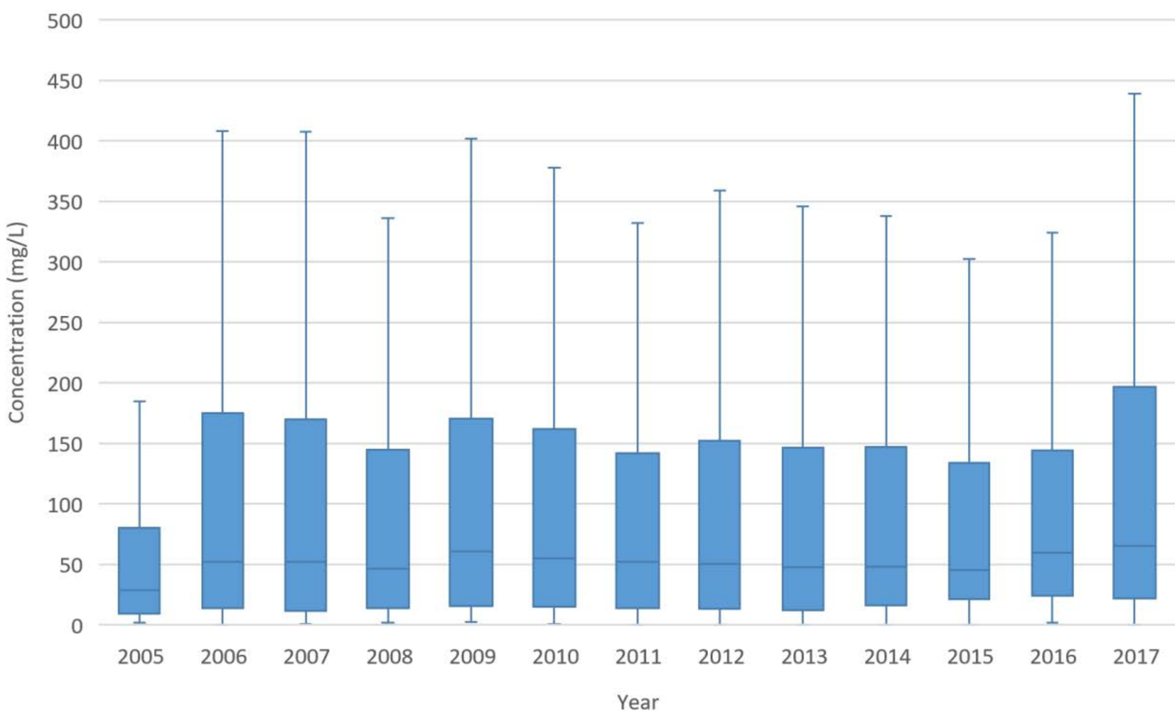


2.1.9.2.3.4 Chloride

Chloride concentrations also vary considerably across the Eastern San Joaquin Subbasin. Based on data in the GAMA database from 2005 to 2017, chloride values generally varied from non-detect to 300 mg/L (Figure 2-38), with a median value of 50 mg/L. Over the 13-year period shown in Figure 2-38, the median concentration of chloride has remained fairly stable. Higher chloride concentrations during 2017 are apparent near the cities of Manteca and Stockton (

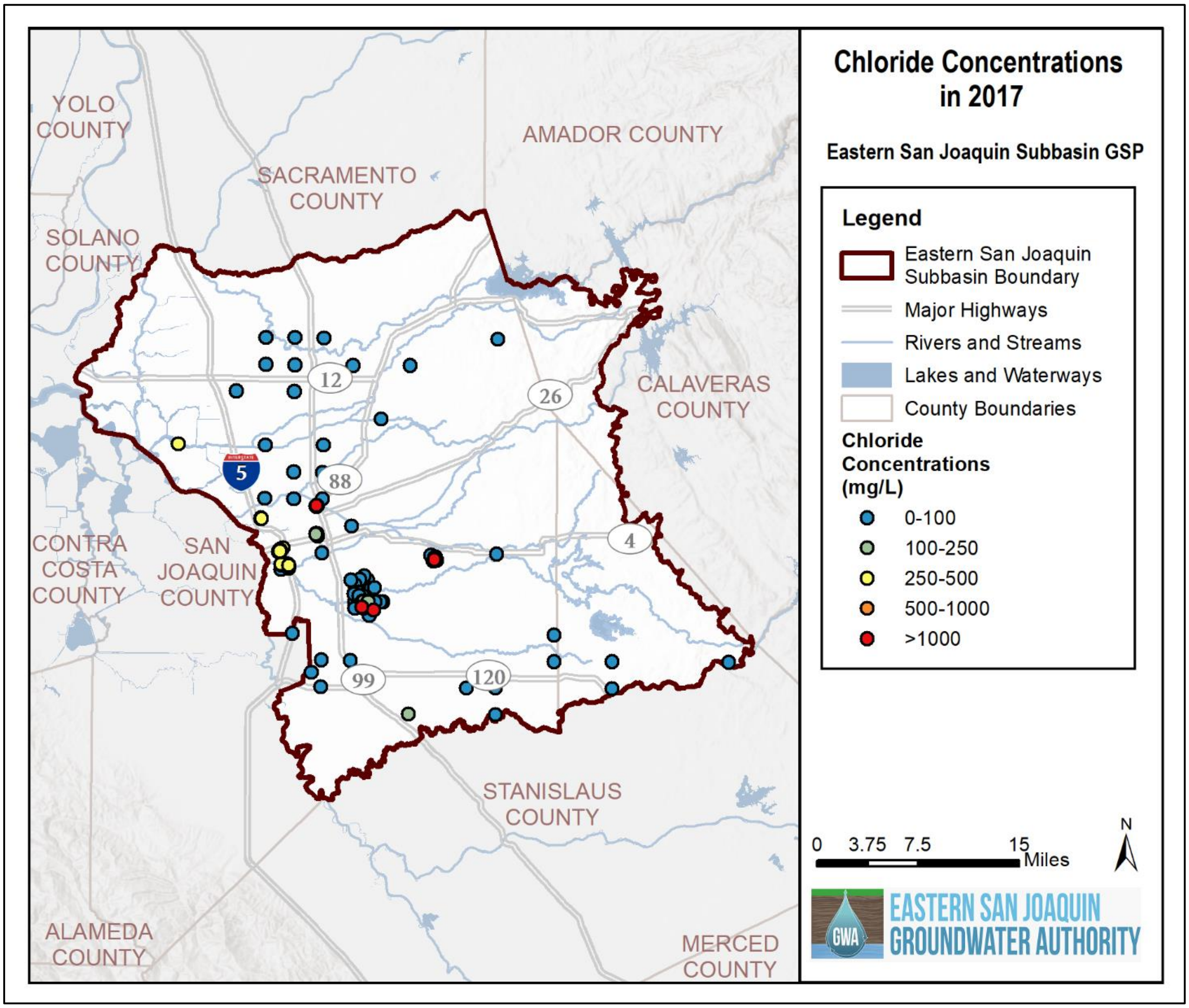
Figure 2-39). Sources of chloride in the Subbasin are similar to those for TDS and include Delta sediments, deep deposits, and irrigation return water. Additional details on chloride concentrations are provided in Section 2.2 (Historical Groundwater Conditions).

Figure 2-38: Chloride Annual Variation



Note: This Box-and-Whisker plot represents a summary of five different statistic values of the distribution. Minimum and maximum values are represented by the end points of the extended lines. The center line indicates the median. The top and bottom of the rectangle indicate the first quartile (25th percentile) and third quartile (75th percentile) of the distribution, respectively.

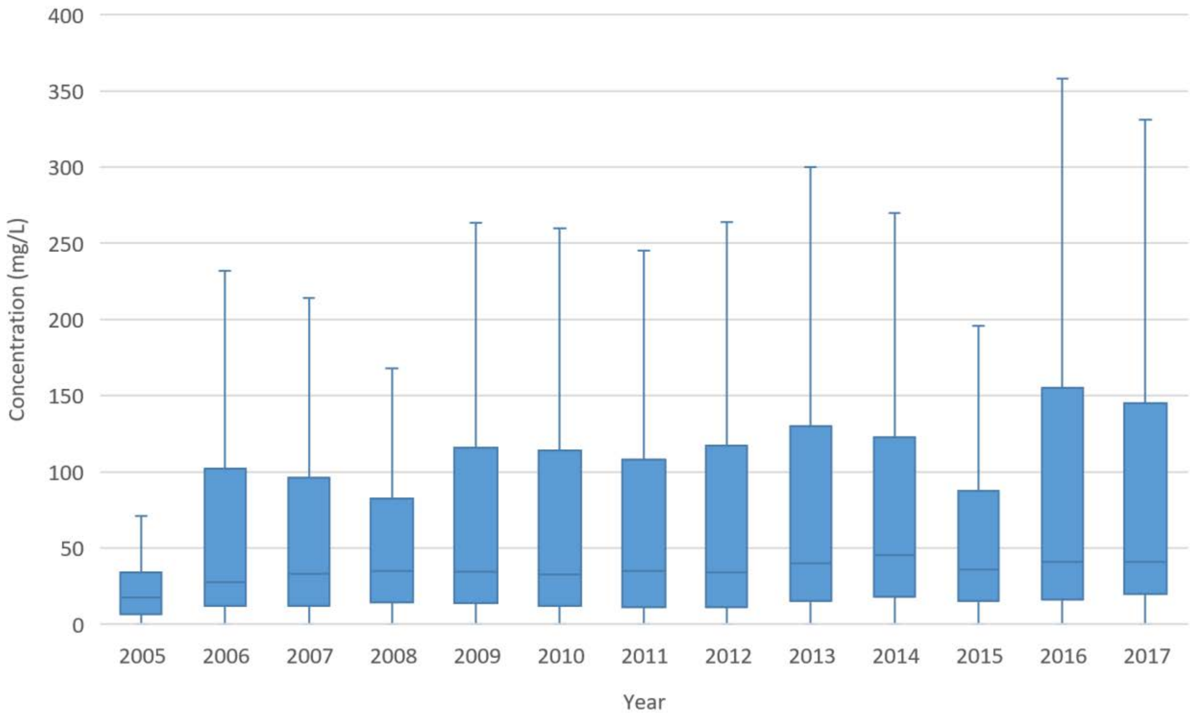
Figure 2-39: Chloride Concentrations in 2017



2.1.9.2.3.5 Sulfate

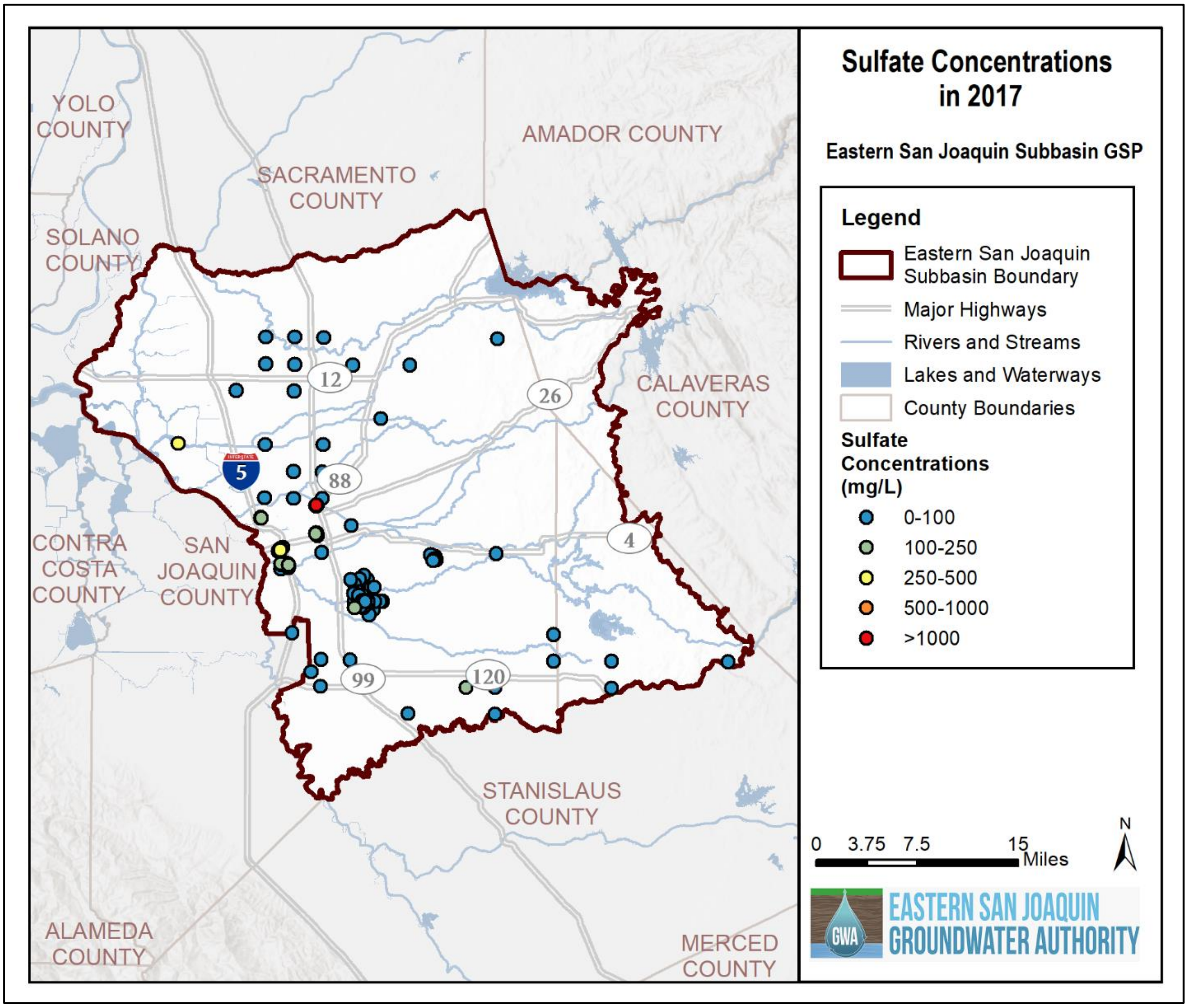
Sulfate concentrations vary considerably across the Eastern San Joaquin Subbasin ranging from non-detect to around 250 mg/L with a median value of around 25 mg/L Figure 2-40, based on data in the GAMA database from 2005 to 2017. Over the 13-year period shown in Figure 2-40, the median concentration of sulfate, like chloride, has remained fairly stable and does not show any obvious trends. Higher sulfate concentrations during 2017 are apparent near the cities of Manteca and Stockton Figure 2-41

Figure 2-40: Sulfate Annual Variation



Note: This Box-and-Whisker plot represents a summary of five different statistic values of the distribution. Minimum and maximum values are represented by the end points of the extended lines. The center line indicates the median. The top and bottom of the rectangle indicate the first quartile (25th percentile) and third quartile (75th percentile) of the distribution, respectively.

Figure 2-41: Sulfate Concentrations in 2017



2.1.10 HCM Data Gaps

All hydrogeologic conceptual models contain a certain amount of uncertainty and can be improved with additional data and analysis. The Eastern San Joaquin Subbasin HCM data gaps are present in the understanding of the HCM presented in this GSP. While recent efforts have been made to address these data gaps, as noted below, the following data gap elements still require additional information and will be updated with future monitoring, modeling, and data refinement efforts.

Aquifer Characteristics

- Aquifer characteristics (such as hydraulic conductivity) have a significant impact on how projects and management actions in one part of the Subbasin may influence sustainability in other parts of the Subbasin. While this data gap has been filled to some extent with the airborne electromagnetic (AEM) data collected by DWR and the boring logs from the new monitoring wells constructed in the Subbasin, improving the understanding of the Subbasin aquifer system and leading to the addition of a shallow alluvium layer and other refinements to ESJWRM numerical flow model refinements, much still remains unknown. Aquifer characteristics should be confirmed through additional aquifer testing or additional monitoring wells.

Groundwater Level Data

- Depth- or zone-specific water levels to assess vertical interconnection, including zones within the principal aquifer. This data gap has been partially addressed by the recent construction of the two Technical Support System (TSS) and Delta multi-completion well.

- Additional shallow groundwater data near surface waters and natural communities commonly associated with groundwater (NCCAGs). This data gap has been partially addressed by the recent construction of five new shallow monitoring wells near interconnected surface waters.

- Additional groundwater level data in the east and northwest areas of the Subbasin. This data gap has been partially addressed by recent improvements to the groundwater level representative monitoring network. See Chapter 4 for additional information.

- Additional groundwater level data near major creeks and rivers to improve quantification and understanding of subsurface flows between groundwater subbasins and surface water-groundwater interaction. This data gap has been partially addressed by the recent construction of five new shallow monitoring wells near interconnected surface waters and formation of a representative monitoring network specific for monitoring impacts to interconnected surface waters.

Groundwater Quality Data

- Water quality of the three zones within the principal aquifer. This data gap has been partially addressed through recent refinements to the representative monitoring network for groundwater quality. See Chapter 4 for additional information.

    - Additional monitoring at various depths for different constituents will help inform the understanding of water quality. This can be achieved through installation of new monitoring wells or through determination of screened intervals of existing monitoring wells.

    - Additional depth-specific water quality data will inform minimum thresholds for the degraded water quality sustainability indicator and help monitor and identify potential undesirable results.

Subsurface Conditions

- Stockton Fault extent and impact on the base of fresh water.
- Improved characterization of near-surface soil conditions as they relate to recharge.
- Further definition of aquifer characteristics (e.g., hydraulic conductivity, transmissivity, and storage parameters) within and near Subbasin boundary areas to the east, southeast, north, and northwest, including aquifer tests.

2.2 HISTORICAL GROUNDWATER CONDITIONS

This section describes historical groundwater conditions in the Eastern San Joaquin Subbasin as of the development of the 2020 GSP. As such, this section includes both historical conditions in the Subbasin prior to 2019, and the current conditions as of the development of the 2020 GSP in 2019. These sections are maintained in the GSP to provide a context of the conditions occurring at the time the 2020 GSP was developed.

As required by the GSP regulations, the groundwater conditions section includes:

- Definition of current groundwater conditions in the Subbasin (as of 2020 GSP development)
- Description of historical groundwater conditions in the Subbasin
- Description of the distribution, availability (storage), and quality of groundwater
- Identification of interactions between groundwater, surface water, groundwater dependent ecosystems, and subsidence

The groundwater conditions described in this section present the historical availability, quality, and distribution of groundwater which are the basis of this Plan's sustainable management criteria and monitoring network. The current and historical conditions discussed are further expanded upon in Chapter 3: Sustainable Management Criteria and are used to define undesirable results and to establish measurable objectives, interim milestones, and minimum thresholds.

Historically, the two aspects of greatest focus for groundwater management in the Eastern San Joaquin Subbasin have been groundwater elevation and, in some areas of the Subbasin, groundwater quality. As discussed herein, a groundwater depression exists in the central portion of the Subbasin, while higher groundwater levels characterize the west portion of the Subbasin. Additionally, there are elevated levels of salinity and nitrate in some areas, along with naturally occurring constituents commonly seen throughout the Central Valley. Detailed descriptions of these conditions are provided in the following sections as part of a discussion of the historical and current conditions for each of the six sustainability indicators:

- Groundwater Elevation (Section 2.2.1)
- Groundwater Storage (Section 0)
- Seawater Intrusion (Section 0)
- Groundwater Quality (Section 2.2.4)
- Land Subsidence (Section 0)
- Interconnected Surface Water (Section 2.2.6)

Details of GDEs are provided in Section 2.2.7 and Section 2.3.7 to support the sustainability indicator discussions.

2.2.1Groundwater Elevation

2.2.1.1 Historical Groundwater Elevations

Data sources for groundwater elevation are abundant in the Eastern San Joaquin Subbasin. As discussed in Section 2.1, the CASGEM and San Joaquin County databases constitute the groundwater level data used for this analysis. These sources provide a robust dataset of groundwater levels going back to 1940.

To visually show long-term trends in groundwater elevations in the Eastern San Joaquin Subbasin, 10 wells that have periods-of-record greater than 40 years and that are relatively evenly distributed across the Subbasin were selected from available data (see Figure 2-42). Long-term hydrographs prepared for these wells show that, throughout most of the Eastern San Joaquin Subbasin, groundwater elevations have declined over time.

Average groundwater level decline was quantified for 1996-2015. In Section 2.3 (Water Budgets), the Historical Water Budget from the 2020 GSP uses 1996-2015 as a representative hydrologic period which includes an average annual precipitation of 14.7 inches, very close to the long-term average of 15.4 inches. The 1996-2015 period also includes the recent 2012-2015 drought, the wet years of 2010-2011, and periods of normal precipitation. Based on data from the 10 selected wells in Figure 2-42, the average groundwater level decline was -0.5 ft/year from 1996-2015. Hydrographs for wells numbered #2, #5, and #6 show the largest decrease in groundwater elevation. These wells are located to the east of the City of Stockton. Hydrograph #9, which corresponds to a well located on the north edge of the Subbasin, shows the least decrease in groundwater elevation from 1996-2015. Hydrograph #4 corresponds with a well located in the western side of the Subbasin and is the only well to show an increasing trend in groundwater elevations. The northeast corner of the Subbasin is an area without a nearby representative hydrograph and was identified as a data gap in Section 2.1.10 (HCM Data Gaps).

Figure 2-42: Hydrographs of Selected Wells

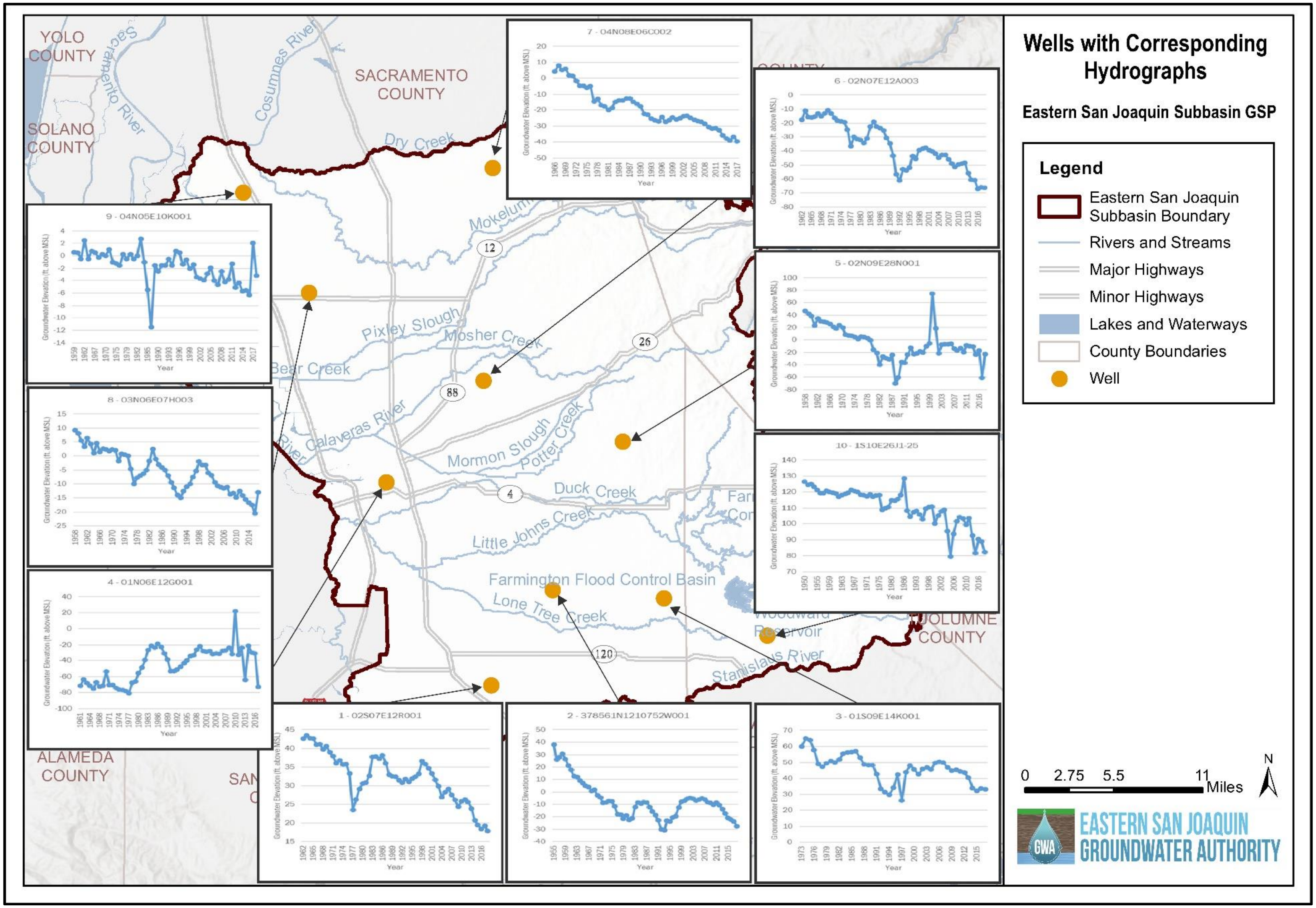
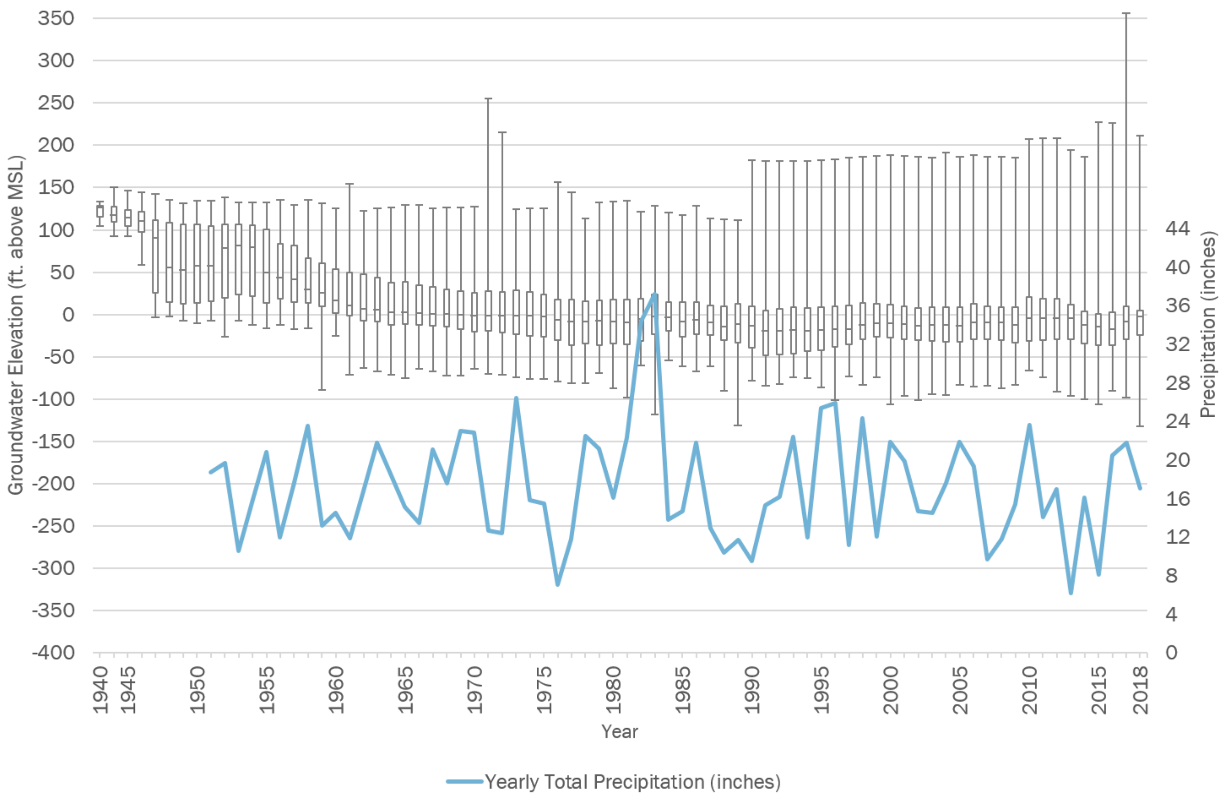


Figure 2-43 shows the distribution of the groundwater elevations from the CASGEM and San Joaquin County databases compared to average precipitation in and near the Subbasin. Figure 2-43 shows an overall decreasing trend in groundwater elevation levels with larger variability over time. The increasing variability comes partly due to a larger number of wells being sampled through time in more varied topography, but also reflects the long-term changes in groundwater levels described above and in Figure 2-42.

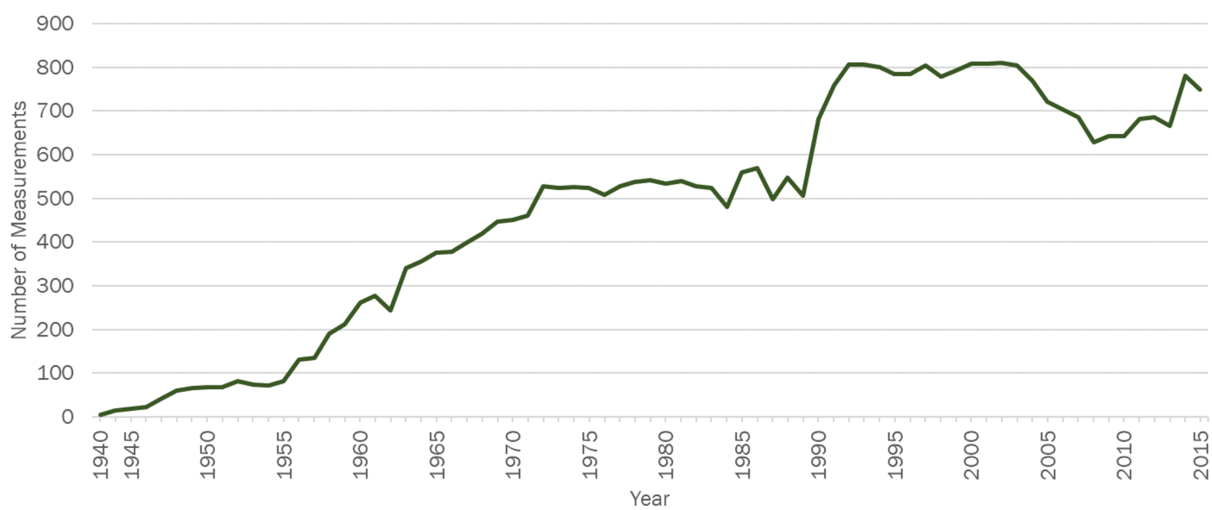
Periods of increases in groundwater elevation moderately correspond to the amount of precipitation in the Eastern San Joaquin Subbasin. A correlating trend can be seen with groundwater elevation increases in several hydrographs in the early 1980s and late 1990s, associated with periods of high precipitation.

Figure 2-43: Summary of Groundwater Elevation Data, 1940-2018

(a) Box-and-Whisker Plot with Precipitation

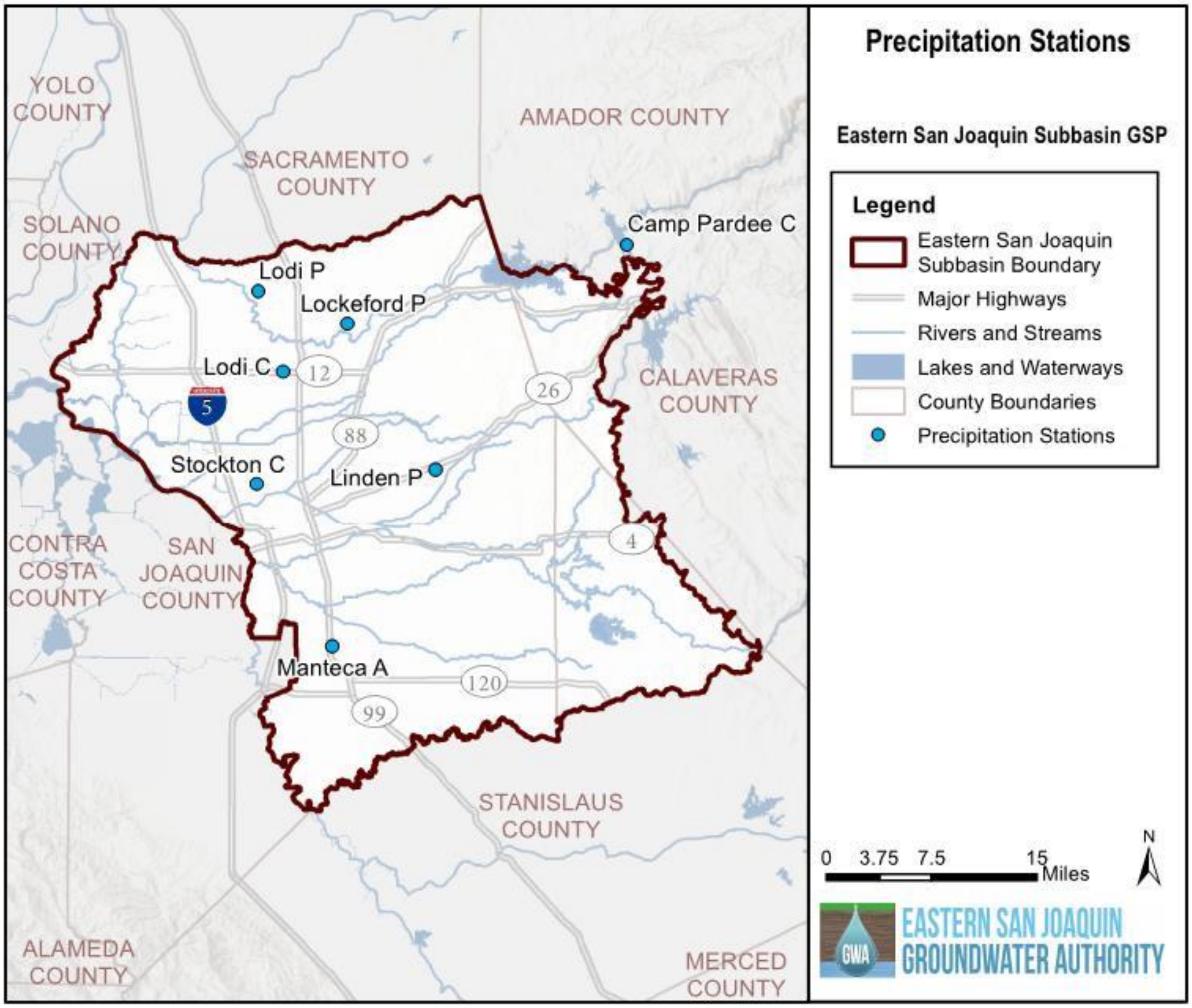


(b) Number of Groundwater Level Measurements



1. Each vertical bar in Figure 2-43 (a) represents the full range of groundwater level measurements recorded in a given year. The central gray box represents the middle 50% of measurements (ranging from the 25th percentile to the 75th percentile), with the horizontal line showing the median. The capped lines below and above the central box represent the minimum and maximum, respectively.
2. Precipitation monitoring depicted in Figure 2-43 (a) began in 1951.
3. The average annual precipitation line presented in Figure 2-43 (b) is based on an average of data collected at 7 stations which are mapped in Figure 2-44.

Figure 2-44: Precipitation Stations



1. These stations are operated by California Irrigation Management Information System (CIMIS) ("A"), National Oceanic and Atmospheric Administration (NOAA) ("C"), and PestCast (University of California Statewide Integrated Pest Management Program [UC IPM] and Department of Pesticide Regulation [DPR]) ("P").

Additionally, extensive reports and research examining the groundwater conditions of the Central Valley are available from a variety of sources, including the USGS and DWR. These documents supplement the water level data provided by the CASGEM and San Joaquin County databases and were used to assess current and historical groundwater elevations.

USGS Water Supply Paper 780 – One of the earliest discussions of measured groundwater levels in the Eastern San Joaquin Subbasin is the USGS Water Supply Paper 780. The report details river stage of the Mokelumne River and the surrounding groundwater table from roughly 1900 to 1930. Groundwater levels in wells around the Mokelumne River varied, but mostly declined due to an increase in groundwater pumping. Even between years of minimal groundwater pumping, from 1927 to 1933, the water table decreased in elevation, most drastically in areas northeast and southeast of the City of Lodi (Piper et al., 1939).

DWR Bulletin 146 – DWR's Bulletin 146 (1967) discusses water levels and flow directions in the 1960s and earlier, which provides added historical context to current groundwater conditions. Figures 4 and 5 of Bulletin 146 show groundwater elevation in most of the Eastern San Joaquin Subbasin in fall of 1950 and 1964, respectively. Both maps show groundwater levels at the lowest elevation underneath the City of Stockton, which is attributed to heavy groundwater pumping. This groundwater depression is attributed as causing groundwater from the Delta to flow toward the City of Stockton and is described as having relatively worse water quality due to natural mineral salts. Barriers between the poorer quality water from the Delta and higher quality water from the Sierra Nevada Mountains noted in previous studies around the City of Stockton are not apparent (CA DWR, 1967).

Williamson, 1989 – Groundwater conditions provided in the groundwater model report by Williamson (1989) included horizontal and vertical flows. A westerly groundwater flow direction that roughly parallels the ground surface in the Eastern San Joaquin Subbasin was confirmed, as depicted on Figure 14 of that report. Estimates of groundwater elevations for before-human-development were provided. Vertical flow characteristics before considerable human development were characterized and mapped; areas of wells that flowed without pumps are shown throughout the valley and in the western portion of the Eastern San Joaquin Subbasin. This is in contrast to current conditions, where wells flowing without pumps have not been currently observed in the Subbasin. At present, USGS nested monitoring wells confirm downward vertical flows (Williamson, 1989).

2.2.1.2 Conditions as of 2019: Groundwater Elevations

For the purposes of the 2020 GSP, current groundwater elevation conditions were characterized as first quarter 2017 (seasonal high, measured in spring 2017) and fourth quarter 2017 (seasonal low, measured in fall 2017) groundwater elevation measurements. At the time of the 2020 GSP, those records constituted the most complete dataset. Groundwater elevations were mapped using the CASGEM dataset (including voluntarily monitored wells) and the San Joaquin County dataset.

Figure 2-45 and Figure 2-46 show the groundwater elevations for the first and fourth quarters of 2017, respectively. A pumping depression at the center of the Subbasin, east of the City of Stockton, existed during both of these periods. A localized pumping depression is shown expanding from the Cosumnes Subbasin across Dry Creek to the Eastern San Joaquin Subbasin in fourth quarter of 2017. However, from the perspective of the entire Eastern San Joaquin Subbasin, the central pumping depression to the east of the City of Stockton is most significant to achieving sustainability in the Subbasin. Groundwater generally flows from the outer edges of the Subbasin towards the depression in the middle of the Subbasin. Along the eastern side of the Subbasin, the lateral gradient of groundwater levels ranged from approximately 21 feet per mile (ft/mi) during the seasonal high to 16 ft/mi during the seasonal low. Along the western side of the Subbasin, the lateral gradient rangef from approximately 7 ft/mi during the seasonal high to 6 ft/mi during the seasonal low. The steeper gradients on the east side of the Subbasin compared to the west side are primarly due to the steeper topography in that area.

Figure 2-45: First Quarter 2017 Groundwater Elevation

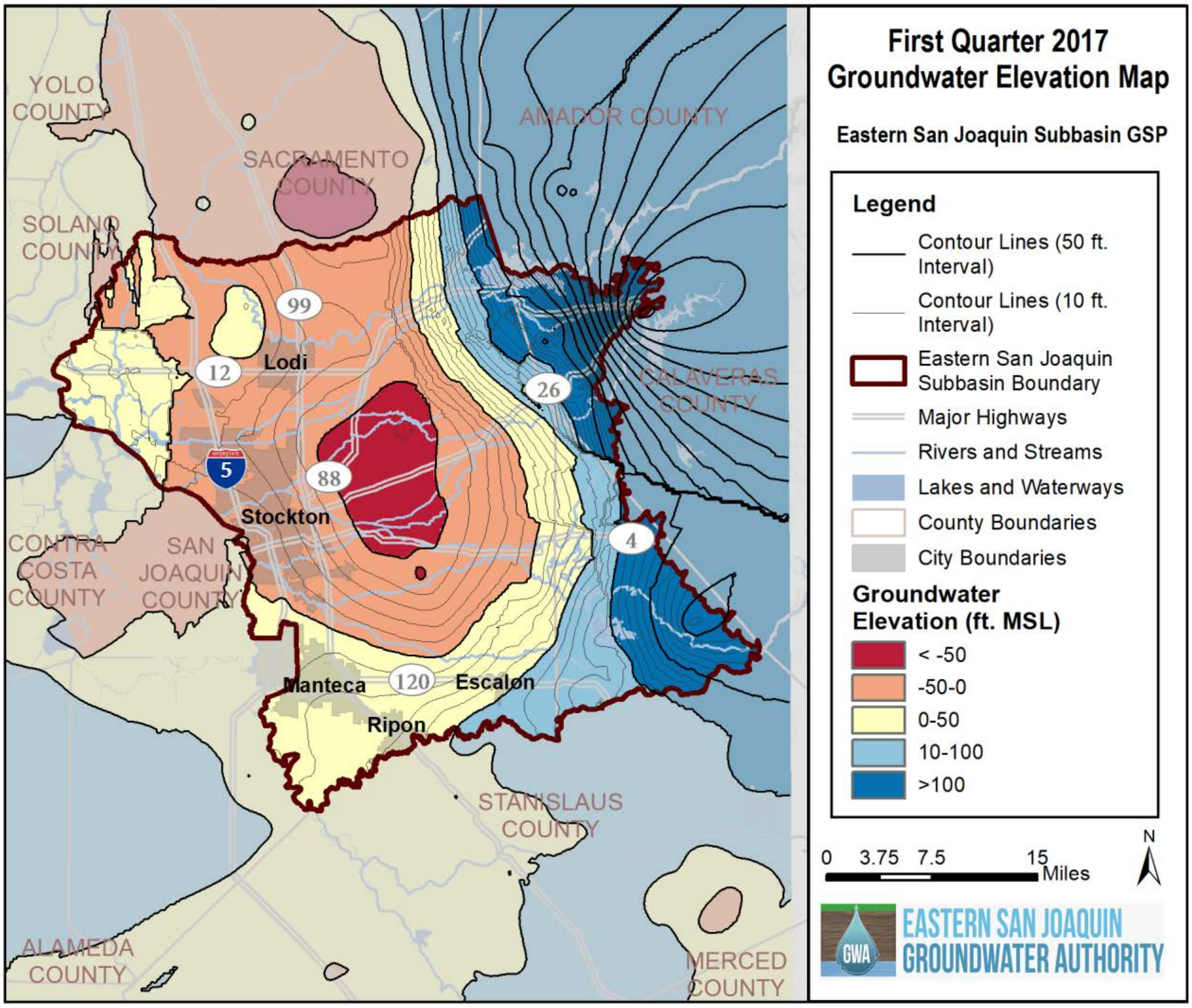
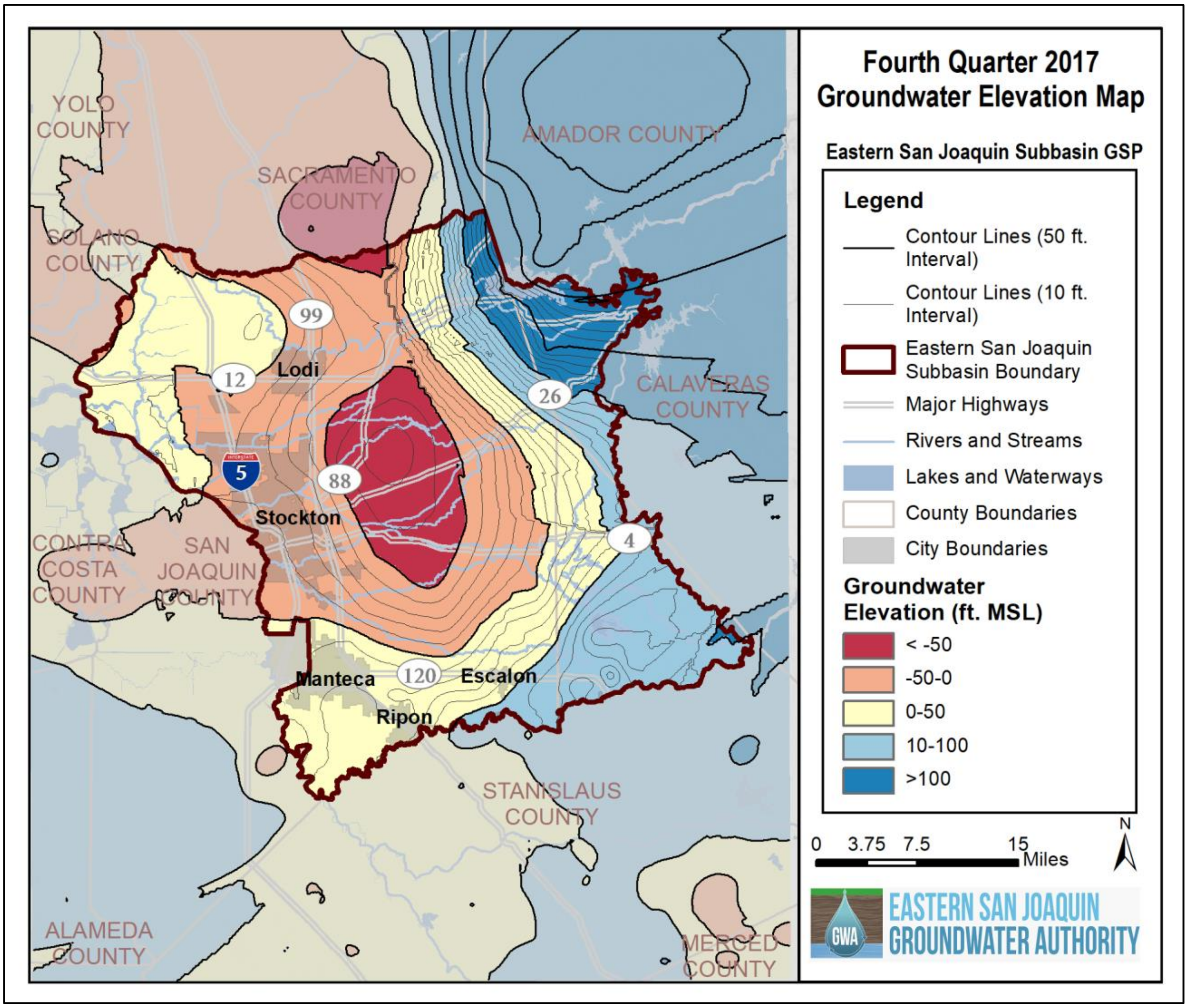


Figure 2-46: Fourth Quarter 2017 Groundwater Levels



2.2.1.2.1 Vertical Gradients

A vertical gradient drives the movement of groundwater perpendicular to the ground surface and is typically measured by comparing the elevations of groundwater in nested and/or clustered wells, wells with multiple completions at different depths. If groundwater elevations in the shallower completions are higher than in the deeper completions, the gradient is identified as a downward gradient. A downward gradient is one where groundwater is moving downward through the subsurface. If groundwater elevations in the shallower completions are lower than in the deeper completions, the gradient is identified as an upward gradient. An upward gradient is one where groundwater is moving upward through the subsurface. If groundwater elevations are the same throughout the completions, there is no vertical gradient. Knowledge about vertical gradients is required by regulation and is useful for understanding how groundwater moves in the Subbasin.

Vertical flow characteristics before considerable human development are characterized and mapped by Williamson (1989), showing that wells flowing without pumps existed in the western portion of the Eastern San Joaquin Subbasin, also corresponding with areas of upward vertical gradients. This contrasts with current conditions, where wells flowing without pumps have not been currently observed in the Subbasin. At present, USGS nested monitoring wells confirm downward vertical gradients (Williamson, 1989).

As of the 2020 GSP, there were 16 nested and/or clustered well sites located in the Eastern San Joaquin Subbasin. The locations of the wells are shown in Figure 2-47. The majority of these wells are located in the northwest portion of the Subbasin near the cities of Stockton and Lodi. Hydrographs with groundwater elevations for each respective set of nested wells are shown in Figure 2-48 through Figure 2-63. 10 out of 16 sets of wells consistently show elevations in shallower completions that are higher than in the deeper completions which indicates a downward gradient. The remaining six wells are located in the City of Lodi. Four of these wells exhibit a minimal downward gradient and two show no downward gradient.

Figure 2-47: Map of Nested and/or Clustered Well Sites (as of 2020 GSP Development)

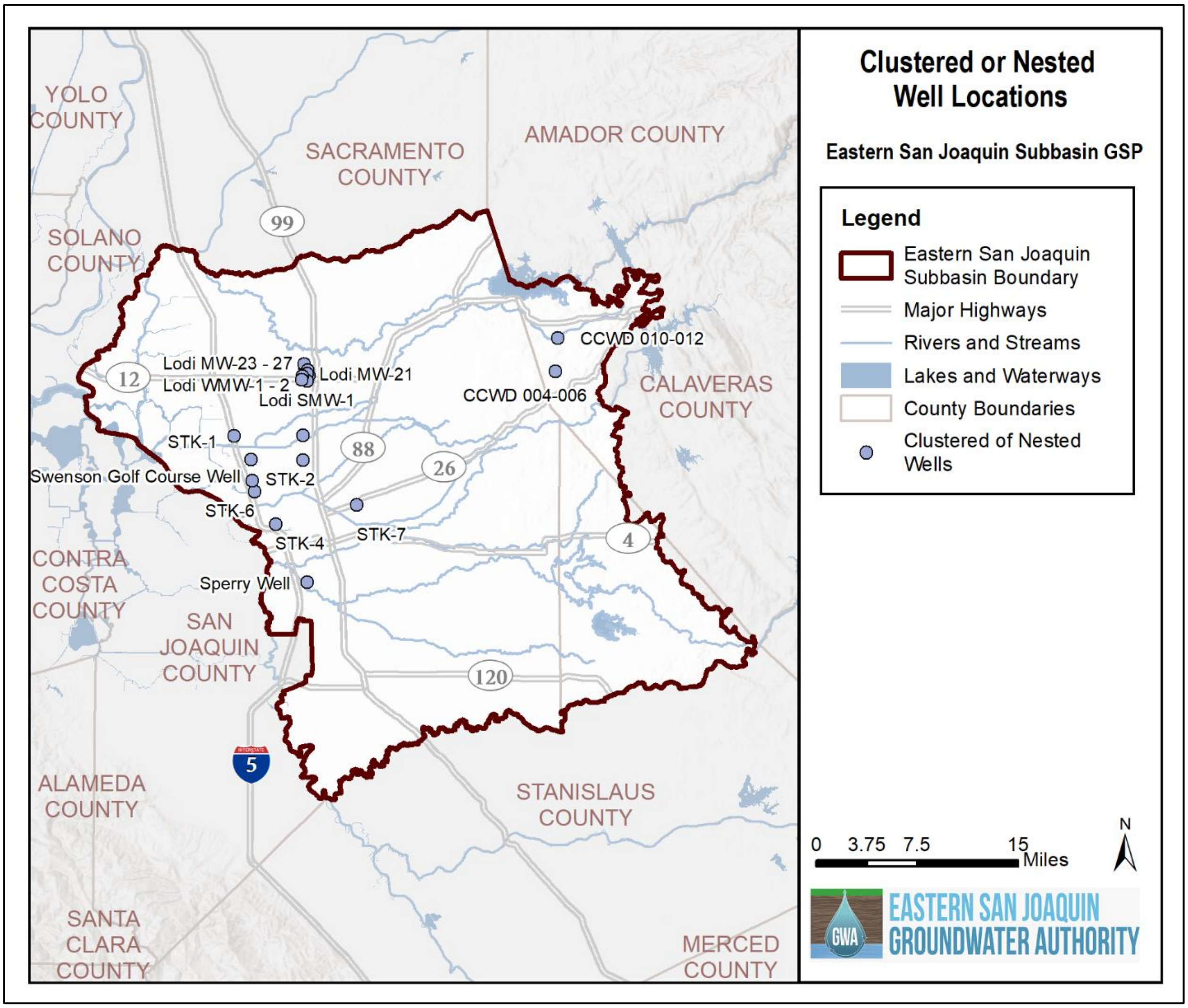


Figure 2-48: Nested Well Hydrographs: CCWD 004-006 (as of 2020 GSP Development)

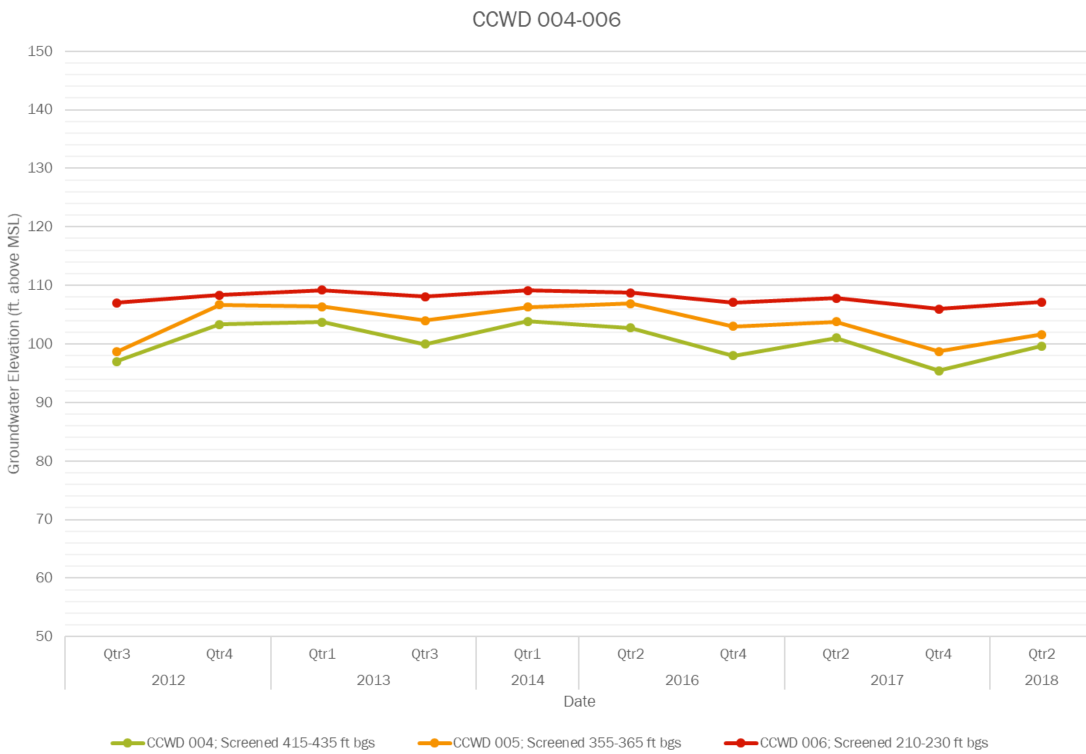


Figure 2-49: Nested Well Hydrographs: CCWD 010-012 (as of 2020 GSP Development)

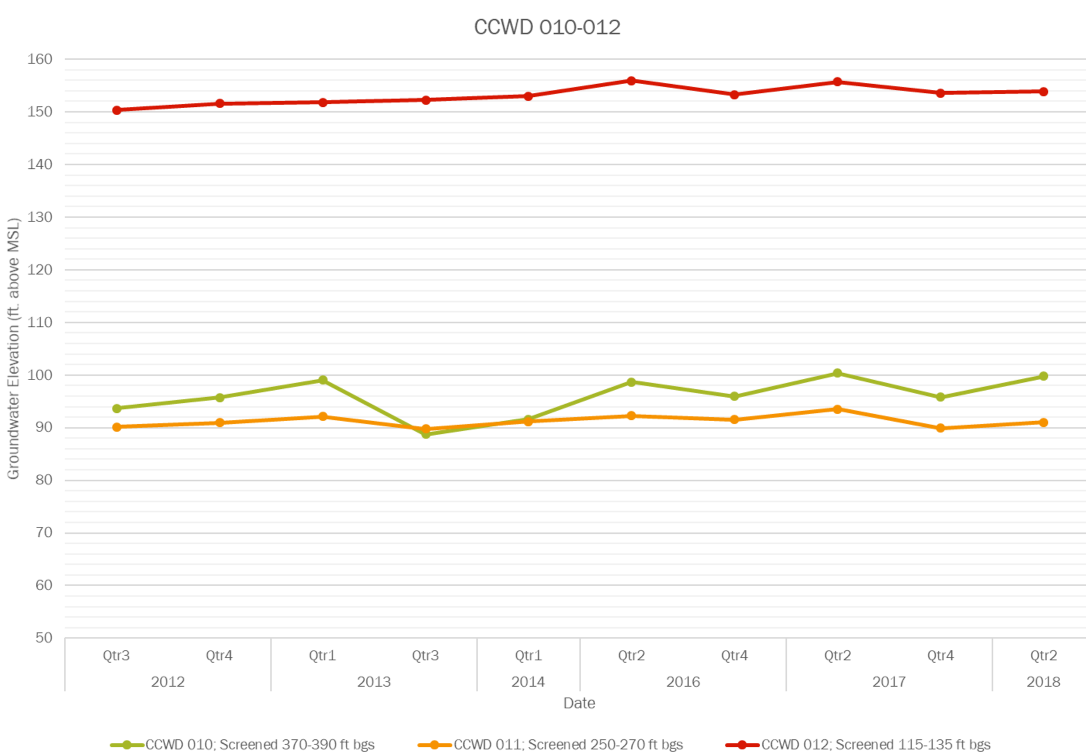


Figure 2-50: Nested Well Hydrographs: Sperry Well (as of 2020 GSP Development)

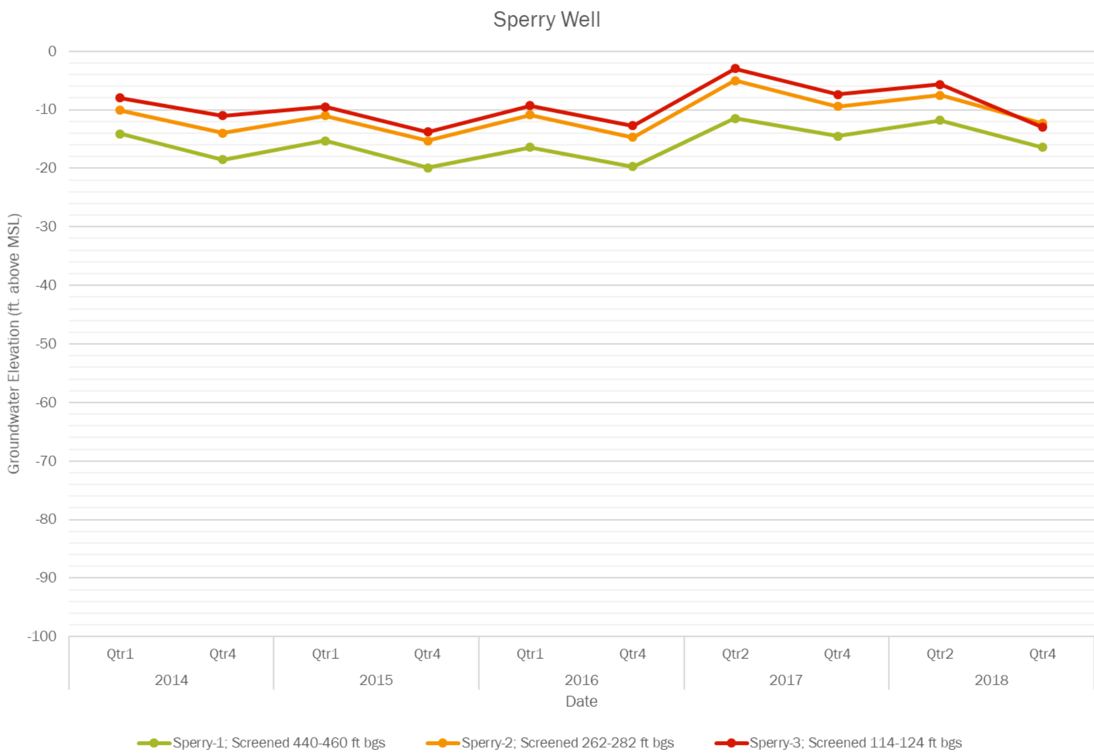


Figure 2-51: Nested Well Hydrographs: Swenson Golf Course (as of 2020 GSP Development)

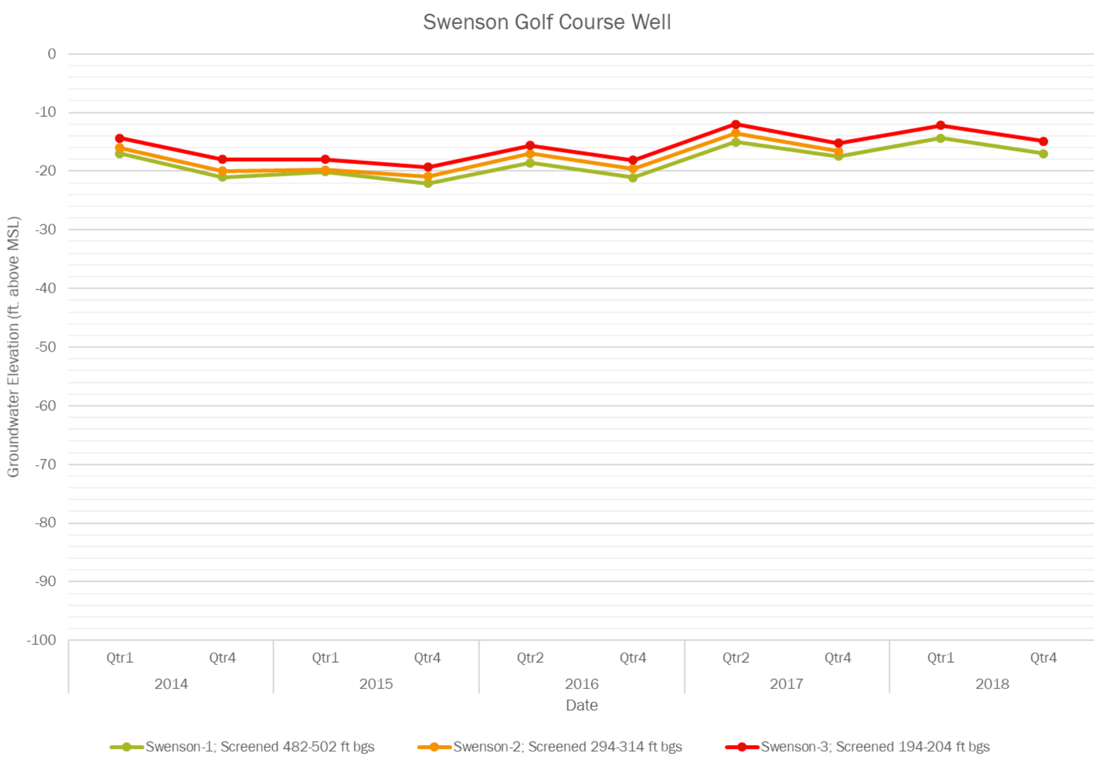


Figure 2-52: Nested Well Hydrographs: STK-1 (as of 2020 GSP Development)

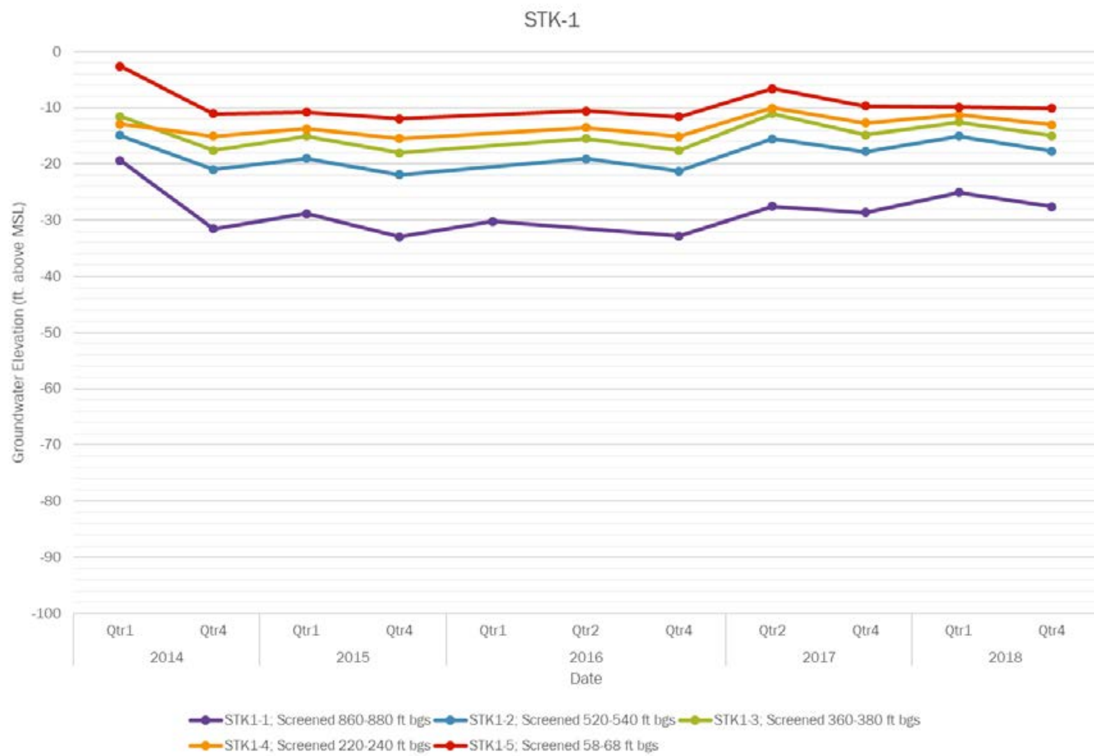


Figure 2-53: Nested Well Hydrographs: STK-2 (as of 2020 GSP Development)

Figure 2-54: Nested Well Hydrographs: STK-4 (as of 2020 GSP Development)

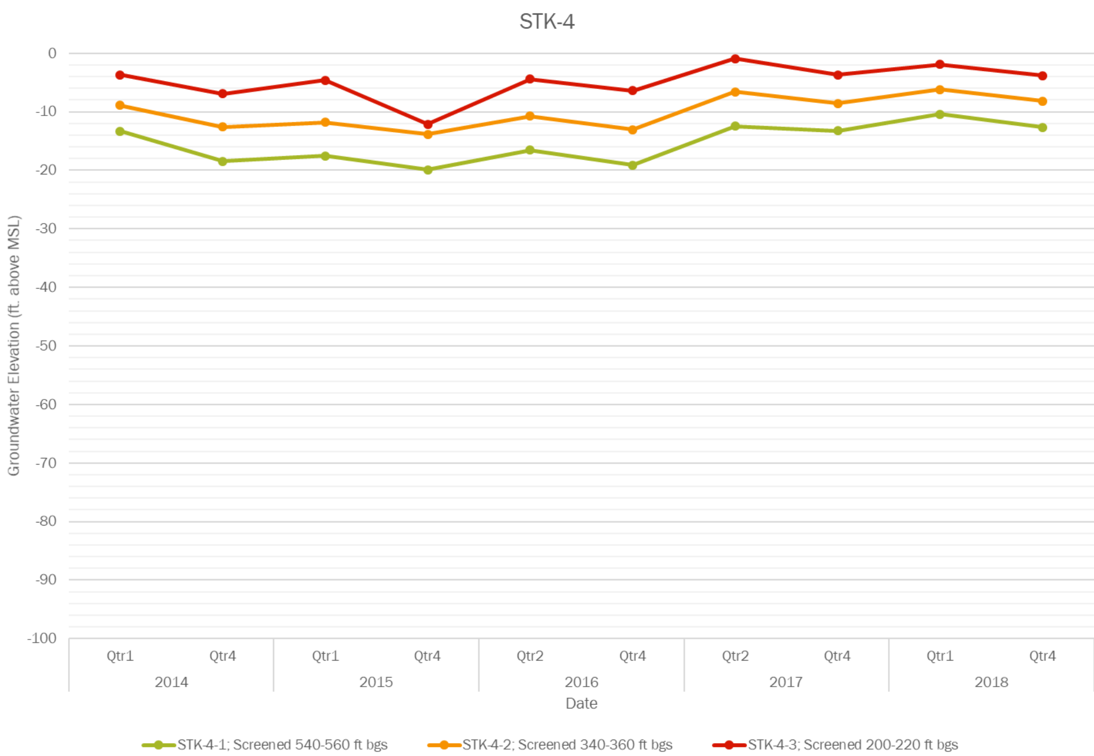


Figure 2-55: Nested Well Hydrographs: STK-5 (as of 2020 GSP Development)

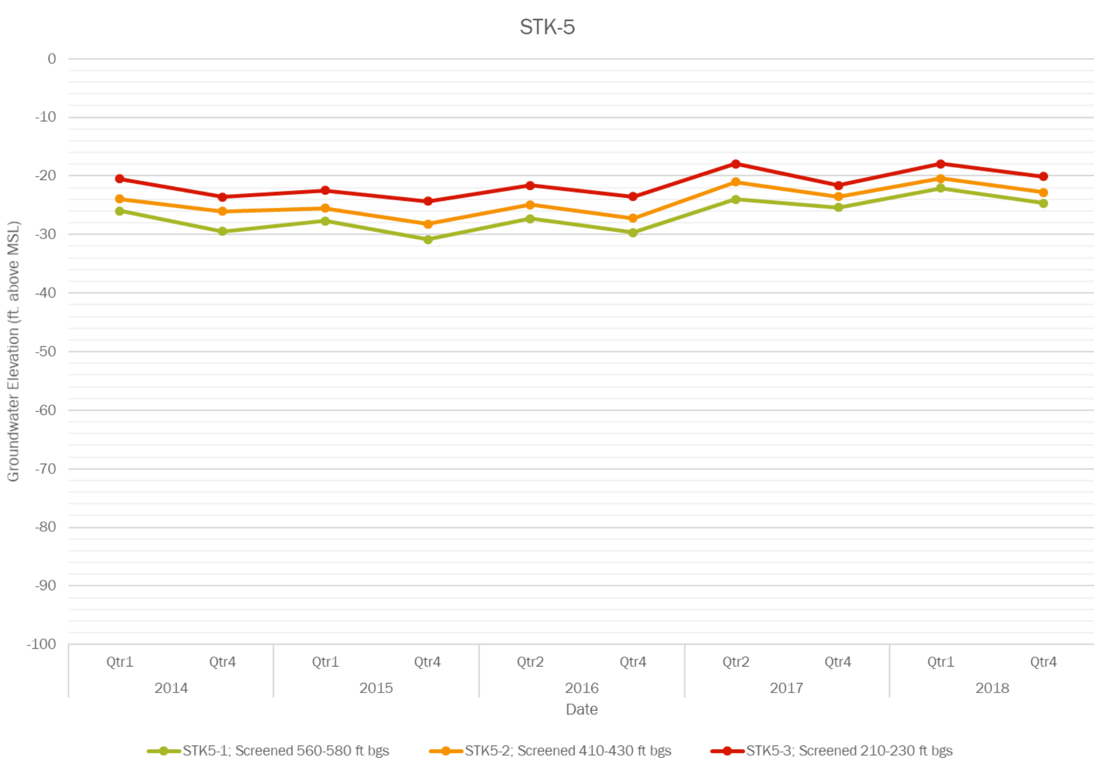


Figure 2-56: Nested Well Hydrographs: STK-6 (as of 2020 GSP Development)

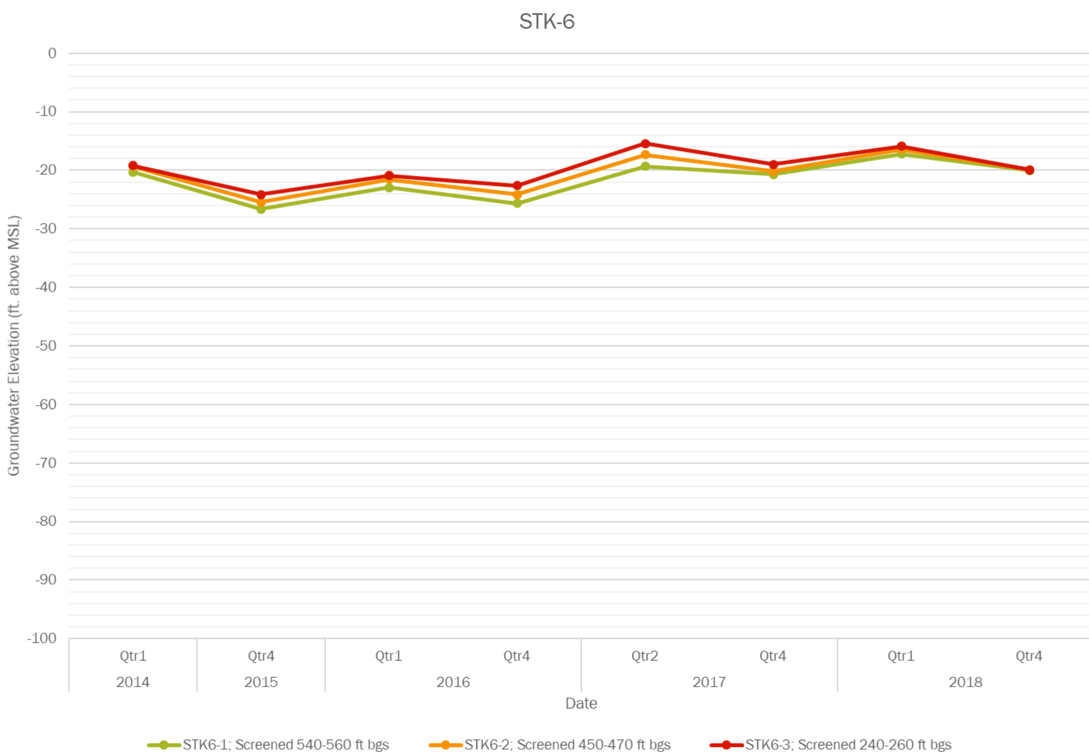


Figure 2-57: Nested Well Hydrographs: STK-7 (as of 2020 GSP Development)

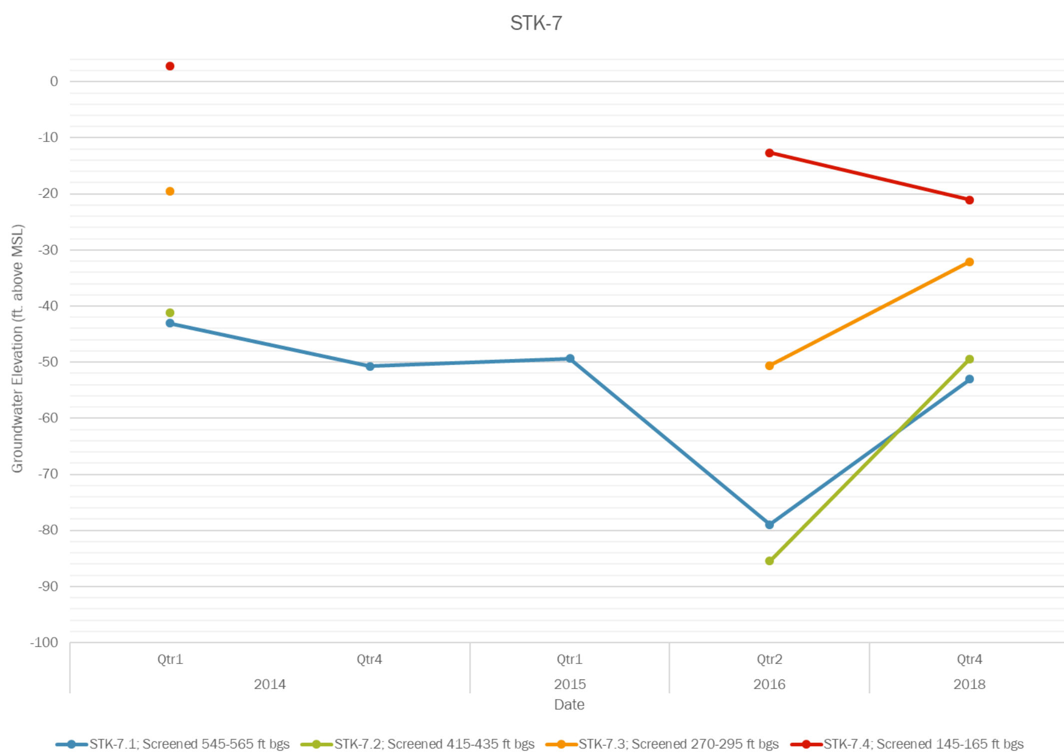


Figure 2-58: Nested Well Hydrographs: Lodi MW-21 (as of 2020 GSP Development)

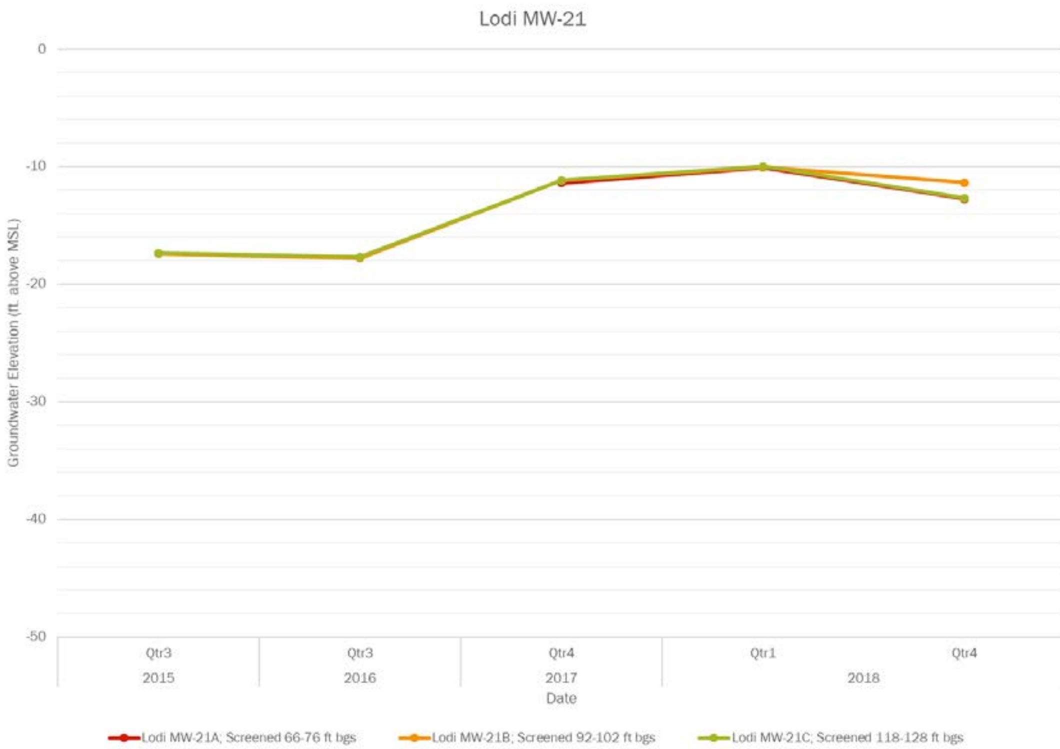


Figure 2-59: Nested Well Hydrographs: Lodi MW-24 (as of 2020 GSP Development)

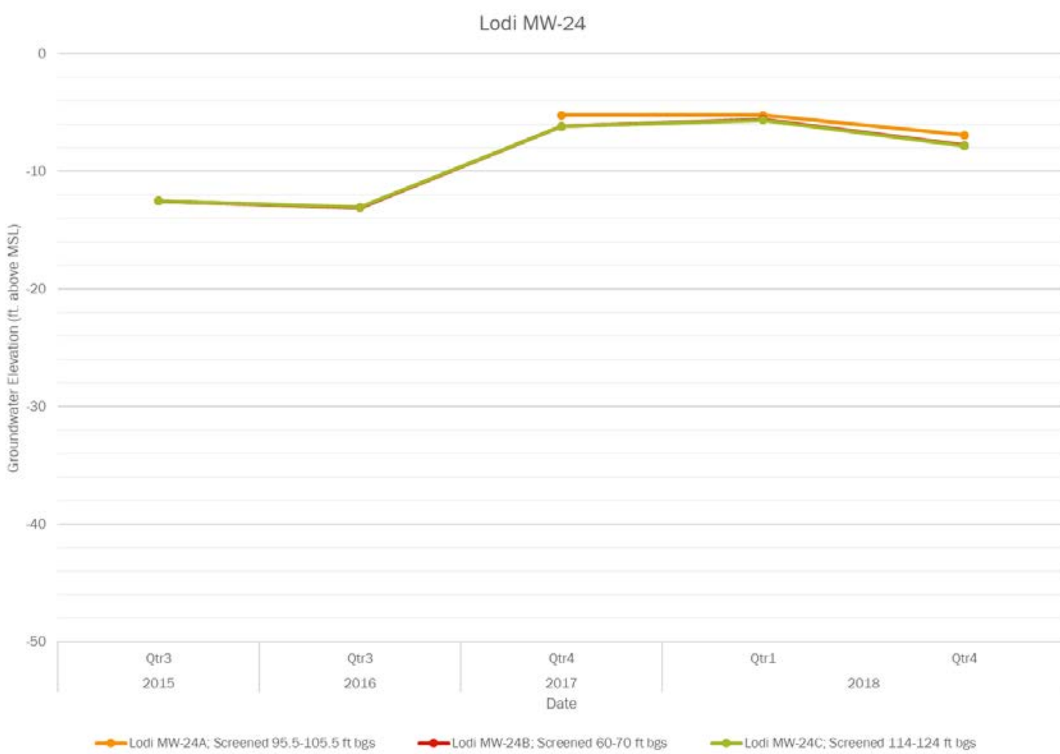


Figure 2-60: Nested Well Hydrographs: Lodi MW-25 (as of 2020 GSP Development)

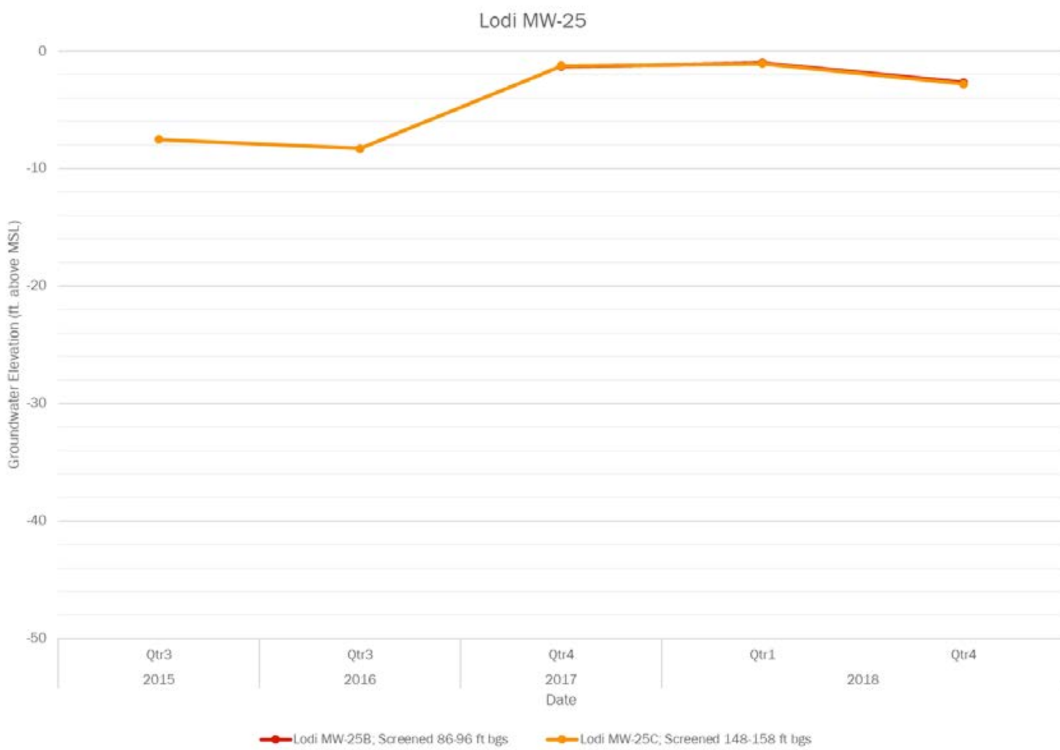


Figure 2-61: Nested Well Hydrographs: Lodi SMW-1 (as of 2020 GSP Development)

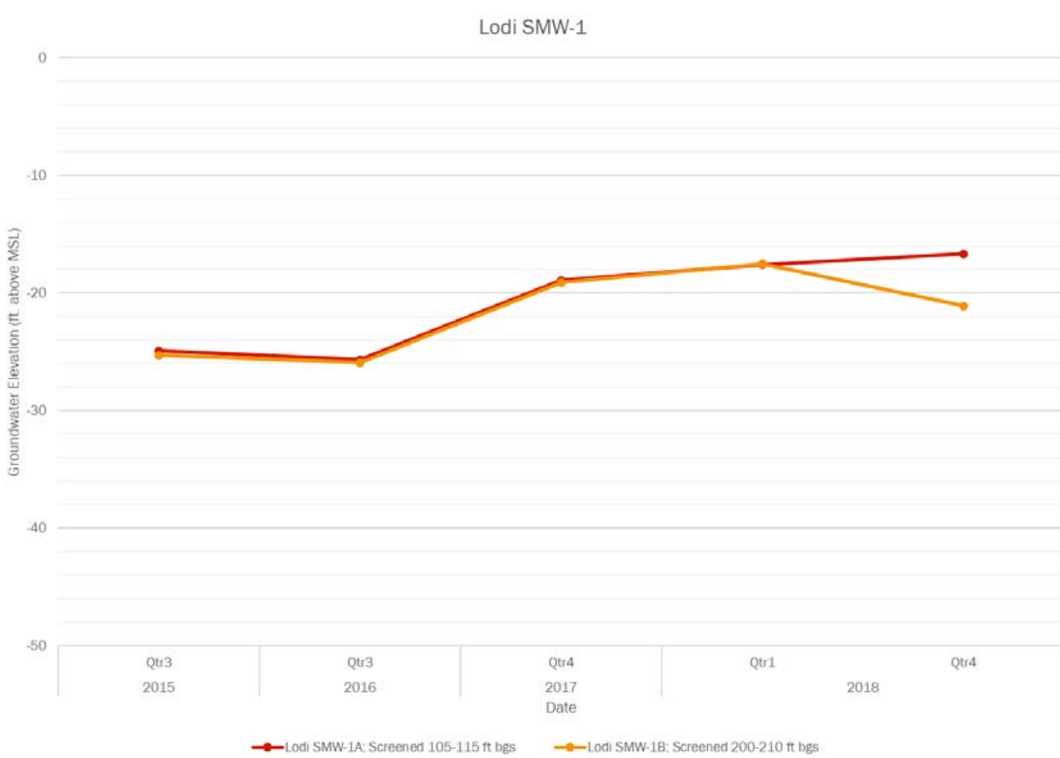


Figure 2-62: Nested Well Hydrographs: Lodi WMW-1 (as of 2020 GSP Development)

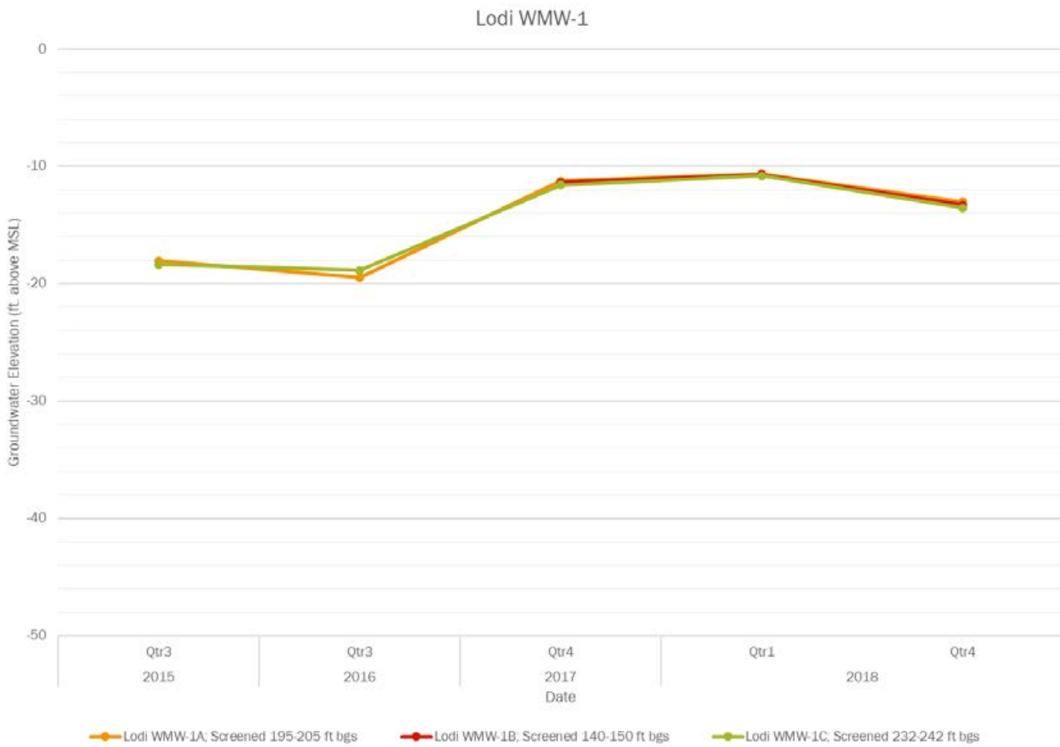
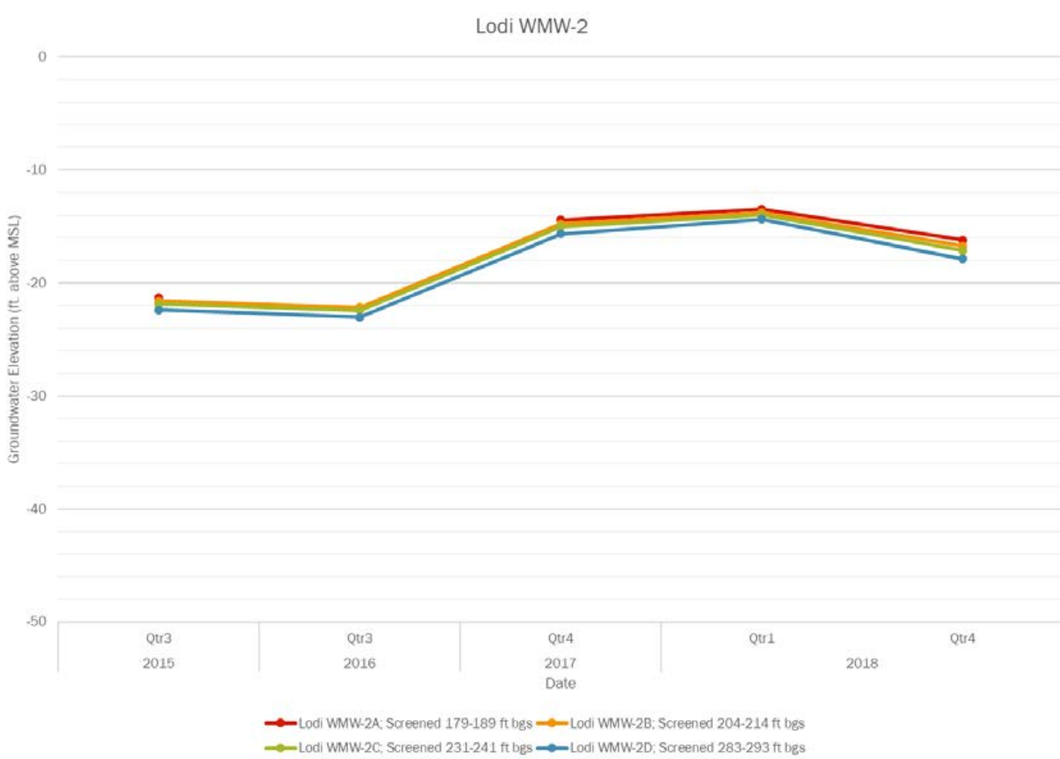


Figure 2-63: Nested Well Hydrographs: Lodi WMW-2 (as of 2020 GSP Development)



2.2.2 Groundwater Storage

The ESJWRM was used to estimate historical change in storage of the Eastern San Joaquin Subbasin from 1995-2023. Figure 2-64 shows annual total storage for the combined ESJWRM Version 3.0 fresh groundwater layers (not including the deep saline layer). Figure 2-65 shows the cumulative change in storage against annual storage change and water year type. In 2015, the total fresh groundwater storage was estimated as 74.0 million acre-feet (MAF). An additional 95.0 MAF in the deepest simulated layer of the model (not pictured) is saline water. More information about the layers of the ESJWRM Version 3.0 and calculation of storage changes can be found in model documentation in Appendix 2-C.

Figure 2-64: Historical Modeled Change in Storage

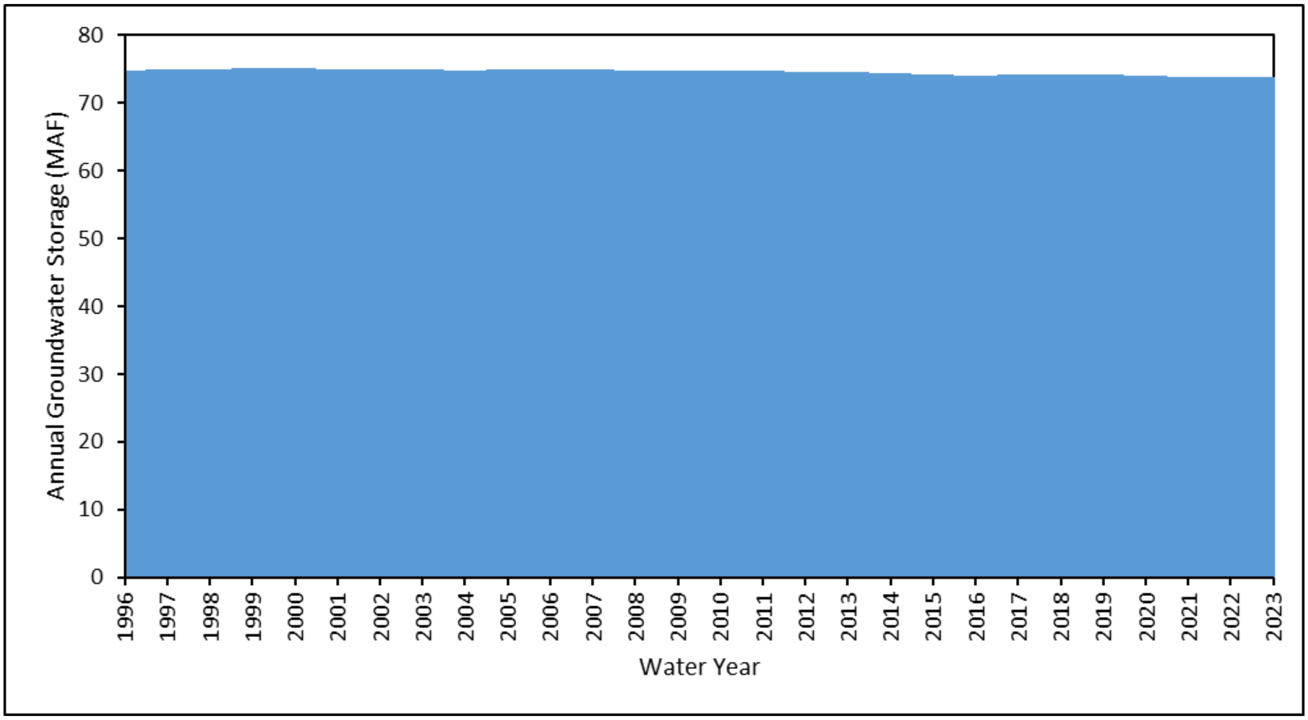
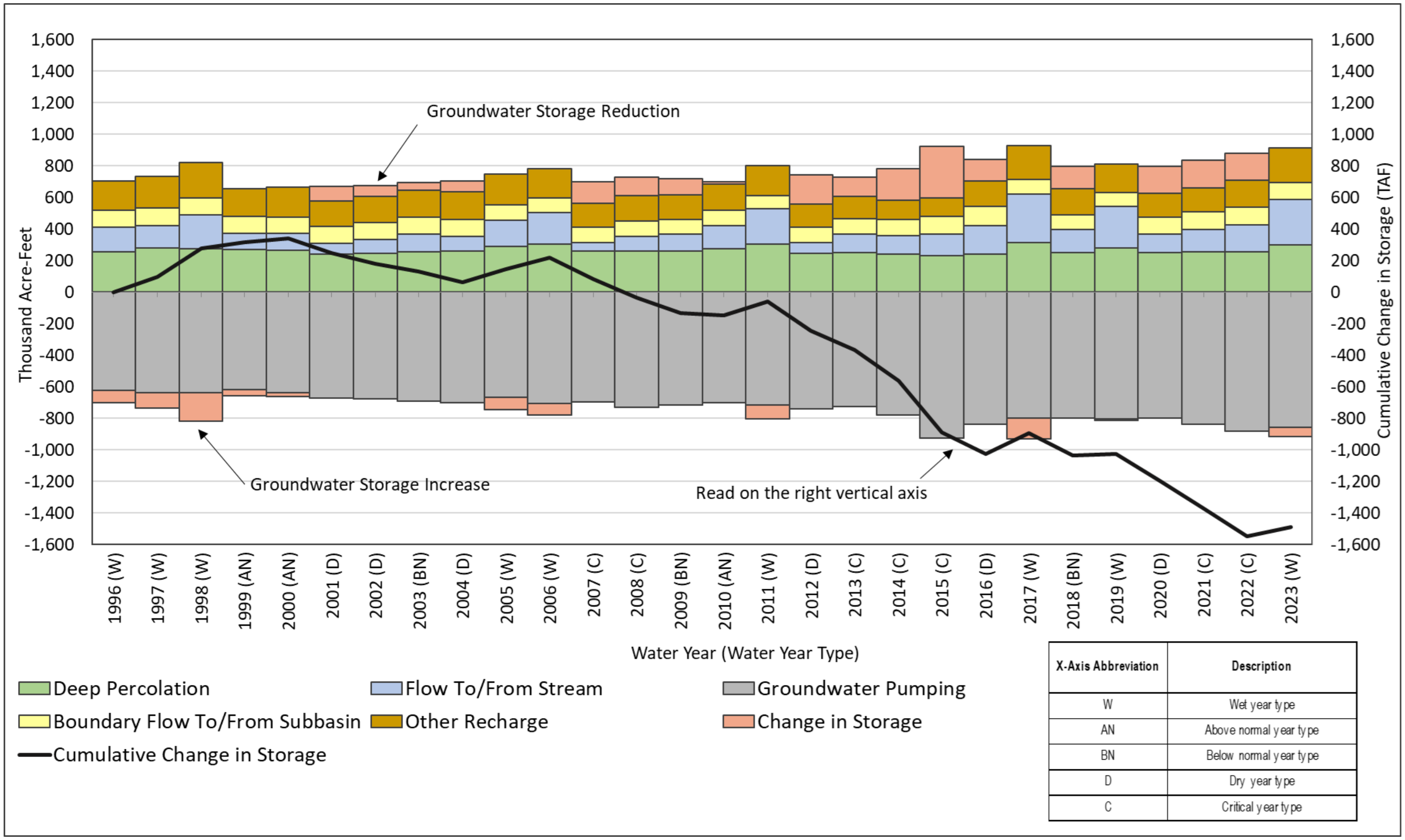


Figure 2-65: Historical Modeled Change in Annual Storage with Water Use and Year Type



X-Axis Abbreviation	Description
W	Wet year type
AN	Above normal year type
BN	Below normal year type
D	Dry year type
C	Critical year type

Notes:
1. Water Year Types based on San Joaquin Valley Water Year Index (CA DWR, 2024)
2. "Other Recharge" includes managed aquifer recharge, recharge from unlined canals and/or reservoirs, and recharge from ungauged watersheds.
3. "Change in Storage" is placed to balance the water budget. For instance, if annual outflows (-) are greater than inflows (+), there is a decrease in storage, but this would be shown on the positive side of the bar chart to balance out the increased outflows on the negative side of the bar chart.

2.2.3 Seawater Intrusion

The Eastern San Joaquin Subbasin is not in a coastal area and seawater intrusion is not present. While the Delta ecosystem evolved with a natural salinity cycle that brought brackish tidal water in from the San Francisco Bay, levees installed to allow development of agriculture, followed by development and operation of the Central Valley Project and the State Water Project, have altered the inward movement of seawater through the Delta. Current management practices endeavor to maintain freshwater flows through a combination of hydraulic and physical barriers and alterations to existing channels (Water Education Foundation, 2019). Portions of the Subbasin do, however, experience water quality issues related to salinity, which are addressed under Section 2.2.4.1 (Salinity). As described in Section 2.2.4.1, salinity in the Subbasin is due to other factors and are not the result of seawater intrusion.

2.2.4 Conditions as of 2019: Groundwater Quality

While groundwater quality in the Eastern San Joaquin Subbasin is generally sufficient to meet beneficial uses, a number of constituents of concern are either currently impacting groundwater use or have the potential to impact it in the future. Depending on the water quality constituent, the source may be anthropogenic in origin or naturally occurring, and the issue may be widespread or localized.

The primary naturally occurring water quality constituents of concern are salinity and arsenic, while the primary water quality constituents related to human activity include nitrates, salinity, and various point-source contaminants.

The sections herein provide information on the historical and current (as of the 2020 GSP) groundwater quality conditions for constituents including:

- Salinity (Section 2.2.4.1)
- Nitrate (Section 2.2.4.2)
- Arsenic (Section 2.2.4.3)
- Point-source contamination (Section 2.2.4.4), which includes petroleum hydrocarbons, solvents, and emerging contaminants

CCR Title 22 establishes water quality standards for drinking water contaminants. A primary maximum contaminant level (MCL) or SMCL is defined for a variety of parameters. For the purposes of this GSP, comparing parameter concentrations to their MCL or SMCL is used as the basis for describing groundwater quality concerns in the Eastern San Joaquin Subbasin. Comparisons to the MCL or SMCL must be considered in context as the measured concentrations represent raw water that may be treated or blended prior to delivery to meet the standard or may not be used for potable uses. Water quality is generally not known to have significantly adversely affected beneficial uses of groundwater in the Eastern San Joaquin Subbasin.

2.2.4.1 Salinity

As identified in prior planning efforts, and as referenced in Section 2.2 (Historical Groundwater Conditions) and Section 2.3 (Current Groundwater Conditions), localized salinity issues are a concern for some areas of the Eastern San Joaquin Subbasin. Pumping in excess of recharge has resulted in declining groundwater levels that have contributed to an increase of salinity in groundwater wells since the 1950s. As identified through isotopic typing, elevated salinity concentrations in the Subbasin are the result of natural processes and overlying land use activities (O'Leary et al., 2015). Within the Subbasin, there are three primary sources of salinity:

1. **Delta Sediments –** Evaporation of groundwater in discharge areas introduces naturally occurring soluble salts into Delta sediments.

2. **Deep Deposits –** Saline groundwater in the Subbasin is principally the result of the migration of a naturally occurring deep saline water body which originates in regionally deposited marine sedimentary rocks that underlie the San Joaquin Valley. This results in a saline aquifer underlying the freshwater aquifer, and well pumping can result in upwelling saline brines into the freshwater aquifer.

3. **Irrigation Return Water –** Irrigation return water is excess applied water that percolates into the groundwater system or flows to the stream system from an irrigated field following the application of irrigation water. Return water may include contaminants typical of agricultural practices (e.g., pesticides, herbicides) and can concentrate salts due to evapotranspiration. The return water may act as a conduit delivering these contaminants to the surrounding watershed or underlying groundwater aquifer. Areas in the Subbasin with salinity resulting from irrigation return water do not commonly exceed chloride concentrations of 100 mg/L (O'Leary et al., 2015).

Salinity is a measure of the mass of dissolved particles and ions in a volume of water. Salinity includes many different ions, including nitrate, but the most common are sodium, calcium, magnesium, chloride, bicarbonate, and sulfate. Chloride and TDS are two common ways to measure and analyze salinity. Each is described separately in the sections below.

2.2.4.1.1 Chloride

Chloride is one way to measure salinity and is reported as a concentration of the Cl^- ion that originates from the dissociation of salts in water. The California Department of Drinking Water (DDW) SMCL of 250 mg/L for chloride is a common approach to identifying water quality concerns for this constituent. The SMCL is a secondary drinking water standard that is established for aesthetic reasons such as taste, odor, and color and is not based on public health concerns. The 250 mg/L value is "recommended" by SWRCB as a threshold below which chloride concentrations are desirable for a higher degree of consumer acceptance of drinking water. An "upper" limit of 500 mg/L is used to define a range above the "recommended" value where chloride concentration is acceptable if it is neither reasonable nor feasible to provide more suitable waters (SWRCB, 2018). Comparisons to the SMCL must be considered in context as the measured concentrations represent raw water, which may be treated or blended prior to delivery to meet the standard or may not be used for potable uses.

As shown in Figure 2-66, the majority of observed chloride concentrations above 250 mg/L occur on the western side of the Subbasin. As shown in Figure 2-67, the number of measurements with observed concentrations above 250 mg/L has decreased since the 1970s. The GAMA dataset was used for analysis.

Figure 2-66: Maximum Chloride Concentration Greater Than 250 mg/L (1940s-2010s)

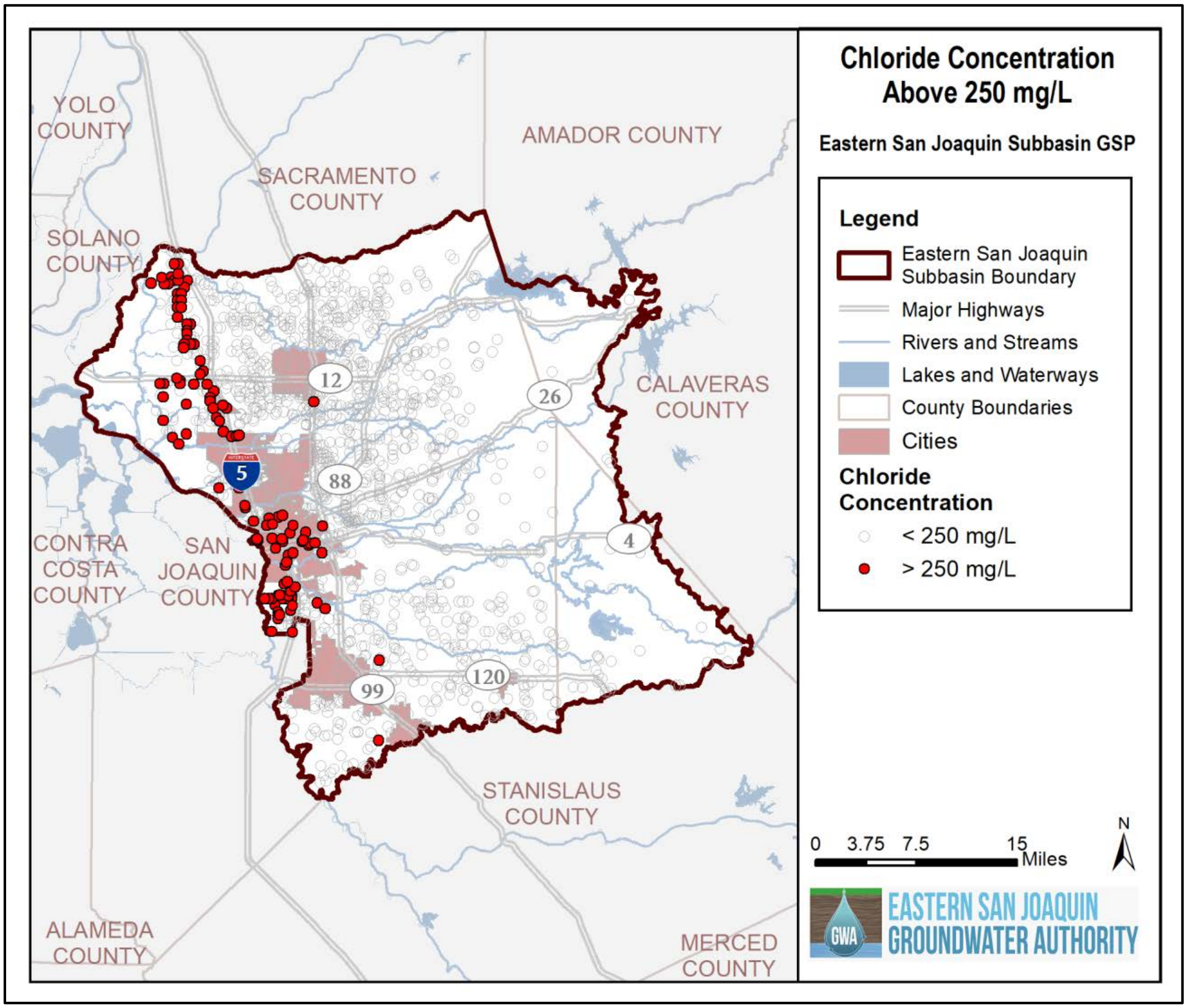


Figure 2-67: Maximum Chloride Concentration Above 250 mg/L by Decade

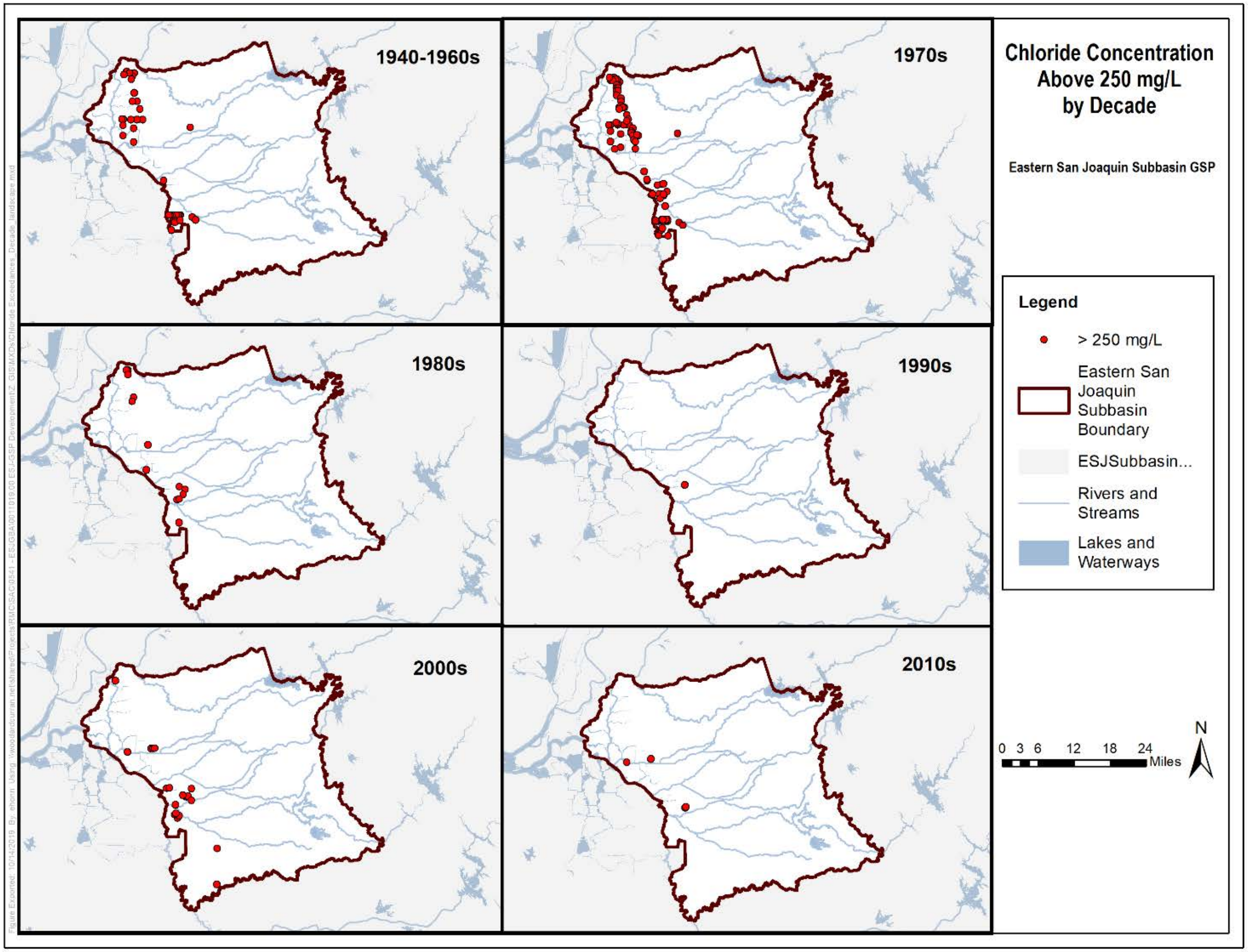


Table 2-5 shows occurrence of chloride measurements greater than 250 mg/L by decade. Chloride records have been observed above 250 mg/L both historically and more recently. Sampling frequencies increased in the 1970s and 2000s.

Table 2-5: Summary of Chloride Data by Decade

Decade	Measurement Above 250 mg/L?		Range of Values (mg/L)				Total Number of Samples
	No	Yes	Minimum	Average	Median	Maximum	
1940	98%	2%	7.0	45.2	20.0	975	180
1950	93%	7%	2.3	89.4	25.0	3,750	699
1960	90%	10%	0.0	115.0	17.0	1,960	312
1970	90%	10%	1.8	85.9	19.0	3,310	1,780
1980	97%	3%	0.0	45.4	20.5	630	858
1990	99%	1%	0.0	31.2	19.0	533	663
2000	95%	5%	0.0	59.6	35.0	2,050	1,453
2010	98%	3%	0.0	34.8	39.0	2,050	986

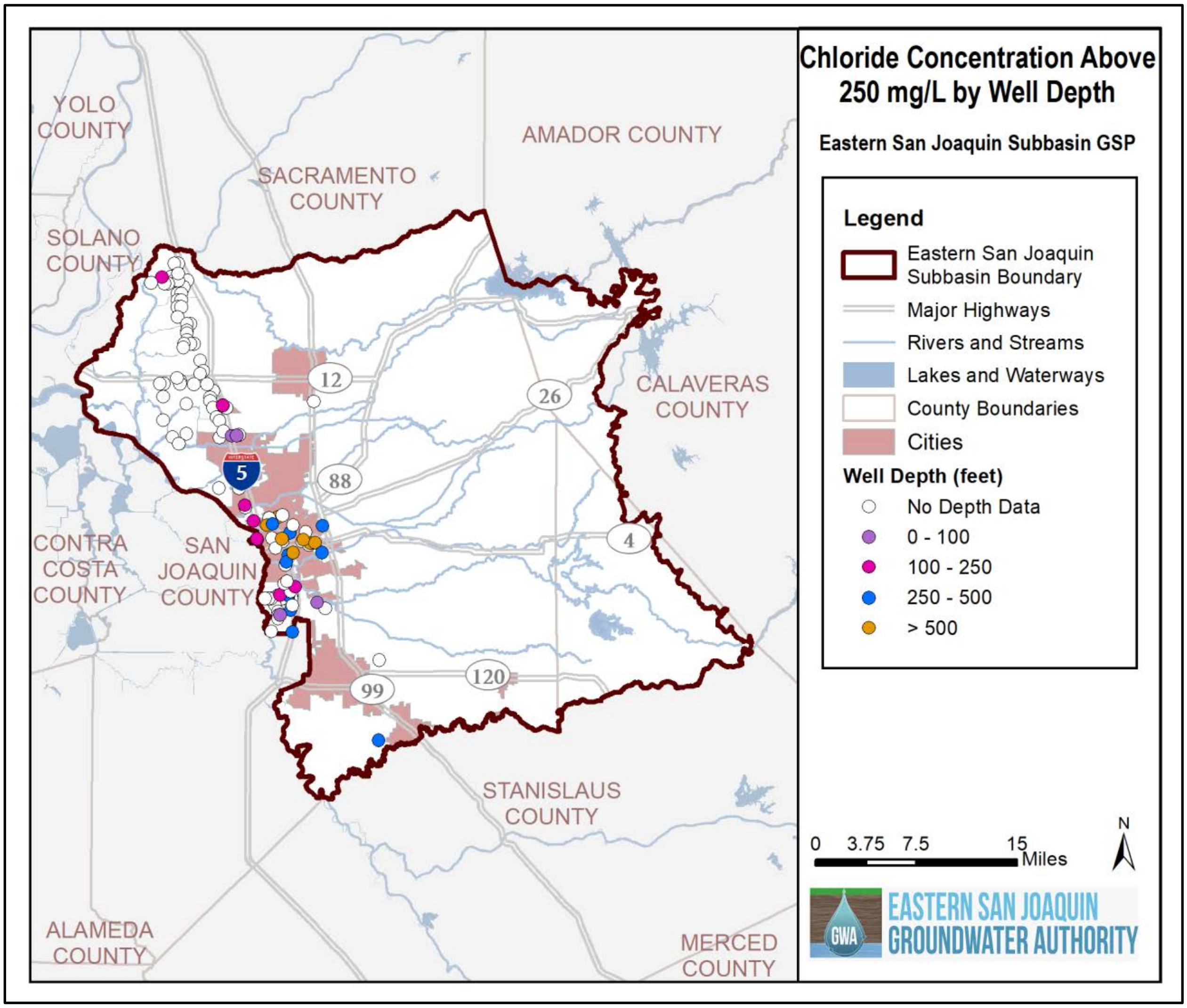
Table 2-6 shows chloride occurrences of concentrations greater than 250 mg/L by well depth. The highest proportion of readings above 250 mg/L occur in the shallowest wells, less than 100 feet deep (8 percent). The highest maximum value also occurred at this depth range (up to 2,050 mg/L).

Figure 2-68 shows the spatial distribution of chloride occurrences greater than 250 mg/L by well depth within the Subbasin.

Table 2-6: Summary of Chloride Data by Depth (1940s-2010s)

Depth (feet)	Measurement Above 250 mg/L?		Range of Values (mg/L)				Total Number of Samples
	No	Yes	Minimum	Average	Median	Maximum	
No Depth Data	92%	8%	0.0	82.5	20.0	3,750	3,566
0 - 100	92%	8%	0.8	73.5	60.0	2,050	239
100 - 250	97%	3%	1.0	44.2	36.0	1,400	1,215
250 - 500	98%	2%	0.0	32.4	16.0	1,100	1,487
> 500	95%	5%	2.7	62.1	15.6	1,940	424

Figure 2-68: Maximum Chloride Concentration Above 250 mg/L by Well Depth (1940s-2010s)



A lack of depth information presents a challenge to analyzing the vertical distribution of chloride measurements which would inform identification of chloride sources. Examples of depth information include total well construction depth or screened interval depths, which vary between wells. Some wells have total depth but not screened interval depth, or vice versa. For this analysis, screened interval depth was used first, and if this information was not available, total depth was used. Approximately 4,600 of the almost 13,000 chloride measurements in the Eastern San Joaquin Subbasin are from wells lacking any construction or screen depth information. Roughly half of the measurements above 250 mg/L occur in the wells lacking depth data, which also show the highest range in values occurring above 250 mg/L. Identifying the source of high-chloride water in wells of various depths over time requires further analysis of geochemical data.

2.2.4.1.2 Total Dissolved Solids (TDS)

TDS, which is a measure of all inorganic and organic substances present in a liquid in molecular, ionized, or colloidal suspended form, is commonly used to measure salinity. Recent TDS sample results show trends that match closely with the overall historical trends for chloride and highlight areas with elevated salinity concentrations in more recent years. TDS concentrations in the Eastern San Joaquin Subbasin ranged from 35 to 2,500 mg/L between 2015 and 2018. Spatially, the highest concentrations of TDS are found along the western margin of the Subbasin and the San Joaquin River and decrease significantly to the east, to typically less than 500 mg/L. TDS measurements, like chloride levels, are elevated near the cities of Stockton and Manteca, and in the Lodi GSA near the White Slough Water Pollution Control Facility.

Figure 2-69 shows the maximum and Figure 2-70 shows the average TDS concentrations from 2015 to 2018 as compared to the SMCL lower limit of 500 mg/L and upper limit of 1,000 mg/L. The GAMA dataset was used for analysis. The SMCL is a secondary drinking water standard that is established for aesthetic reasons such as taste, odor, and color and is not based on public health concerns. The 500 mg/L value is “recommended” by the State Water Resources Control Board (SWRCB) as a threshold below which TDS concentrations are desirable for a higher degree of consumer acceptance of drinking water. The “upper” limit is used to define a range above the “recommended” value where TDS concentration is acceptable if it is neither reasonable nor feasible to provide more suitable waters (SWRCB, 2006). Comparisons to the SMCL must be considered in context as the measured concentrations represent raw water, which may be treated or blended prior to delivery to meet the standard or may not be used for potable uses.

Figure 2-69: Maximum TDS Concentrations 2015-2018

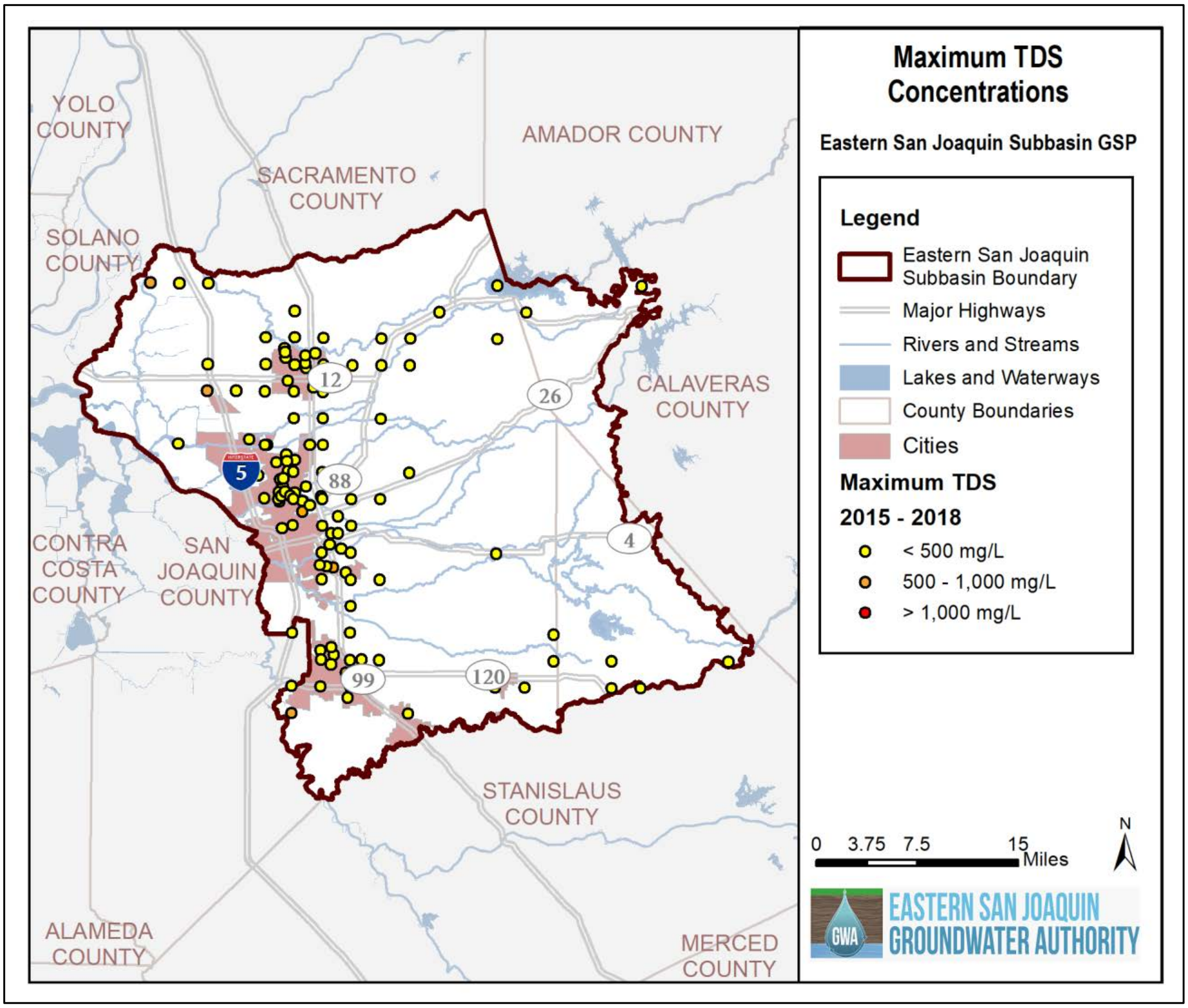
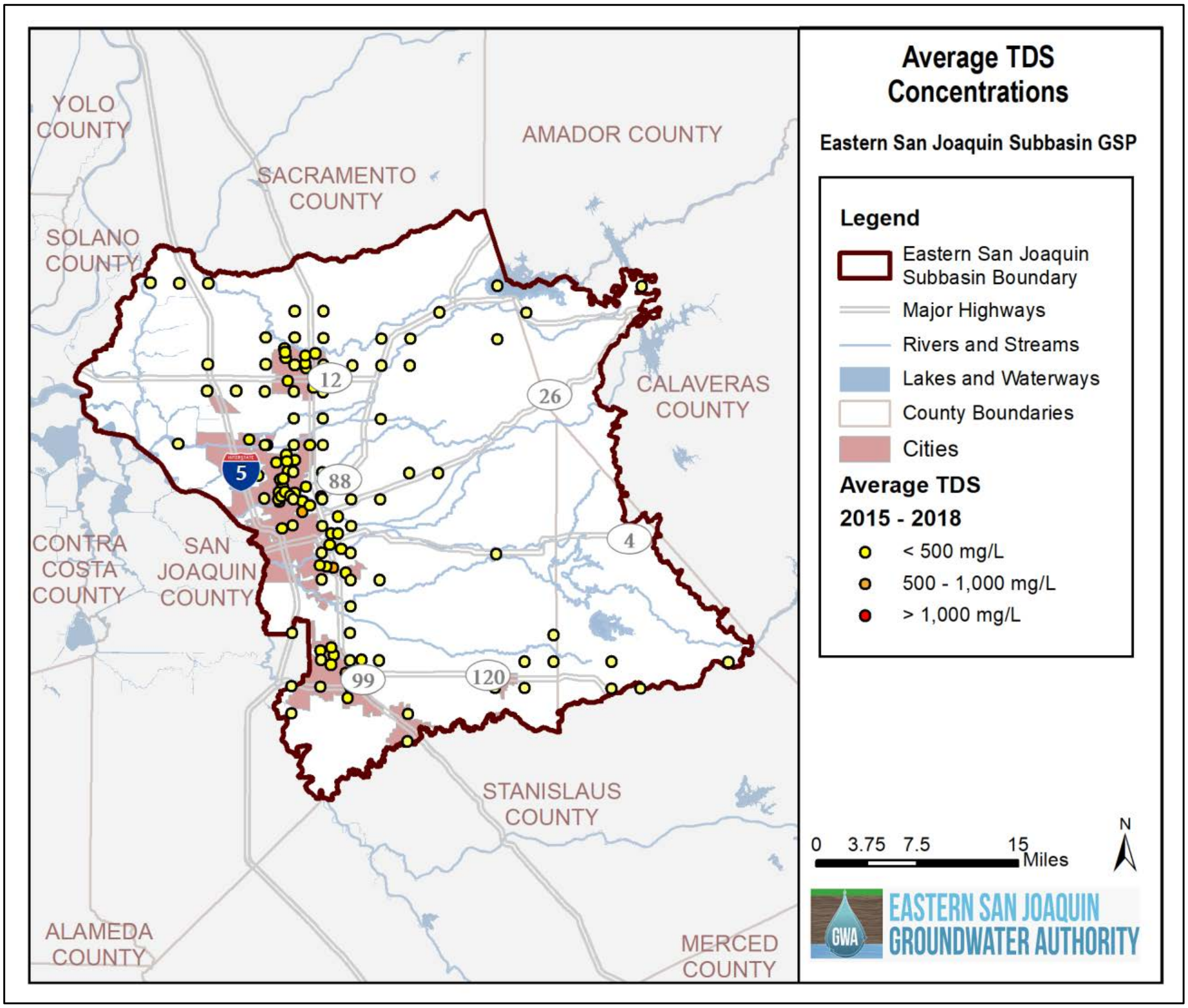


Figure 2-70: Average TDS Concentrations 2015-2018



Elevated TDS concentrations are apparent in very shallow groundwater in close proximity to the San Joaquin River, while deep wells (depths greater than 200 feet) typically have TDS concentrations below 500 mg/L. TDS trends by depth are summarized in

Table 2-7.

Figure 2-71 shows the maximum TDS concentrations for shallow wells in the Eastern San Joaquin Subbasin from years 2015 to 2018, and Figure 2-72 shows the maximum TDS concentrations for deep wells in the same timeframe. As with chloride measurements, depth-dependent TDS data are not widely available.

Table 2-7: Summary of TDS Data by Depth (2015-2018)

Depth (feet)	% Measurements in Range			Range of Values (mg/L)				Total Number of Samples
	< 500 mg/L	500 – 1000 mg/L	> 1,000 mg/L	Minimum	Average	Median	Maximum	
No Depth Data	90%	8%	2%	94	339	310	1,180	451
0 - 100	N/A							0
100 - 250	54%	46%	0%	280	438	480	540	13
250 - 500	93%	7%	0%	120	344	340	560	75
> 500	N/A							0

Figure 2-71: Maximum TDS Concentrations in Shallow Wells 2015-2018

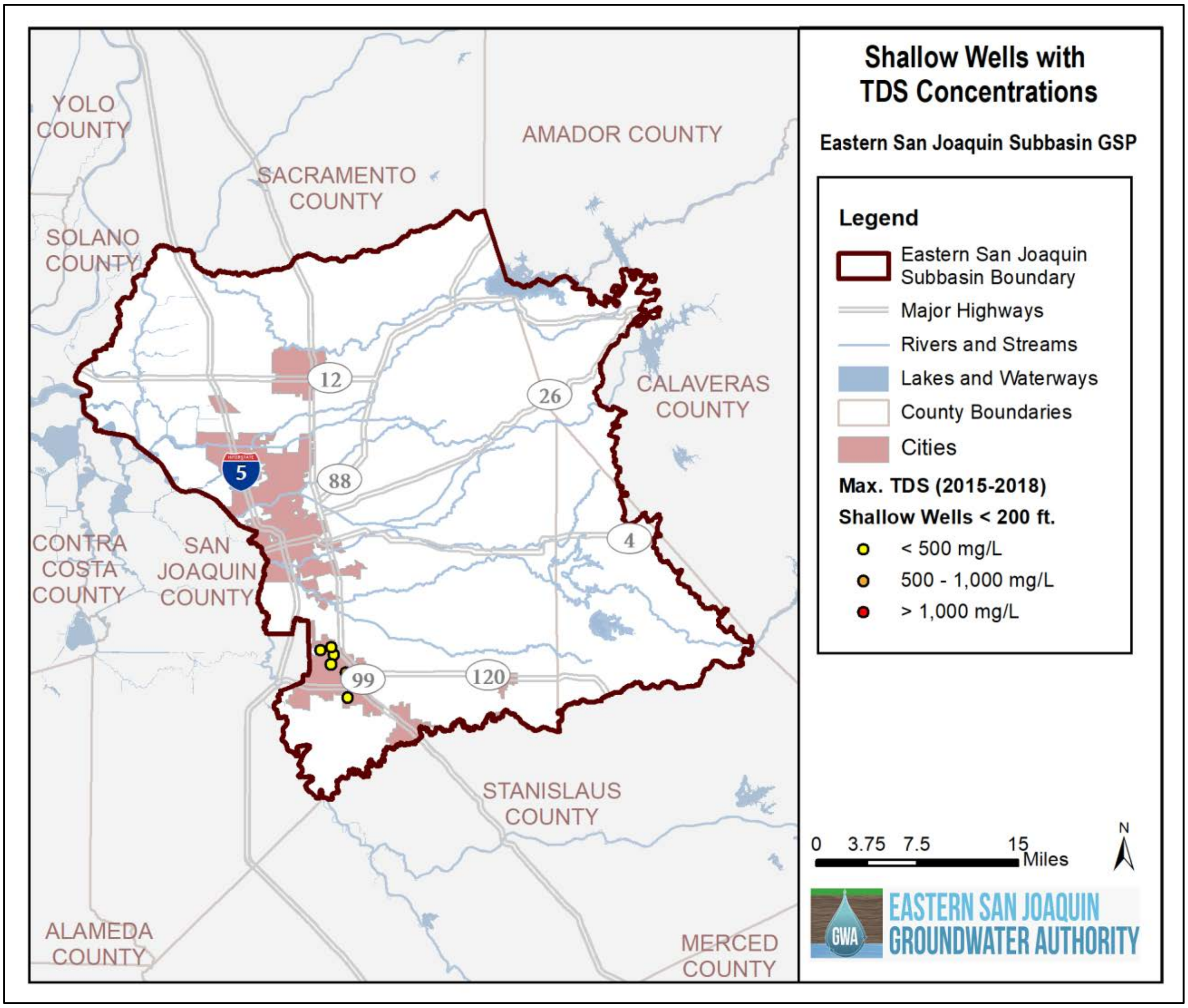
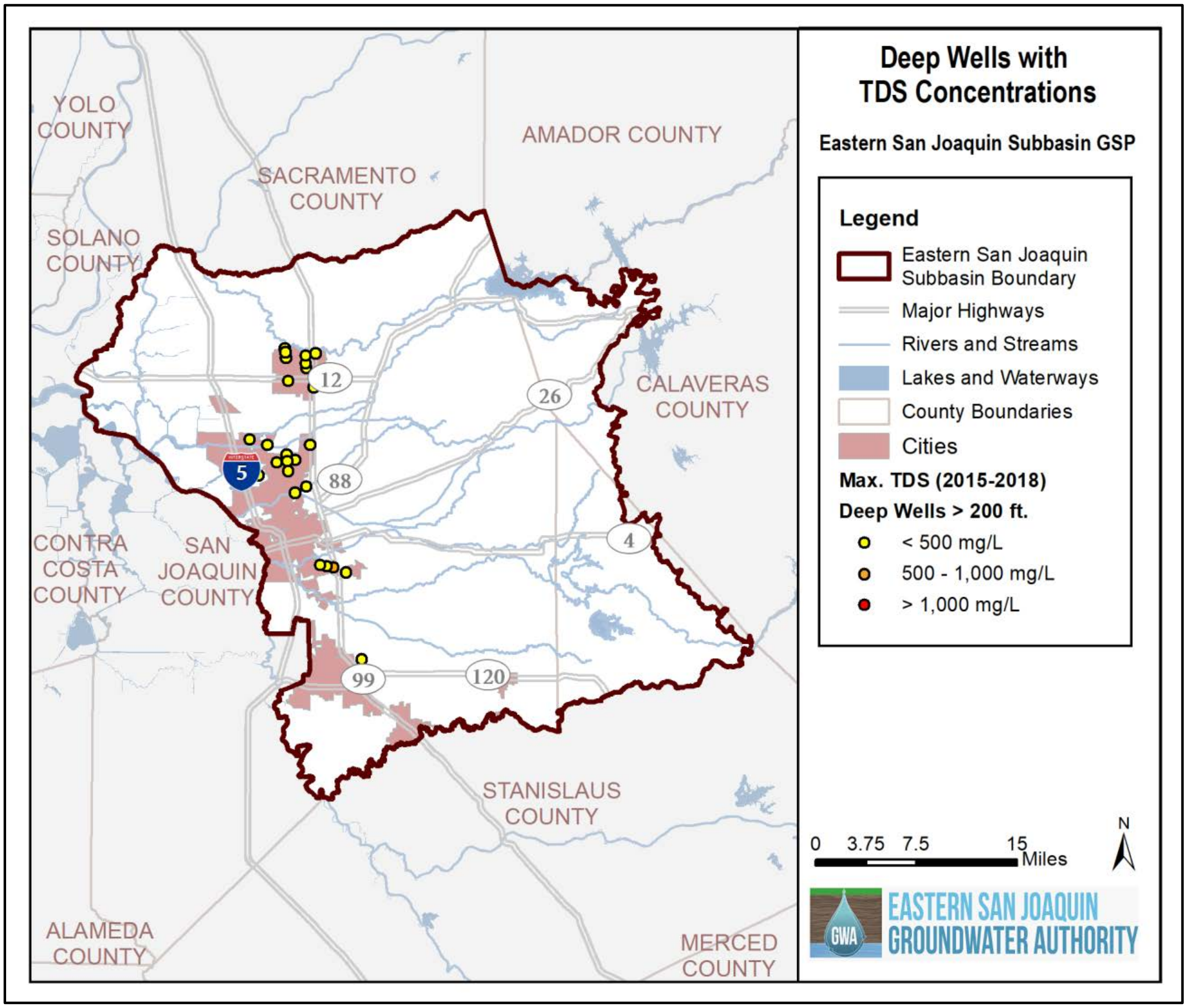


Figure 2-72: Maximum TDS Concentrations in Deep Wells 2015-2018



2.2.4.2 Nitrate

Nitrate is both naturally occurring and can be contributed a result of human activity. Nitrate can cause adverse human health effects. Anthropogenic sources of nitrate include fertilizers, septic systems, and animal waste. The DDW's MCL of 10 mg/L for Nitrate as N delimits high levels of nitrate for drinking water use. Many measured concentrations are above this value, both historically and more recently. Comparisons to the MCL must be considered in context as the measured concentrations represent raw water, which may be treated or blended prior to delivery to meet the standard or may not be used for potable uses.

Table 2-8 provides the total number of nitrate values by decade and the percentage of those values greater than 10 mg/L. The total number of nitrate measurements has grown since 2000 as has the percentage of occurrences of concentrations greater than 10 mg/L. The GAMA dataset was used for analysis.

Table 2-8: Nitrate as N Concentrations by Decade

Decade	% of Samples		Number of Nitrate Samples
	<10 mg/L	>10 mg/L	
1940	88%	13%	8
1950	99%	1%	362
1960	99%	1%	240
1970	96%	4%	1,500
1980	95%	5%	420
1990	98%	2%	1,716
2000	87%	13%	9,679
2010	83%	17%	11,060

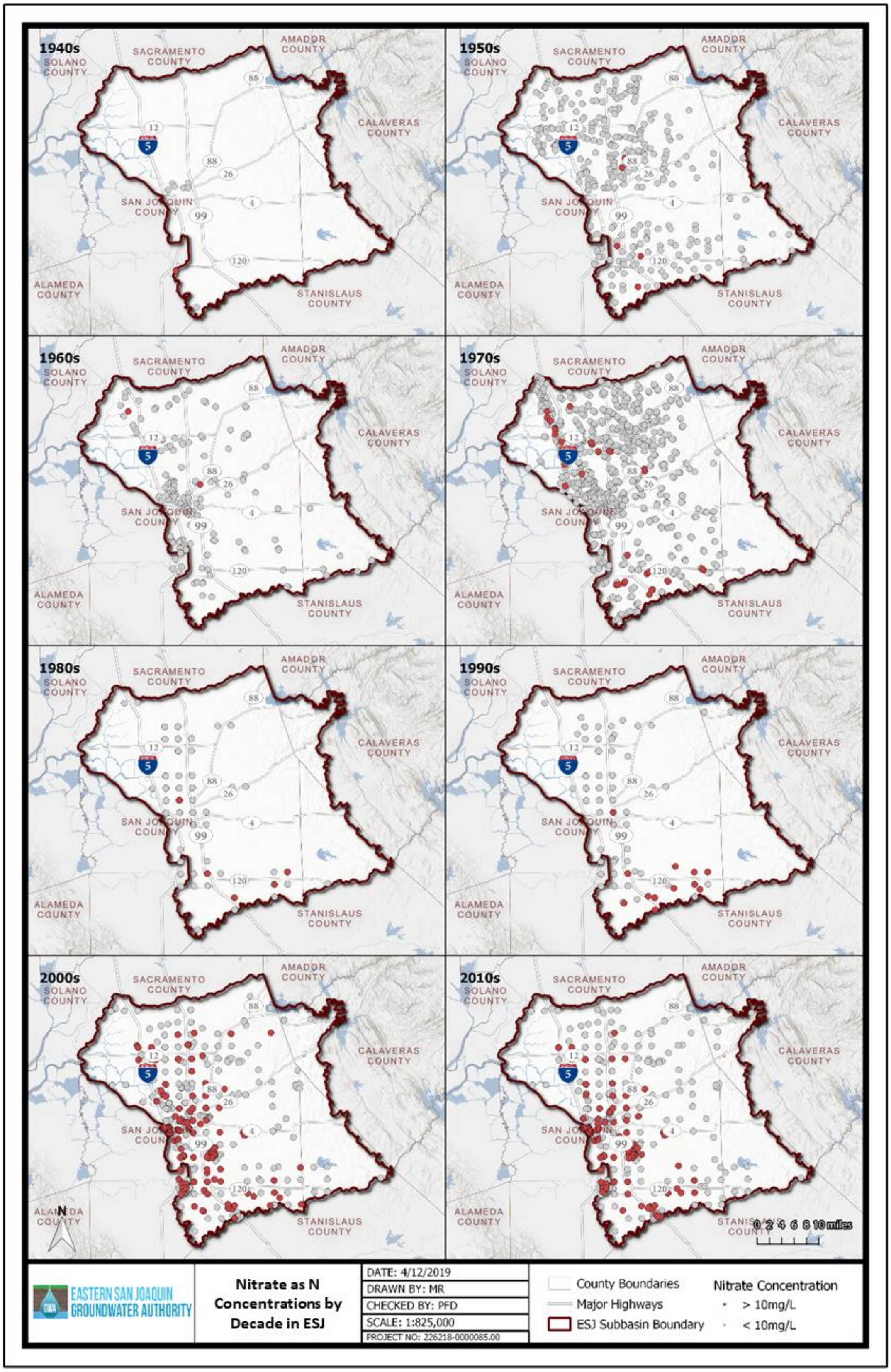
Figure 2-73 shows the historical spatial distribution of nitrate samples and detections by decade. During the 1940s, the earliest decade with nitrate measurements, very few records exist, and no significant conclusions can be made from this timeframe. The 1950s and 1960s have larger datasets, but measurements above 10 mg/L during these decades are sporadic and localized. Nitrate concentrations during the 1970s show a significant number of measurements above 10 mg/L in the northwest portion of the Eastern San Joaquin Subbasin, adjacent to Interstate 5. The 1980s and 1990s show similar patterns, with areas measurements above 10 mg/L primarily around the cities of Stockton, Lodi, and Manteca. Nitrate as N measurements above 10 mg/L are also located near the southern edge of the Eastern San Joaquin Subbasin, close to Highway 120. Although a much greater number of records exists for the 1990s than the 1980s, these decades have approximately the same spatial distribution. One possible explanation is similar wells were sampled during the 1980s and 1990s, but much more frequently in the 1990s. The 2000s and 2010s had both the greatest number of nitrate measurements and the largest number of measurements above 10 mg/L. Measurements above 10 mg/L during these decades follow previous trends: they are primarily between Highway 99 and Interstate 5, from Ripon to near Lodi.

Recent (as of 2019) nitrate measurements above the MCL correspond to the overall historical trends and highlight areas with elevated nitrate concentrations in more recent years. These areas include the cities of Stockton and Ripon, areas of the Lodi GSA near the White Slough Pollution Control Facility, the N.A. Chaderjian Youth Correctional Facility, Republic Services Landfill on South Austin Road, and the Kruger and Sons, Inc. site off Highway 4 outside Farmington.

While the extent of groundwater quality impacts from nitrate is a data gap area, increased nitrate concentrations have not been found to have a causal nexus between SGMA-related groundwater management activities in the Subbasin. The causal nexus reflects that the degraded water quality issues are associated with groundwater pumping and other SGMA-related activities rather than water quality issues resulting from land use practices, naturally occurring water quality issues, or other issues not associated with groundwater pumping. Additional monitoring conducted through the implementation of this GSP will inform trends such that the Eastern San Joaquin Groundwater Authority (ESJGWA) can be informed to take action to address nitrite contamination if a causal nexus is identified.

Section 3.3 of this Plan discusses Irrigated Lands Regulatory Program (ILRP) and Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), two existing regulatory programs for the monitoring and regulation of nitrate. Under the ILRP, the San Joaquin County & Delta Water Quality Coalition is required to test and potentially mitigate for nitrate in domestic wells. Additionally, the 2017 Salt and Nitrate Management Plan developed by CV-SALTS identifies long-term nitrate management practices (CVRWQCB, 2016).

Figure 2-73: Nitrate as N Concentrations by Decade



2.2.4.3 Arsenic

Arsenic is ubiquitous in nature and is commonly found in drinking water sources in California. Determining the source of arsenic in groundwater is difficult because arsenic is both naturally occurring and used in human activities such as agriculture. Public health concerns about arsenic in drinking water related to its potential to cause adverse health effects are addressed through DDW's MCL, established at 10 micrograms per liter (µg/L). California's revised arsenic MCL of 10 µg/L became effective on November 28, 2008. A 10-µg/L federal MCL for arsenic has been in effect since January 2006. Previous California and federal MCLs for arsenic were 50 µg/L.

Figure 2-74 shows the spatial distribution of arsenic concentrations contained in the GAMA database. From the 1970s to present, the total number and percentage of arsenic values above 10 µg/L has increased (see Table 2-9). The spatial distribution of measurements above 10 µg/L is similar to nitrate, largely between Interstate 5 and Highway 99, from Manteca to Lodi. The increased arsenic concentrations near urban areas are not necessarily indicative of contamination from these areas and may partially be due to the fact that arsenic measurements are more abundant in these urban areas; GAMA water quality records are rarely evenly distributed throughout the Subbasin for any constituent. Recent (as of 2019) arsenic samples show measurements above 10 µg/L similar to the overall trends (see Figure 2-75). Measurements above 10 µg/L in years 2015, 2016, 2017, and 2018 are primarily located in the cities of Stockton and Manteca, with fewer occurring around the City of Lodi. While the extent of groundwater quality impacts from arsenic is a data gap area, increased arsenic concentrations have not been found to have a causal nexus between SGMA-related groundwater management activities in the Subbasin.

Figure 2-74: Arsenic Concentrations by Decade

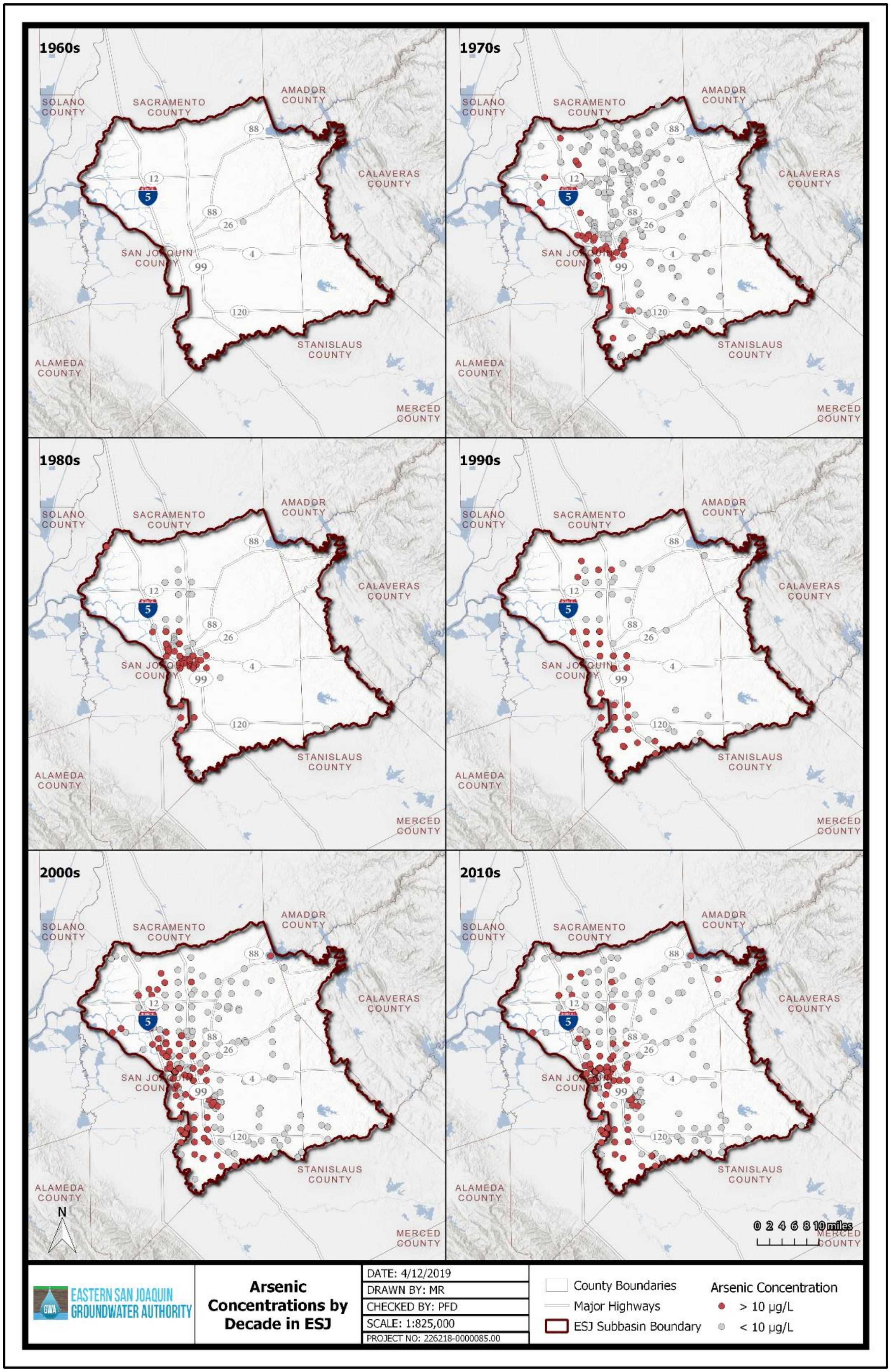
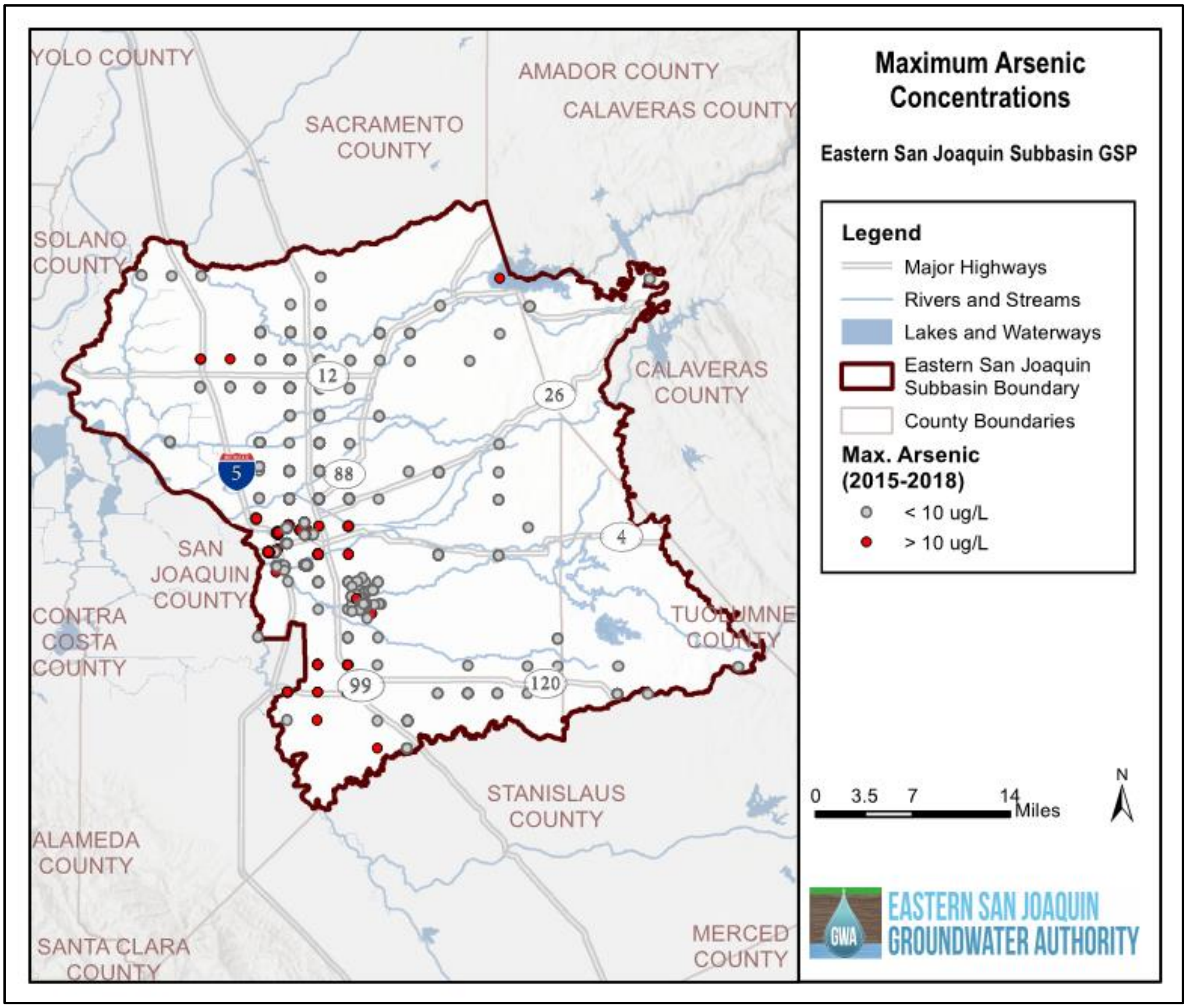


Table 2-9: Arsenic Concentrations by Decade

Decade	% of Samples		Number of Arsenic Samples
	<10 µg/L	>10 µg/L	
1960	100%	0%	1
1970	86%	14%	339
1980	72%	28%	363
1990	72%	28%	645
2000	56%	44%	4,051
2010	48%	52%	5,109

Figure 2-75: Maximum Arsenic Concentrations 2015-2018



2.2.4.4 Point Sources

Point sources are discrete or discernable sources of pollutants which may introduce undesirable constituents into groundwater and may negatively impact water quality. In the Eastern San Joaquin Subbasin, point sources include leaking underground storage tanks, landfills, dry cleaners, and others. These sites are actively investigated and monitored within the Eastern San Joaquin Subbasin in response to these known or potential sources of groundwater contamination.

The Regional Water Quality Control Board (RWQCB), the Department of Toxic Substances Control (DTSC), and the USEPA provide oversight of point-source pollution through existing regulatory programs, including management of remedial action for point-source contamination sites. Figure 2-76 shows the results of a query from both the GeoTracker database and the EnviroStor database. GeoTracker documents contaminant concerns that the RWQCB is or has been working with site owners to remediate while EnviroStor is the DTSC's data management system to track known contamination sites undergoing cleanup, permitting, enforcement, and investigation efforts. As shown in Figure 2-76, there are 258 active sites within the Eastern San Joaquin Subbasin which are color-coded based on the site's constituent(s) of concern: fuels (gas and/or diesel); synthetic organics (pesticides, herbicides, insecticides, etc.); or a mix of constituents (multiple constituents such as heavy metals and pesticides).

Most sites within the Eastern San Joaquin Subbasin are fuel sites (e.g., gas or diesel) that are under active investigation or remediation. Sites with the potential to cause plumes are mapped in Figure 2-77, which were identified by filtering for sites containing soluble and mobile constituents such as volatile organic compounds (VOCs); benzene, toluene, ethylbenzene, and xylenes (BTEX); and/or petroleum hydrocarbons (gas or diesel).

Sites with the potential to cause plumes are currently managed by existing regulatory programs through the RWQCB, DTSC, and USEPA, as described above. New projects undertaken by the GSAs as part of GSP implementation will evaluate contaminant plume movement in a CEQA document. Specific point source sites and contaminants are discussed in the sections below.

Figure 2-76: Active Investigation and Remediation Sites as of 2019

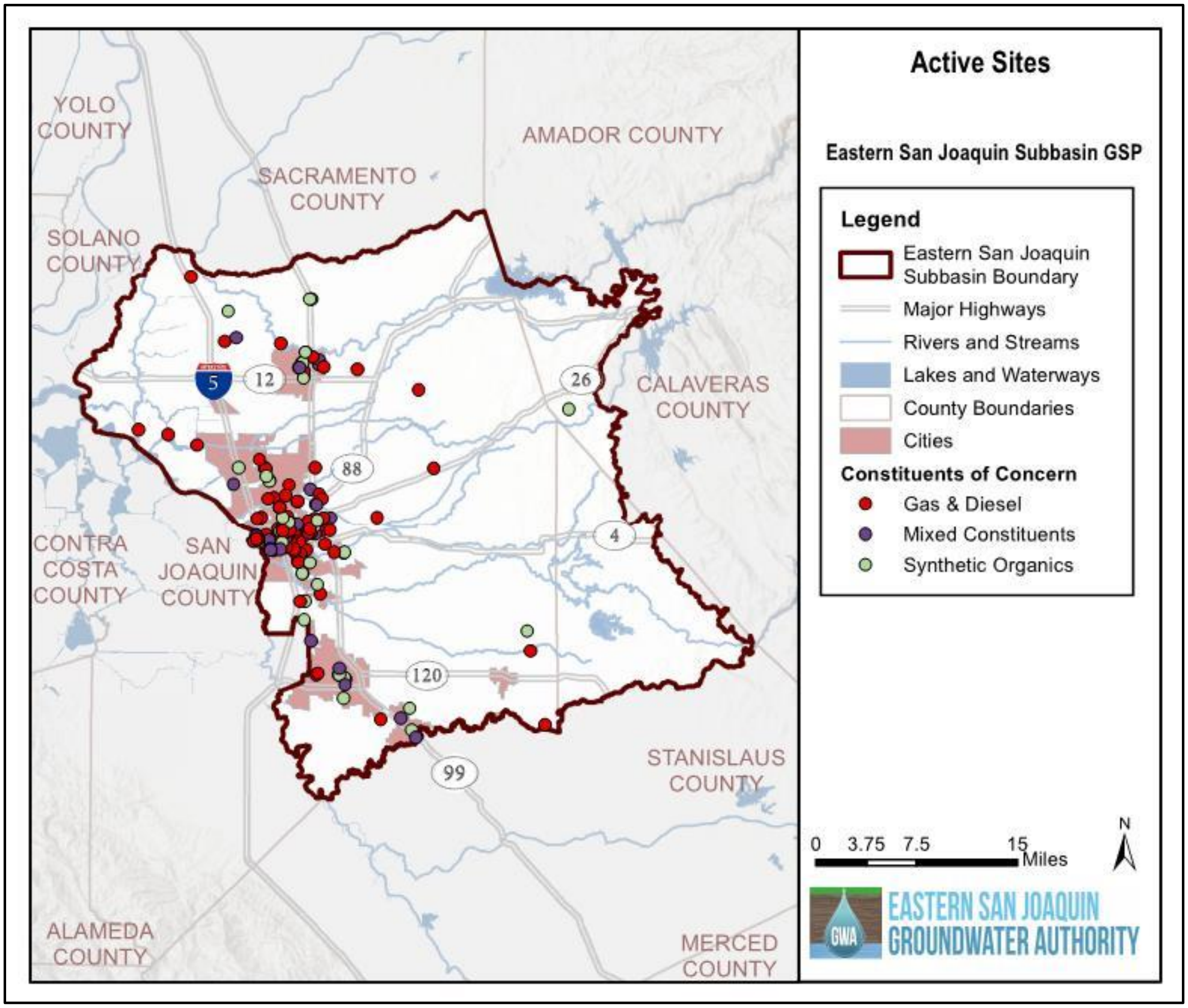
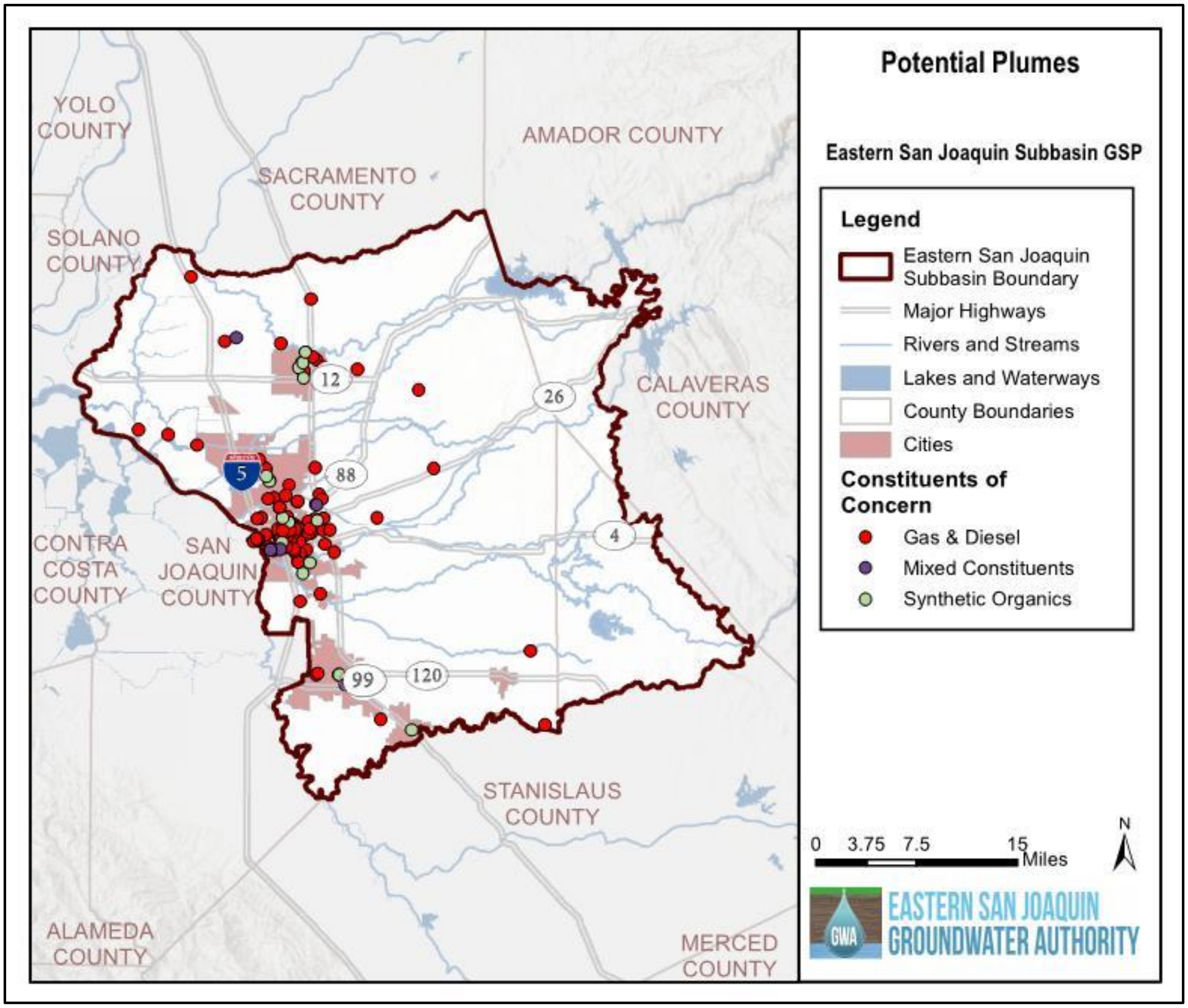


Figure 2-77: Active Sites with the Potential to Cause Plumes



2.2.4.4.1 Publicized Plumes in and near the Subbasin

As indicated above, the Eastern San Joaquin Subbasin has numerous open cleanup sites, including areas contaminated by chlorinated solvents, methyl tertiary-butyl ether (MtBE), pesticides and herbicides, and leaking underground storage tanks. Plume sites are often clustered around urban centers but are also found near sites where historical industrial or agricultural practices have released contaminants of concern. While other plumes exist in and around the Subbasin, three specific plumes have been highly publicized: the Lodi Plumes, the Sharpe Army Depot Plume, and the Occidental Chemical Corporation Plume.

In the late 1980s, the City of Lodi discovered the chlorinated solvents perchloroethylene (PCE) and trichloroethene (TCE) in drinking water supplies and pursued a groundwater investigation that revealed a series of five separate plume areas located in the northeastern portion of the city: the Northern, Western, Central, Southern, and Busy Bee plumes. The Busy Bee plume, named after a dry cleaner business that previously operated on the site, now has regulatory closure, with cleanup moving toward completion under CVRWQCB oversite (Water Resources Control Board, 2011).

Groundwater contamination plumes in the City of Lathrop, located just outside the Subbasin boundary, include the Sharpe Army Depot and Occidental Chemical Corporation sites. Contamination of groundwater at the Sharpe Army

Depot consists primarily of trichloroethene, tetrachloroethene, and cis-1,2-dichloroethene from historical industrial activities related to military activities. Due to concerns of potential contamination, the City of Lathrop abandoned their wells in the area. Three groundwater extraction and treatment systems are located at Sharpe Army Dept and are used to treat existing groundwater (EKI Environment & Water, 2015).

The Occidental Chemical Corporation Plume was discovered in the late 1970s and is the result of former leaking wastewater holding ponds containing pesticides and chemicals used for equipment cleaning by the Occidental Chemical Corporation. Contaminants of concern include the pesticides 1,2-dibromo-3-chloropropane (DBCP) and ethylene dibromide (EDB), lindane, 2,3,4,5-tetrahydrothiopene-1, 1-dioxide, sulfate, nitrate, chloride, and BHC (RWQCB, 2012). Since the discovery of these plumes in the 1980s, groundwater monitoring and evaluation at point source locations has led to the implementation of remedial activities such as the installation of groundwater extraction and remedial systems, implementation of a Salinity Reduction Plan, and mandated waste discharge requirements (WDRs) (CVRWQCB, 2012).

2.2.4.4.2 Petroleum Hydrocarbons

Approximately 134 sites in the Eastern San Joaquin Subbasin are identified as actively investigating or remediating an unauthorized release of petroleum hydrocarbons, according to the GeoTracker and EnviroStor databases. At these sites, petroleum hydrocarbon constituents are most commonly fuels (diesel, gasoline, motor oil, or aviation fuel) and VOCs commonly added to fuels, including MTBE and BTEX constituents. Concentrations of petroleum hydrocarbons have not been modeled across the Subbasin; concentrations are local and site specific. A summary description of the aforementioned constituents is provided in Table 2-10 below:

Table 2-10: MCLs for Common Petroleum Hydrocarbons and MTBE

Constituent	Source	Primary MCL
MTBE	Oxygenate commonly added to gasoline	13 µg/L
BTEX		
Benzene	Industrial solvent added to crude oil paint, varnish, and lacquer thinner	1 µg/L
Toluene	Aromatic hydrocarbon used in industrial feedstock, as a solvent, and to produce benzene and added to gasoline	150 µg/L
Ethylbenzene	Used as a solvent and added to fuel, asphalt, and naphthalene	300 µg/L
Xylenes	Naturally occurring in petroleum, coal and wood tar	1.750 mg/L

Source: (SWRCB, 2018)

2.2.4.4.3 Synthetic Organics

Approximately 47 sites in the Eastern San Joaquin Subbasin are identified as actively investigating or remediating an unauthorized release of synthetic organics, according to the GeoTracker and EnviroStor databases. At these sites, pesticides, herbicides, fertilizer, and pesticides are the most common constituents. Other constituents include VOCs such as PCE and TCE. Concentrations of synthetic organics have not been modeled across the Subbasin; concentrations are local and site specific. For context, a brief description of the aforementioned VOCs is provided in Table 2-11.

Table 2-11: MCLs for Common Synthetic Organic Constituents

Constituent	Source	Primary MCL[1]
TCE	Used as a solvent in manufacturing facilities and dry cleaners	5 µg/L
PCE	Used as a solvent in manufacturing facilities, dry cleaners, printing shops, and auto repair facilities	5 µg/L

Note:
[1] Source: (SWRCB, 2018)

2.2.4.4.4 Mixed Constituents

Approximately 28 sites in the Eastern San Joaquin Subbasin are identified as actively investigating or remediating an unauthorized release of mixed constituents, according to the GeoTracker and EnviroStor databases. Sites with mixed constituents are those that include a release of more than one type of contaminant, such as a mix of heavy metals, diesel, inorganics, and/or organics. At these sites, the most common constituents include a mixture of heavy metals (chromium, arsenic, and lead), inorganics, and solvents. The sources and primary MCL for many contaminants found in the 'mixed constituents' classification have been discussed throughout Section 2.2.4.

2.2.4.4.5 Emerging Contaminants

Many chemical and microbial constituents that have not historically been considered as contaminants are occasionally, and in some cases with increasing frequency, detected in groundwater. These newly recognized (or emerging) contaminants are commonly derived from municipal, agricultural, industrial wastewater, and domestic wastewater sources and pathways. These newly recognized contaminants are dispersed to the environment from domestic, commercial, and industrial uses of common household products and include caffeine, artificial sweeteners, pharmaceuticals, cleaning products, and other personal care products. Residual waste products of genetically modified organisms are also of potential concern. Several studies, such as by Watanabe et al. in 2010, have recently been published or are underway regarding the potential link between dairies and the occurrence of pharmaceuticals in shallow groundwater in the San Joaquin Valley.

Perfluorooctanesulfonic acid (PFOS) and perfluorooctantoic acid (PFOA) are organic chemicals synthesized for water and lipid resistance, used in a wide variety of consumer products as well as fire-retarding foam and various industrial processes. These chemicals tend to accumulate in groundwater, though typically in a localized area in association with a specific facility, such as a factory or airfield (California Water Boards, 2018). There are currently no MCLs for PFOS or PFOA; however, the USEPA is moving forward with establishing the MCL and is recommending municipalities notify customers at levels at or greater than 70 parts per trillion in water supplies (USEPA, 2019). California's DDW has established notification levels at 6.5 parts per trillion for PFOS and 5.1 parts per trillion for PFOA (SWRCB, 2019).

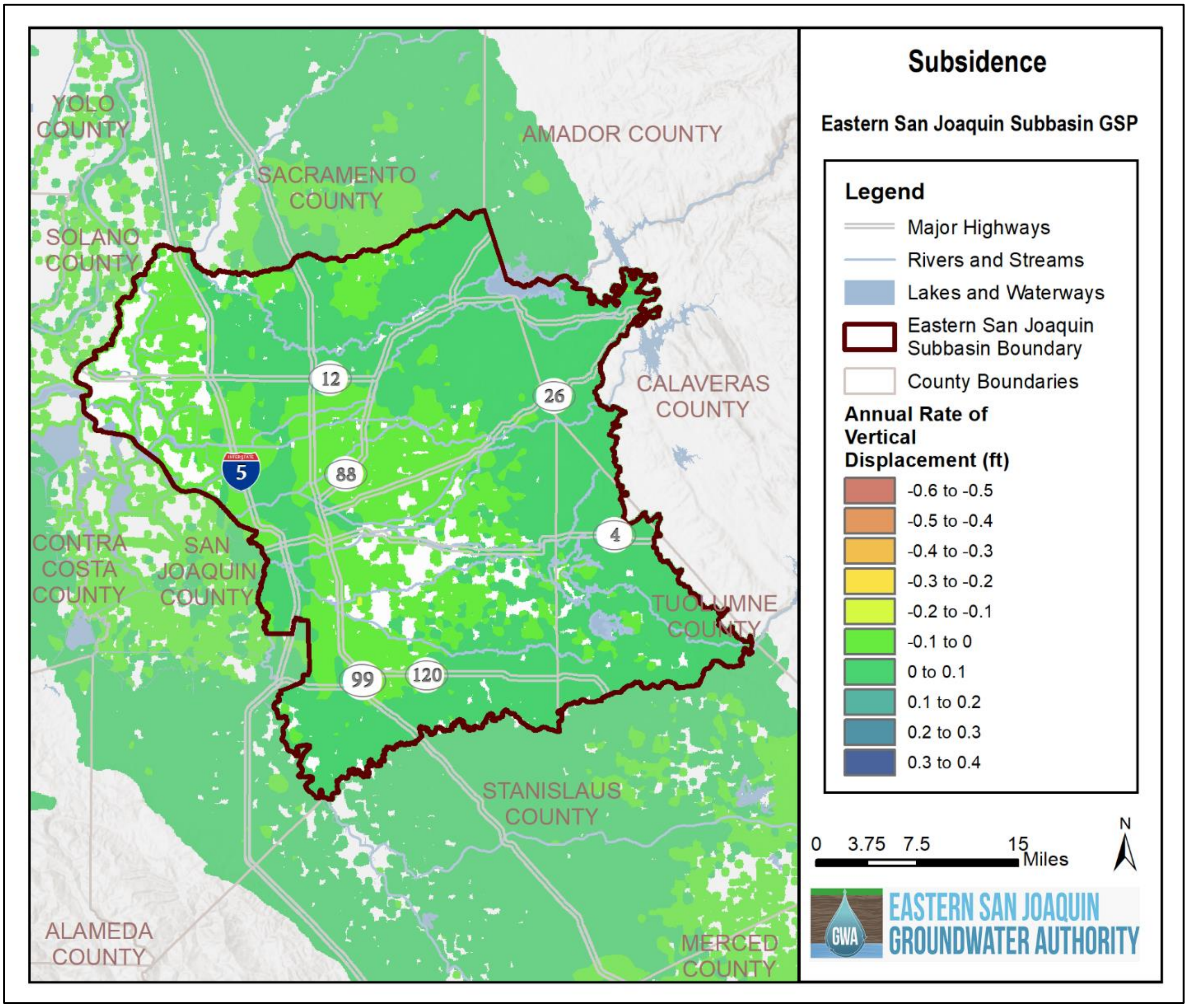
1,2,3-Trichloropropane (1,2,3-TCP) is a solvent and is typically found in industrial or hazardous waste sites. Along with an industrial solvent, 1,2,3-TCP is a cleaning and degreasing agent and associated with pesticide products. Though there is currently no federal MCL, the MCL for 1,2,3-TCP in California is 0.005 µg/L (SWRCB, 2019).

Currently, data on PFOS, PFOA, and 1,2,3-TCP are limited in the Eastern San Joaquin Subbasin since these are emerging contaminants.

2.2.5 Conditions in 2019: Land Subsidence

Despite long-term declining groundwater levels, there are no historical records of significant and unreasonable impacts from subsidence in the Eastern San Joaquin Subbasin. Figure 2-78 shows regional subsidence produced from TRE Altamira Interferometric Synthetic Aperture Radar (InSAR) data, provided by DWR for SGMA application. InSAR is a satellite-based method for showing ground-surface displacement over time. This figure illustrates that subsidence has historically been minimal in the Subbasin and surrounding areas (ranging from -0.1 to 0.1 feet of vertical displacement annually). The error range of a single InSAR measurement is +/- 5 millimeters (TRE Altamira, 2019). See Section 2.1.5 for a discussion of the soils and clays within the Subbasin, including the extent of Corcoran Clay.

Figure 2-78: Subsidence (Annual Rate of Vertical Displacement)



Note: This dataset represents measurements of vertical ground surface displacement in between spring 2015 and summer 2017 (TRE Altamira, 2019).

2.2.6 Conditions in 2019: Interconnected Surface Water Systems

Interconnected surface waters (ISW) are surface water features that are hydraulically connected by a saturated zone to the groundwater system. In these systems, the water table and surface water features intersect at the same elevations and locations. Interconnected surface waters may be either gaining or losing, wherein the surface water feature itself is either gaining water from the aquifer system or losing water to the aquifer system.

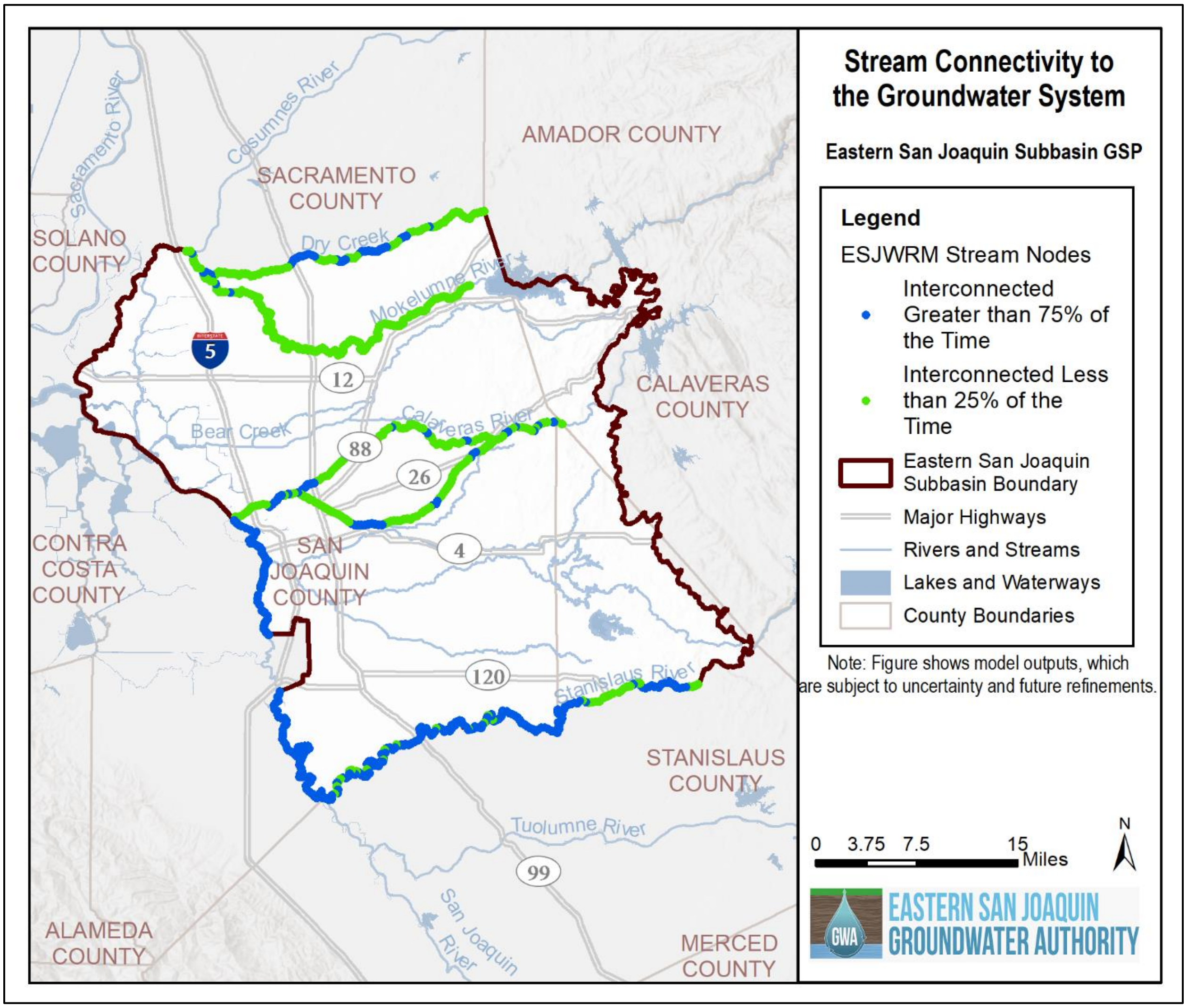
In the Eastern San Joaquin Subbasin, stream connectivity was analyzed by comparing monthly groundwater elevations from the historical calibration of the ESJWRM to streambed elevations along the streams represented in ESJWRM. This analysis was based on modeling results from the historical calibration of the ESJWRM for approximately 900 stream nodes in the Eastern San Joaquin Subbasin, which represents that best available information for current and historical conditions related to interconnected surface water systems. Figure 2-79 shows locations where streams are interconnected at least 75 percent of the time (shown in blue) or interconnected less than 25 percent of the time (shown in green).

Disconnected streams will always be losing streams, but interconnected streams may be either losing or gaining, depending on the surface water and groundwater conditions. Groundwater discharge from the aquifer is primarily through groundwater pumping, however, groundwater also discharges to streams where groundwater elevations are higher than the streambed elevations. Figure 2-80 shows mostly gaining streams in blue where groundwater discharges to rivers more than 75 percent of the time, mostly losing streams in red where streams lose water to the groundwater system more than 75 percent of the time, and mixed streams (gaining or losing less than 75 percent of the time) in orange.

Due to limited model calibration based on insufficient calibration information, stream nodes in the Delta area and along stretches of streams near the foothill boundary of the Subbasin are not shown on Figure 2-79 and Figure 2-80. Interconnected surface water is highlighted as a data gap in Section 4.7.3 due to a lack of data from shallow monitoring wells near streams. Future improvements to the understanding of interconnected surface water include proposed monitoring wells in Section 4.7.5 that are largely located along streams or in areas of the foothills where current monitoring coverage is lacking and a specific project in Section 6.2 to improve understanding of losses along Mokelumne River. Section 7.4.1 discusses model refinements over the next five years in order to improve calibration of the model and its use in analysis of GSP water budgets and sustainability criteria. The analysis in this section includes the results from the 2019 model and Appendix 3-G details an updated analysis.

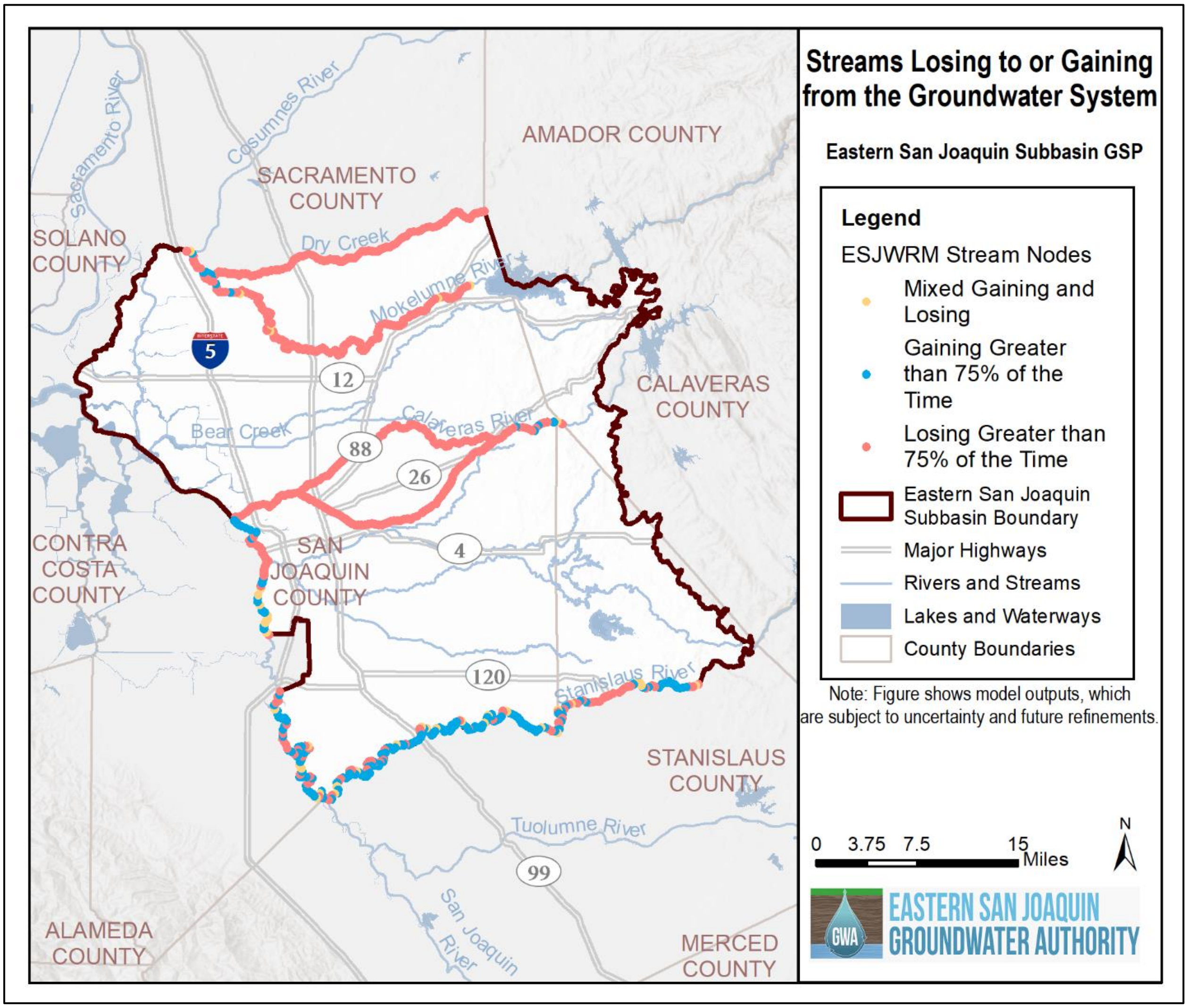
Figure 2-79 and Figure 2-80 are illustrations to describe model outputs, which are subject to uncertainty and future refinements and are not intended for regulatory purposes beyond the use in this Plan.

Figure 2-79: Stream Connectivity to the Groundwater System



Note: Analysis is based on limited data recognized to have significant gaps. Interconnected surface water is a recognized data gap in the GSP as discussed in Section 4.7.

Figure 2-80: Losing and Gaining Streams



Note: Analysis is based on limited data recognized to have significant gaps. Interconnected surface water is a recognized data gap in the GSP as discussed in Section 4.7.

2.2.7 Conditions in 2019: Groundwater-Dependent Ecosystems

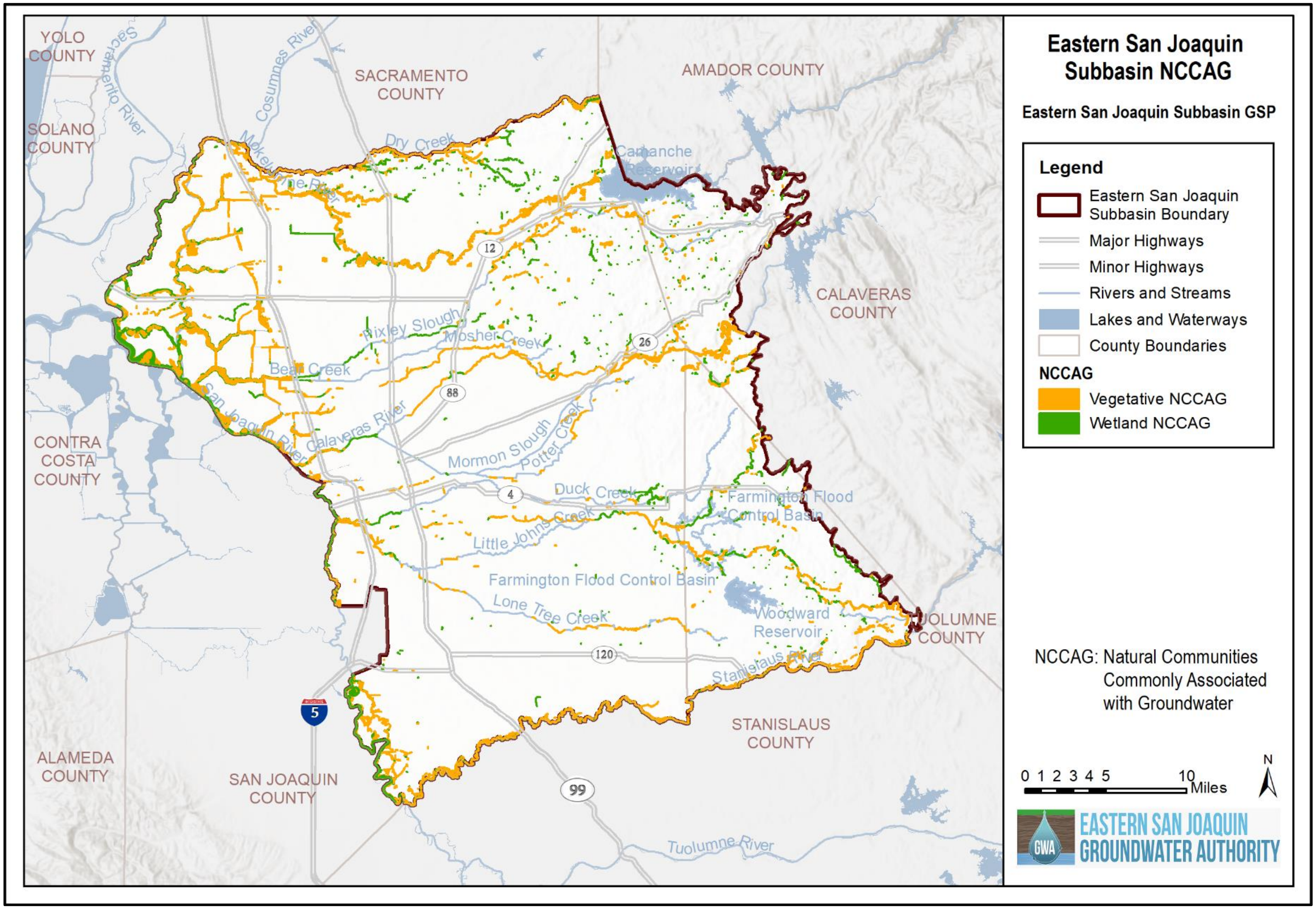
Groundwater-dependent ecosystems (GDEs) are defined in the GSP regulations as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface." SGMA requires the identification of GDEs. SGMA does not require that additional sustainable management criteria be established to specifically manage these areas, but rather includes GDEs as a beneficial user of water to be considered when developing other sustainable management criteria.

GDEs exist where vegetation accesses shallow groundwater for survival. This Plan identifies GDEs within the Eastern San Joaquin Subbasin based on determining the areas where vegetation is dependent on groundwater.

2.2.7.1 Methodology for GDE Identification

The Natural Communities Commonly Associated with Groundwater (NCCAG) database was used as a starting point to identify GDEs within the Subbasin. The NCCAG database was developed by a working group comprised of DWR, California Department of Fish and Wildlife (CDFW), and The Nature Conservancy (TNC). The working group reviewed publicly available datasets which mapped California vegetation, wetlands, springs, and seeps and conducted a screening process to retain communities known to be commonly associated with groundwater. The NCCAG database defines two habitat classes: wetland and vegetative. The wetland class includes wetland features commonly associated with the surface expression of groundwater under natural, unmodified conditions. The vegetative class includes vegetation types commonly associated with the shallow subsurface presence of groundwater (phreatophytes). Figure 2-81 shows the location of the two NCCAG classes within the Eastern San Joaquin Subbasin. The distribution of freshwater fish and wildlife species that may be dependent on GDEs is not well known and is not included in this analysis. A list of freshwater species in the Eastern San Joaquin Subbasin is provided in Appendix 1-H. Instream flows for rivers and streams interconnected with groundwater are evaluated through the Depletions of Interconnected Surface Water sustainability indicator (see Section 3.3.6).

Figure 2-81: Natural Communities Commonly Associated with Groundwater (NCCAGs)



Source: NC Dataset Viewer, CADWR Sustainable Groundwater Management (https://gis.water.ca.gov/app/NCDatasetViewer/)

This Plan uses the NCCAG database as a starting point for identifying potential GDEs. To identify NCCAG areas that are potential GDEs, the analysis identified communities in areas where groundwater levels are shallower than 30 feet bgs, as these areas are thought to be reachable by the root zone of vegetation.[1] Oak trees are considered the deepest-rooted plant in the region with a root zone of roughly 25 feet.[2] This value is considered conservative, as this depth is unlikely to support recruitment of new oak seedlings. NCCAG-identified communities in areas with groundwater shallower than 30 feet were considered as potential GDEs. Communities in areas deeper than 30 feet were identified as data gap areas for future refinement and are labeled on Figure 2-82 as "Depth to Water > 30 ft". These areas will be refined in future analyses to identify potential existing GDEs that may have been misclassified through this screening process. Additional information regarding plans to fill GDE-related data gaps can be found in Section 4.7.4.

The NCCAG database was then further refined to identify communities without access to alternate water supplies, as those communities would not be dependent on groundwater. This was done by screening for the following: 1) areas not close to managed wetlands, 2) areas not adjacent to irrigated agriculture, and 3) areas not near perennial surface water bodies. NCCAG-identified communities with access to shallow water (less than 30 feet bgs) and without access to alternate water supplies were classified as GDEs. Communities with access to alternate water supplies were identified as data gap areas requiring additional investigation to determine the reliability of the alternate supply.

- <u>Proximity to Managed Wetlands</u> **–** Managed wetlands receive supplemental water to support wildlife habitat. Managed wetlands, and areas within 150 feet of a managed wetland, are assumed to be able to access this supplemental delivered water regardless of the condition of the underlying aquifer. Areas farther than 150 feet from a managed wetland that meet the other GDE criteria in this section are assumed to be dependent on groundwater and were identified as GDEs. A criterion of 150 feet was used to reflect ponded conditions at the wetlands. Identified wetlands were reviewed with local water managers to verify supplemental water deliveries.

  NCCAG-identified communities not identified as GDEs through this analysis are identified as data gap areas for future refinement and are labeled on Figure 2-82 as "Managed Wetland". These areas will be refined in future analyses to determine if the alternate source of surface water is reliable over time and to identify potential existing GDEs that may have been misclassified through this screening process.

- <u>Adjacent to Irrigated Agriculture</u> **–** Irrigated agricultural lands are dependent on regular irrigation. This irrigation benefits not only the crops, but also the surrounding vegetation. Irrigated lands, and areas within 50 feet of irrigated lands, are assumed to be able to access this supplemental delivered water regardless of the condition of the underlying aquifer. Areas farther than 50 feet from irrigated lands that meet the other GDE criteria in this section are assumed to be dependent on groundwater and were identified as GDEs. A criterion of 50 feet was used to reflect non-ponded conditions in the fields.

  NCCAG-identified communities not identified as GDEs through this analysis are identified as data gap areas for future refinement and are labeled on Figure 2-82 as "Adjacent to Agriculture". These areas will be refined in future analyses to determine if the alternate source of surface water is reliable over time and to identify potential existing GDEs that may have been misclassified through this screening process.

- <u>Proximity to Perennial Surface Water Bodies</u> **–** Perennial surface water bodies provide year-round water supplies that can be accessed by adjacent vegetation. These water bodies include much of the Delta; large, managed rivers; and smaller water bodies that flow throughout the summer due to agricultural deliveries or

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[1] This analysis uses 2015 groundwater levels (winter, spring, summer, and fall), which may be deeper than representative levels due to drought conditions, a factor which will be considered in future GDEs analyses.

[2] *Quercus chrysolepis* (canyon live oak) has a maximum rooting depth of 7.3 meters (23.95 feet) (Canadell et al., 1996). *Quercus lobata* (valley oak) has a maximum rooting depth of 7.41 meters (24.31 feet), although available data are from fractured rock aquifers (Lewis & Burgy 1964 and Schenk, H. J. and Jackson, R. B. 2002, as cited in TNC, 2019).

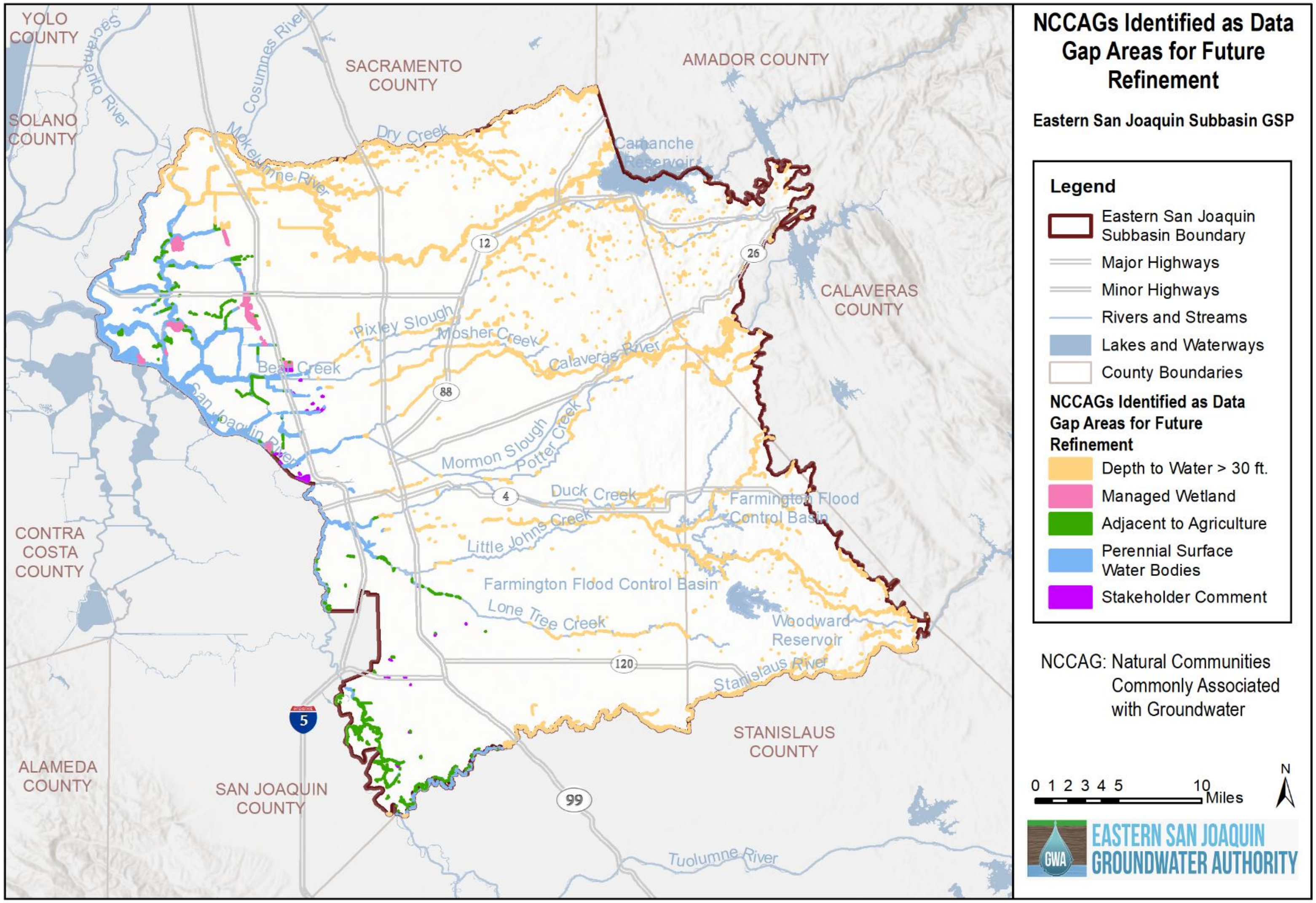
tailwater. Areas within 150 feet of such surface water bodies are assumed to be able to access that surface water regardless of the condition of the underlying aquifer. Areas father than 150 feet from such surface water bodies that meet the other GDE criteria in this section are assumed to be dependent on groundwater and were identified as GDEs. A criterion of 150 feet was used to reflect open water conditions in the surface water bodies.

NCCAG-identified communities not identified as GDEs through this analysis are identified as data gap areas for future refinement and are labeled on Figure 2-82 as “Perennial Surface Water Bodies”. These areas will be refined in future analyses to determine if the alternate source of surface water is reliable over time and to identify potential existing GDEs that may have been misclassified through this screening process.

Next, areas identified as GDEs were ground-truthed electronically with GSA staff and Groundwater Sustainability Workgroup (Workgroup) members. Through this process, areas identified GDEs were investigated, and areas identified as known irrigated parcels such as parks were reclassified. These areas are labels on Figure 2-82 as “Stakeholder Comment.”

This methodology was developed to focus groundwater management activities on the most appropriate areas. The distinction between GDEs and other wetland or vegetative areas is important from a management perspective, as GDEs are expected to be more responsive to changes in groundwater management. Management of communities that access alternate supplies, on the other hand, may require greater focus on land use protection or irrigation activities, for which the GSAs have limited authority to manage through SGMA.

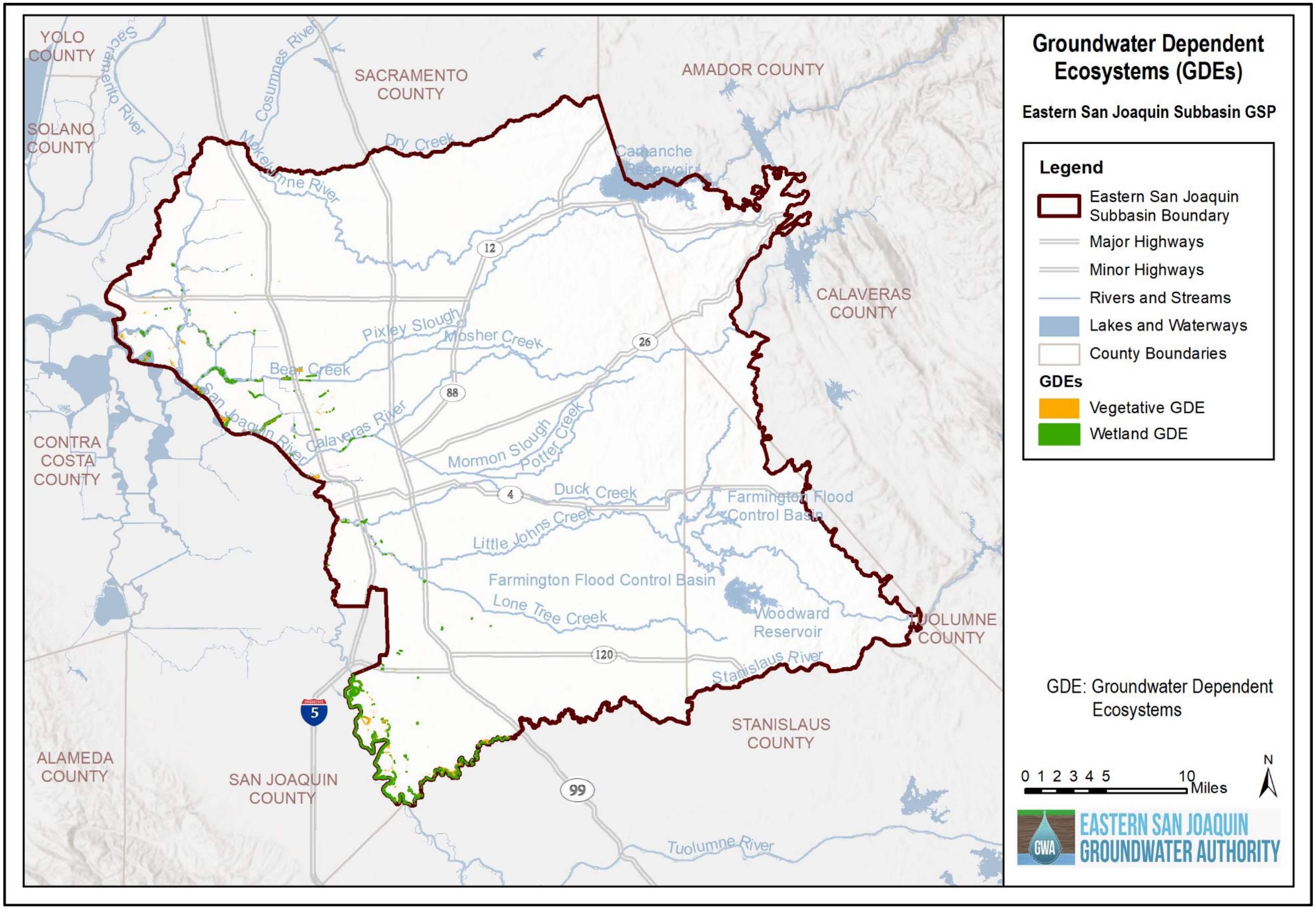
Figure 2-82: NCCAGs Identified as Data Gap Areas for Future Refinement, Likely to Access Non-groundwater Water Supplies



2.2.7.2 Areas Identified as GDEs

Following the methodology presented above, this Plan identifies several GDEs, primarily located along the western boundary of the Subbasin and in the Delta areas where groundwater is typically shallow. These areas are divided into two categories: Vegetative GDEs and Wetland GDEs, as shown in Figure 2-83.

Figure 2-83: Areas Identified as GDEs



2.3 CURRENT GROUNDWATER CONDITIONS

This section describes the current groundwater conditions in the Eastern San Joaquin Subbasin since development of the 2020 GSP.

As required by the GSP regulations, the current groundwater conditions section includes:

- Definition of current groundwater conditions in the Subbasin
- Description of the distribution, availability (storage), and quality of groundwater
- Identification of interactions between groundwater, surface water, groundwater dependent ecosystems, and subsidence

Current conditions are generally assumed to be the conditions of the Subbasin roughly between WY 2020 and WY 2023, unless otherwise noted in the below sections.

2.3.1 Groundwater Elevation

2.3.1.1 Groundwater Levels

For the purposes of the 2024 GSP, the most current groundwater elevation conditions were characterized as fourth quarter 2022 (recent seasonal low, measured in fall 2022) and first quarter 2023 (recent seasonal high, measured in spring 2023) groundwater elevation measurements. However, WY 2023 represented a wetter than average water year. For comparison, fourth quarter 2019 and first quarter 2020 of WY 2020 are also included. WY 2020 was a dry year. Groundwater elevations were mapped using wells with available data in WDL.

Figure 2-84 and Figure 2-85 show the groundwater elevations for WY 2020. Figure 2-86 and Figure 2-87 show the groundwater elevations for WY 2023. A pumping depression at the center of the Subbasin, east of the City of Stockton, generally exists during periods of lower groundwater elevations, as shown in Fourth Quarter 2019, First Quarter 2020, and Fourth Quarter 2022. In wetter years, this pumping depression can recover, as shown in First Quarter 2023. Similar to historical conditions, groundwater generally flows from the outer edges of the Subbasin towards the depression in the middle of the Subbasin. The predominant hydraulic gradient across the Subbasin is from east to west.

Figure 2-84: Fourth Quarter 2019 Groundwater Elevation (WY 2020)

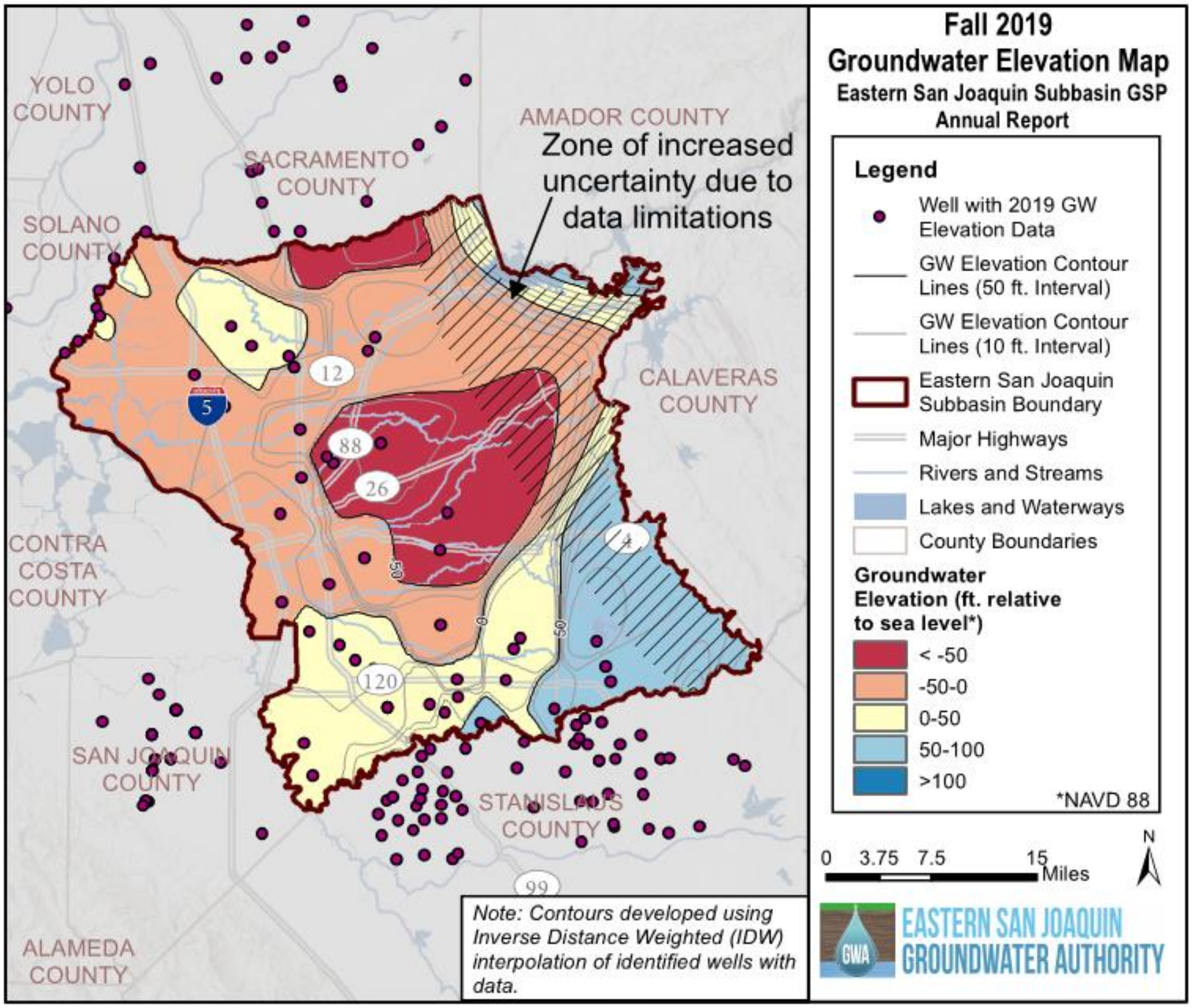


Figure 2-85: First Quarter 2020 Groundwater Levels (WY 2020)

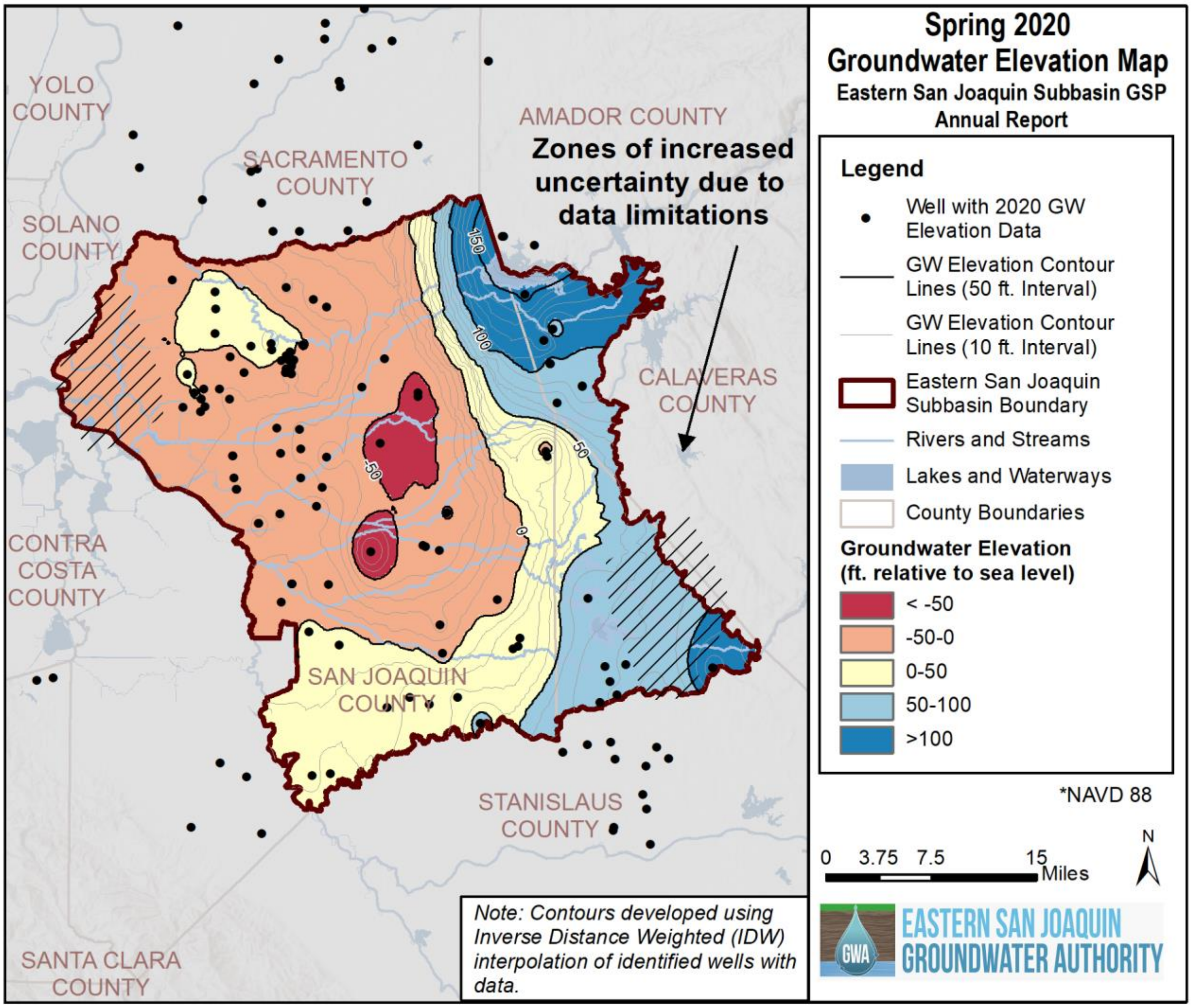


Figure 2-86: Fourth Quarter 2022 Groundwater Elevation (WY 2023)

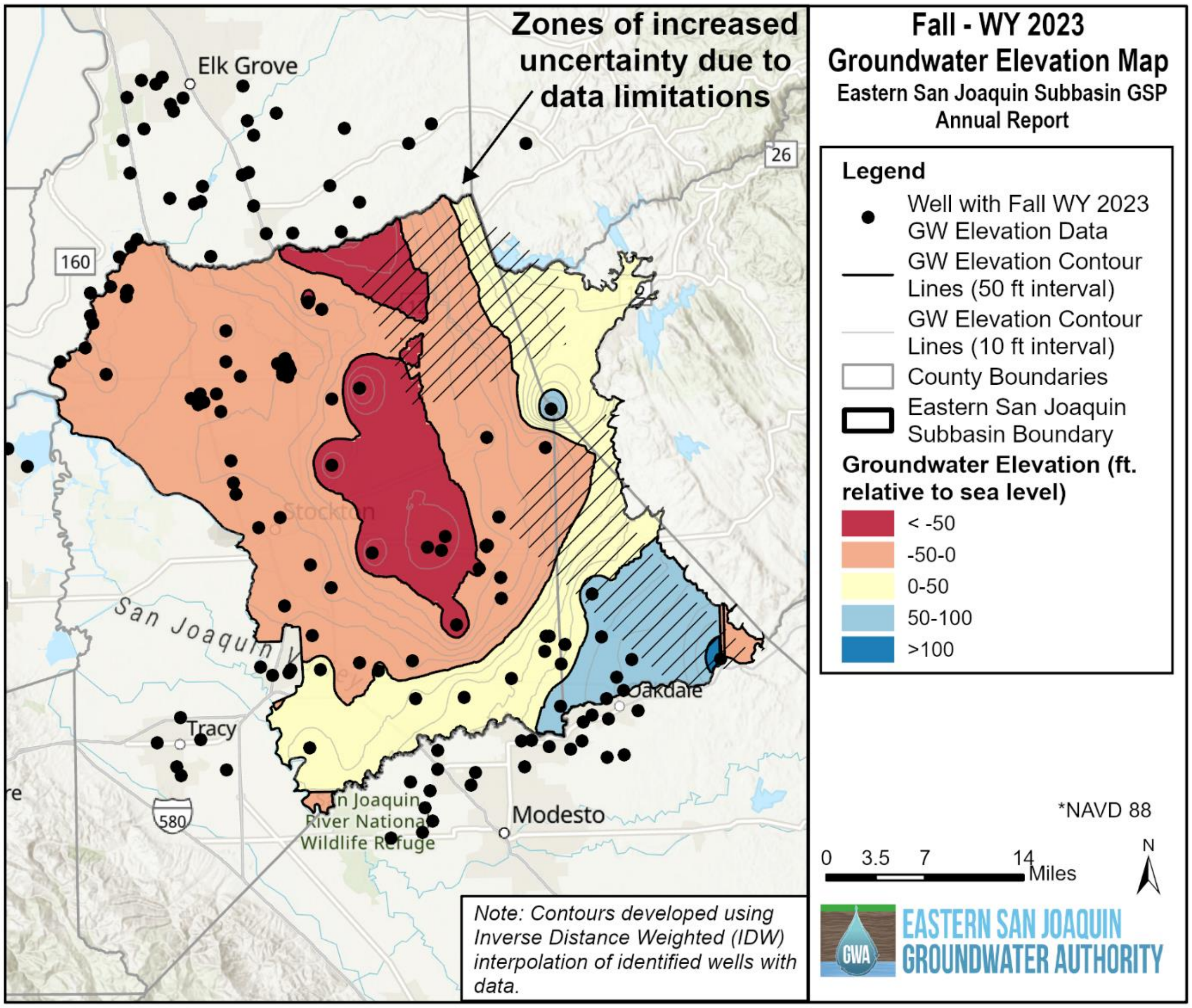
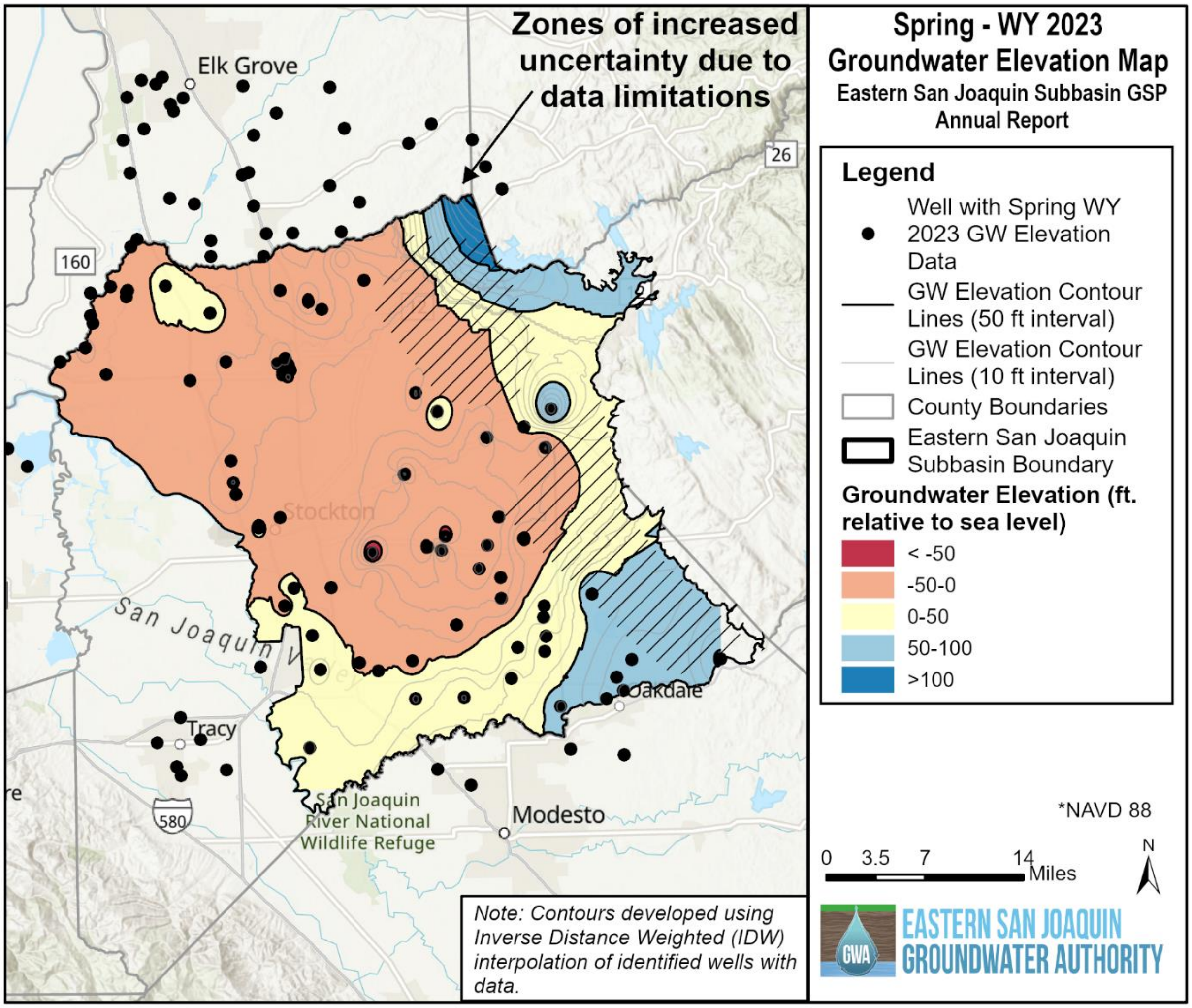


Figure 2-87: First Quarter 2023 Groundwater Levels (WY 2023)

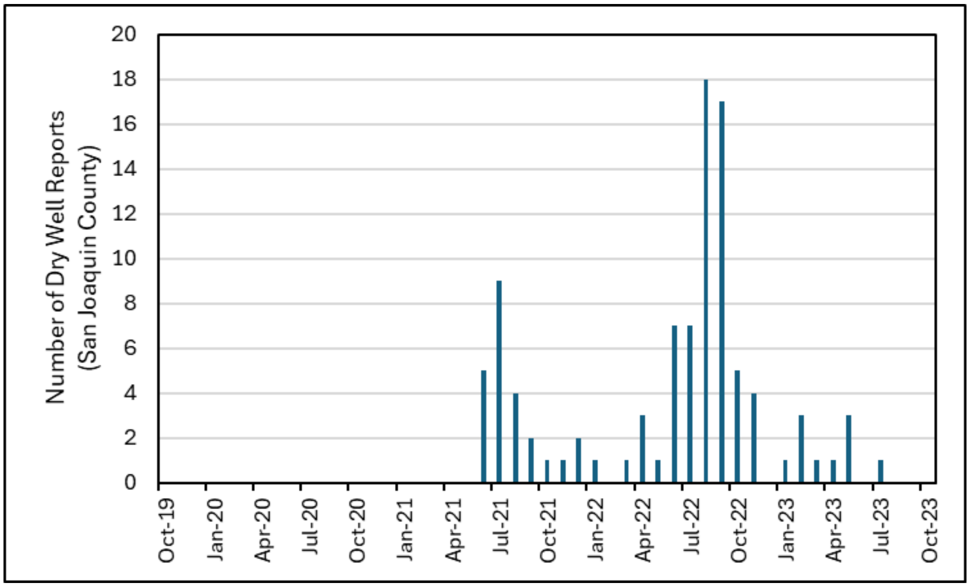


Hydrographs are reported annually to DWR in the Annual Reports for 76 single completion wells and 52 nested wells. The most recent hydrographs for these wells can be found in the WY 2023 ESJ Subbasin Annual Report, available on DWR's SGMA Portal (https://sgma.water.ca.gov/portal/). All hydrographs show yearly cycles of groundwater level declines in summer due to typical patterns in groundwater pumping and recharge during winter recovery.

2.3.1.2 Reported Dry Wells

According to DWR's Dry Well Reporting System, San Joaquin County has had 106 reported dry wells since the start of WY 2020 (CA Department of Water Resources, 2023). Figure 2-88 shows the number of reports made to DWR by month between WY 2020 and WY 2023. However, it is important to note that dry wells are reported for many reasons other than a failure due to increasing depth to groundwater. Staff interviews with DWR confirmed that the system does not determine the cause of the well failure unless monitored by outside parties. As expected, reports of dry wells were higher in the critical years of WY 2021 and 2022 than in WY 2023, a wet year.

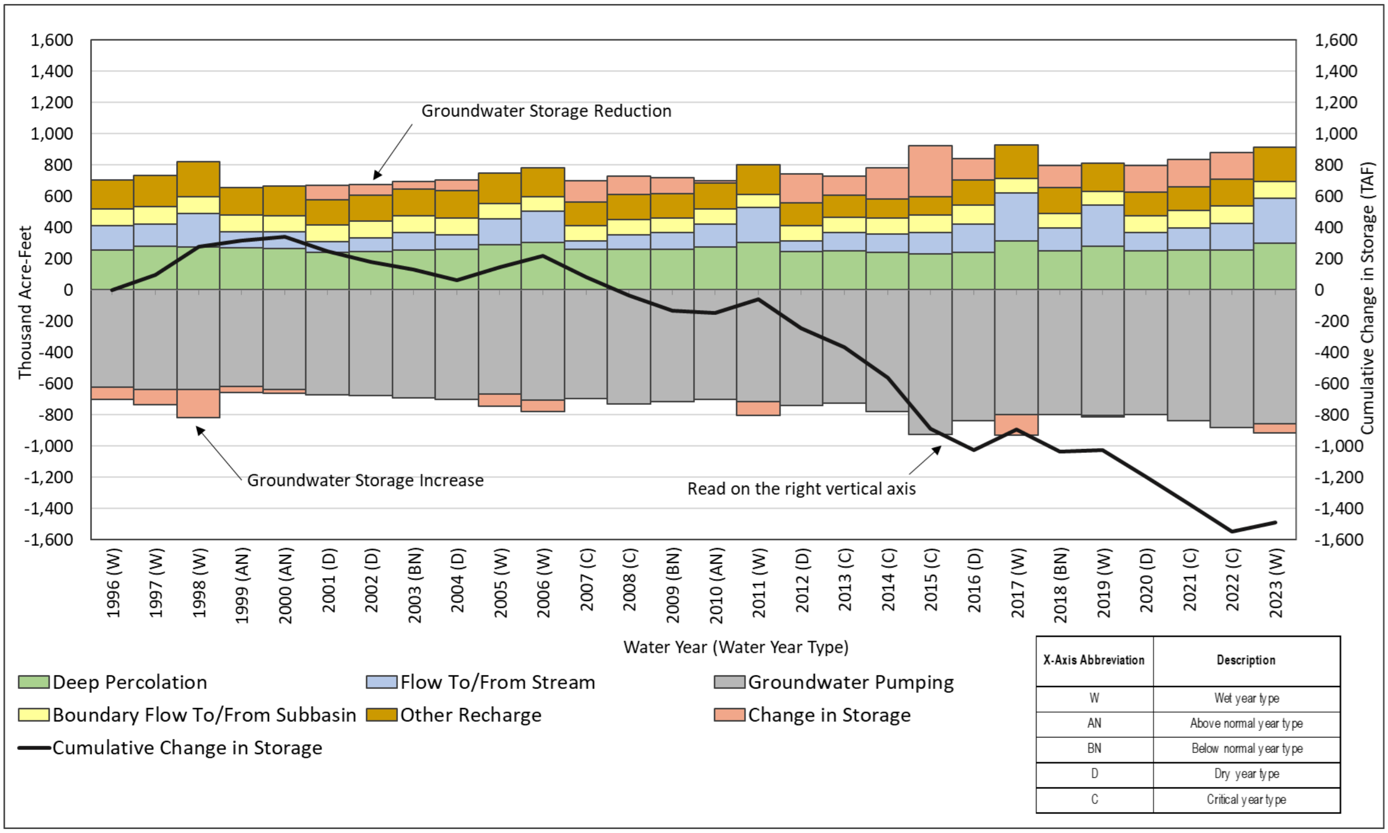
Figure 2-88 : Number of Reported Dry Wells in San Joaquin County between WY 2020-2023



2.3.2 Groundwater Storage

The ESJWRM was used to estimate historical change in storage of the Eastern San Joaquin Subbasin from 1995-2023. Figure 2-89 shows the cumulative change in storage against annual storage change and water year type, including current condition years WY 2020 through 2023. The cumulative change in storage from 1996 to 2023 was estimated as on average -0.34 million acre-feet per year (MAF/year). More information about the layers of the ESJWRM and calculation of storage changes can be found in model documentation in Appendix 2-C.

Figure 2-89: Modeled Change in Annual Storage with Water Use and Year Type



Notes:

4. Water Year Types based on San Joaquin Valley Water Year Index (CA DWR, 2024)
5. "Other Recharge" includes managed aquifer recharge, recharge from unlined canals and/or reservoirs, and recharge from ungauged watersheds.
6. "Change in Storage" is placed to balance the water budget. For instance, if annual outflows (-) are greater than inflows (+), there is a decrease in storage, but this would be shown on the positive side of the bar chart to balance out the increased outflows on the negative side of the bar chart.

2.3.3 Seawater Intrusion

The northwest corner of the Eastern San Joaquin (ESJ) Subbasin overlies a portion of the Delta. The Delta originally experienced groundwater fluctuations closely tied to tidal cycles, with a mix of brackish, saline ocean water, and fresh streamflow typical of an inland river delta and estuary. However, after decades of land reclamation and the implementation of managed operations as a result of the State Water Project and Central Valley Project, the Delta is now managed as a freshwater body. Saline water is no longer able to migrate eastward beyond the extensive network of levees and engineering alterations to the original natural channels. As a result, seawater intrusion has not historically been observed within the Subbasin nor is it likely to occur in the future.

The following section provides analysis supporting this claim, demonstrating that:

1. The Delta is managed as a freshwater body in the Subbasin
2. There is minimal pumping near the Delta
3. There are relatively low chloride concentrations in the Subbasin

Further detail can be found in Appendix 3-F.

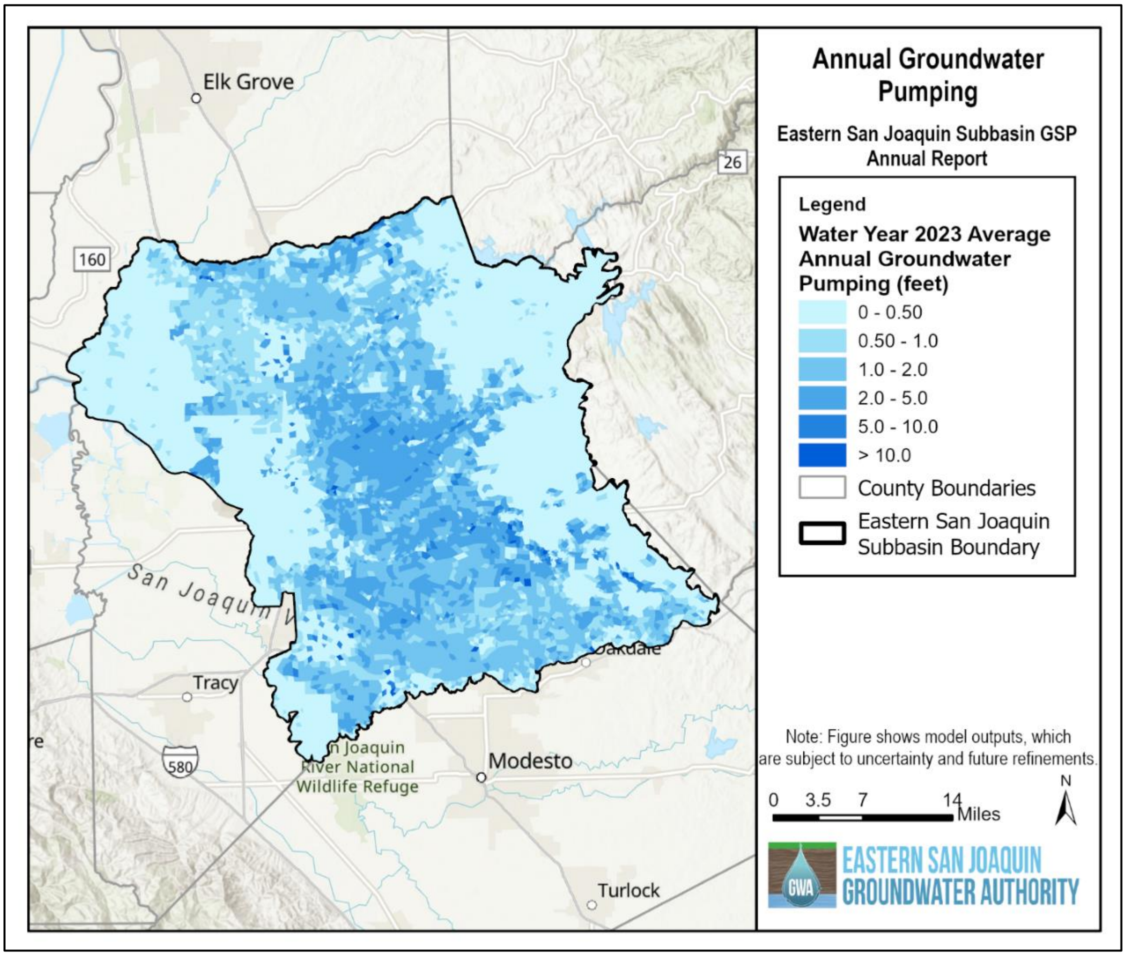
2.3.3.1 Delta is Managed to Maintain Freshwater Flows

The Subbasin is located in the Delta region. Prior to the construction of the Shasta Dam in 1943, brackish water had entered the surface waterways throughout the Delta. The Delta ecosystem naturally adapted to a salinity cycle that brought brackish tidal water from the San Francisco Bay. However, the construction of levees for agricultural development, followed by the development and operation of the Central Valley Project and the State Water Project, has changed the pattern of seawater movement into the Delta (Water Education Foundation, 2019). Historically, some saltwater may have infiltrated the aquifers locally affecting groundwater quality. Current management practices aim to maintain freshwater flows in the Delta through a combination of hydraulic and physical barriers and modifications to existing channels (Water Education Foundation, 2019). The "X2" barrier, where the salinity is approximately 2 parts per thousand (ppt), is located well outside of the Subbasin boundary further downstream in the Delta (Cloern, 2012). (For reference purposes, the salinity of the ocean is about 35 ppt.) Various agencies and regulations, such as the Delta Protection Commission (DPC), Delta Stewardship Council, San Joaquin County & Delta Water Quality Coalition, and State Water Board Resolution No. 2009-011, contribute to managing and maintaining salinity conditions in the Delta region.

2.3.3.2 Minimal Groundwater Pumping Near the Delta

Figure 2-90 presents the Subbasin's 2023 average groundwater pumping in feet across the Subbasin. The majority of pumping is in the northwest portion of Subbasin, areas adjacent to the Delta pump less than half a foot of groundwater per year.

Figure 2-90: 2023 Annual Groundwater Pumping



This figure reflects groundwater pumping from the 2023 Eastern San Joaquin Annual Report. Results may vary with the updated 2024 Eastern San Joaquin Water Resources Model.

2.3.3.3 Low Chloride Concentrations

Historical and current chloride concentrations were analyzed in the Subbasin. A variety of groundwater quality data were collected and examined. The datasets used for this analysis include (1) the Groundwater Ambient Monitoring and Assessment (GAMA) database, (2) The National Water (NWQMC) database, (3) the region's Opti Data Management System (DMS), and (4) SGMA Data Viewer (DWR). From these datasets, 4,000 unique wells were utilized with approximately 19,500 chloride observations.

Most wells had chloride concentrations well below the SMCL of 250 mg/L for chloride. (Secondary MCLs are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. Contaminants with SMCLs are not considered to present a risk to human health and are not enforced.) Chloride concentrations throughout the Subbasin have remained relatively low. Table 2-12 shows the percentage of chloride measurements after 2015 that exceed thresholds of 250 mg/L, 500 mg/L, and 2,000 mg/L. Notably, the majority of measurements (80%) fell within the 0–250 mg/L range, indicating low chloride levels throughout the Subbasin. Additionally, 14% of chloride observations were in the 250–500 mg/L range. Overall, 94% of measurements are below the 500 mg/L threshold. This analysis demonstrates that chloride concentrations in the Subbasin are generally low.

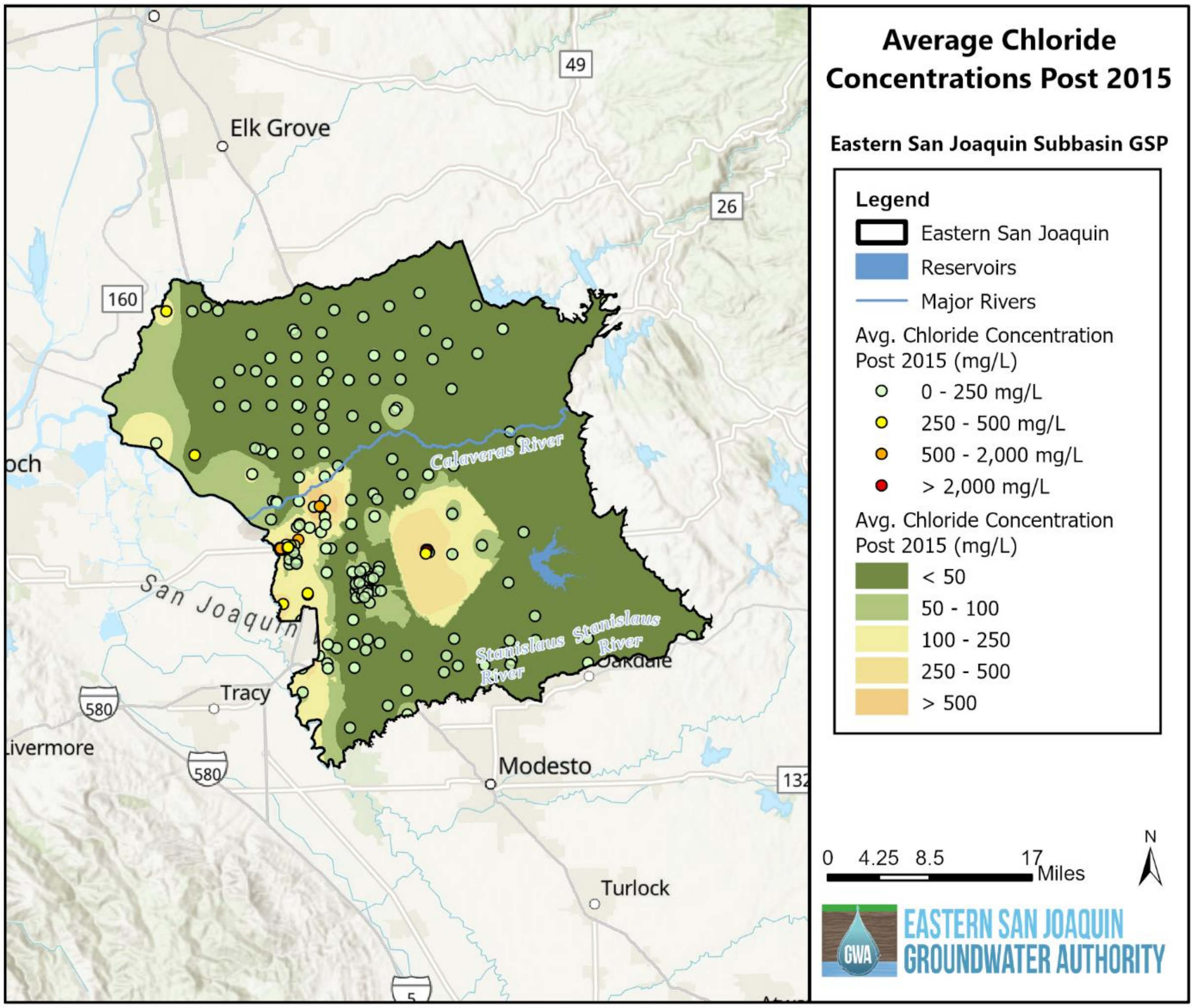
Table 2-12: Chloride Concentrations after 2015

Threshold Concentration	Percentage of Measurements after 2015 above Threshold
250 mg/L	14%
500 mg/L	5%
2,000 mg/L	1%

Chloride measurements in Table 2 are based on approximately 19,500 observations from 4,000 unique wells.

Figure 2-91 shows the average chloride concentration in the Subbasin since January 2015. These results are consistent with the ranges shown in Table 2-12. As shown in Figure 2-91, the majority of chloride concentrations in the Subbasin are within the 0 to 250 mg/L range. There are instances of higher concentrations in the 250 to 500 mg/L range, localized within the central and western regions of the Subbasin. Notably, these areas of relatively higher chloride concentrations are not located only in the Delta area and do not form a seawater intrusion front pattern. Overall, concentrations of chloride in the Subbasin are minimal and seawater intrusion is not occurring in the Subbasin or expected to occur in the future.

Figure 2-91: Average Chloride Concentrations Post-2015



2.3.4 Groundwater Quality

In addition to the chloride data shown in Section 2.3.3, available recent TDS data from the Groundwater Ambient Monitoring and Assessment (GAMA) Program were also analyzed to characterize current groundwater quality conditions. The locations, observations, and concentrations of the new set of monitoring wells were examined, as shown in Figure 2-92 through Figure 2-94.

Figure 2-92 illustrates the count of TDS groundwater quality observations for each well between January 2015 and January 2024. The majority of wells have 10 or fewer observations, indicating that most wells were not sampled on an annual basis. Several wells closer to the City of Stockton have up to 50 groundwater quality observations. The wells with the highest sample count appear to be located near groundwater cleanup sites. Ideally, wells in the representative monitoring network for groundwater quality would have been sampled regularly; however, some wells in the specific areas have not sampled frequently (greater than 10 times) in recent years.

Figure 2-93 displays wells with TDS observations in recent years (2015 through early 2024) by well depth. The threshold between shallow and deep wells was set at 200 feet for consistency with the 2020 GSP. There were several wells without perforation or depth information. Between shallow, deep, and unknown well depths, there is a similar distribution of high- and low-quality groundwater. In other words, TDS was not observed in just the shallow portions or just the deep portions of the aquifer.

Figure 2-94 illustrates the maximum TDS concentrations since January 2015. The majority of wells have TDS concentrations below 600 mg/L (the measurable objective for TDS). However, some wells have recent TDS concentrations above 1,000 mg/L (the minimum threshold for TDS). These wells are primarily located near the City of Stockton. Public water purveyors closely monitor groundwater quality and source and treat their water accordingly.

Figure 2-92: Monitoring Frequency for Wells Measuring Total Dissolved Solids

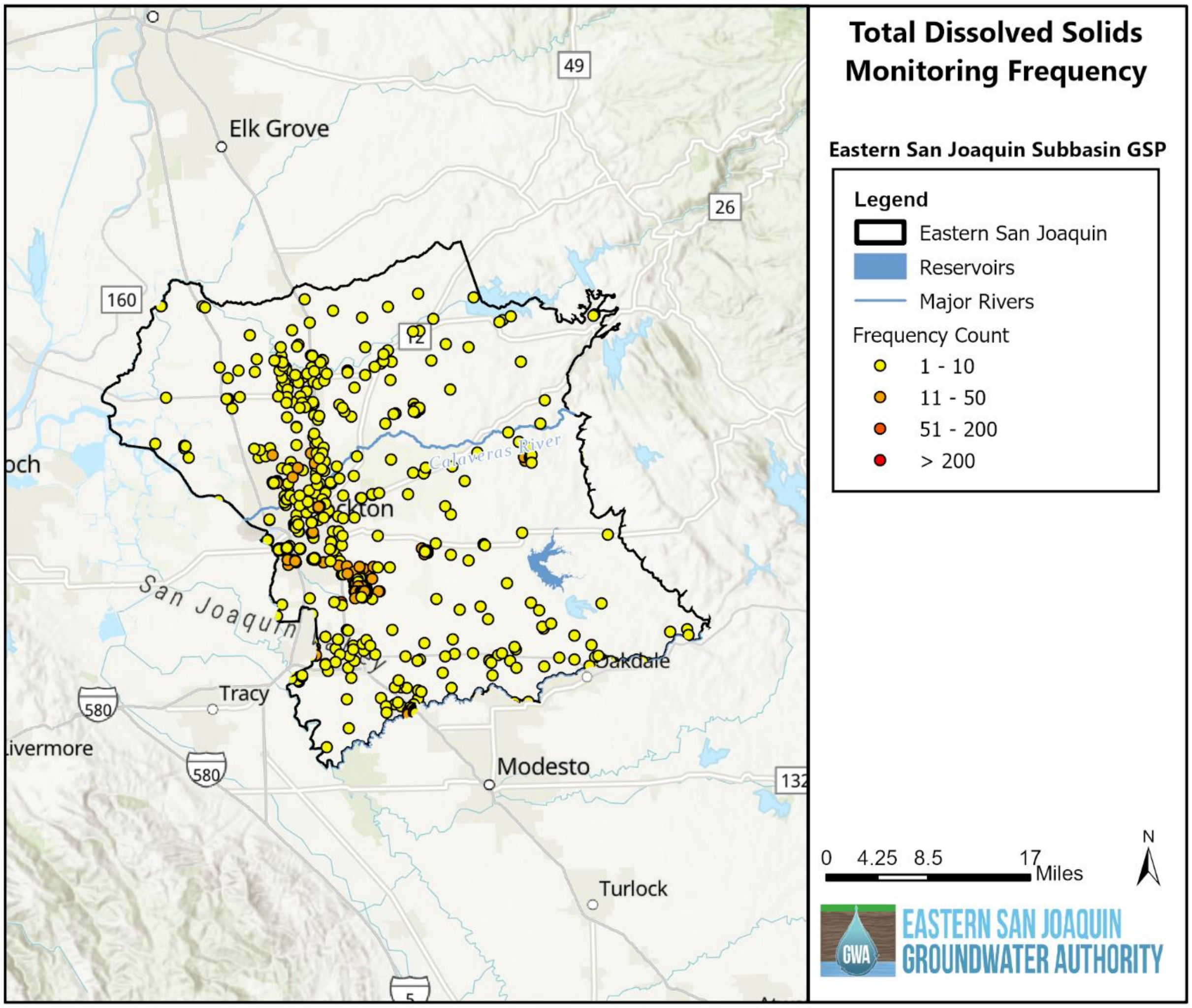


Figure 2-93: Wells with Recent TDS Observations by Well Depth

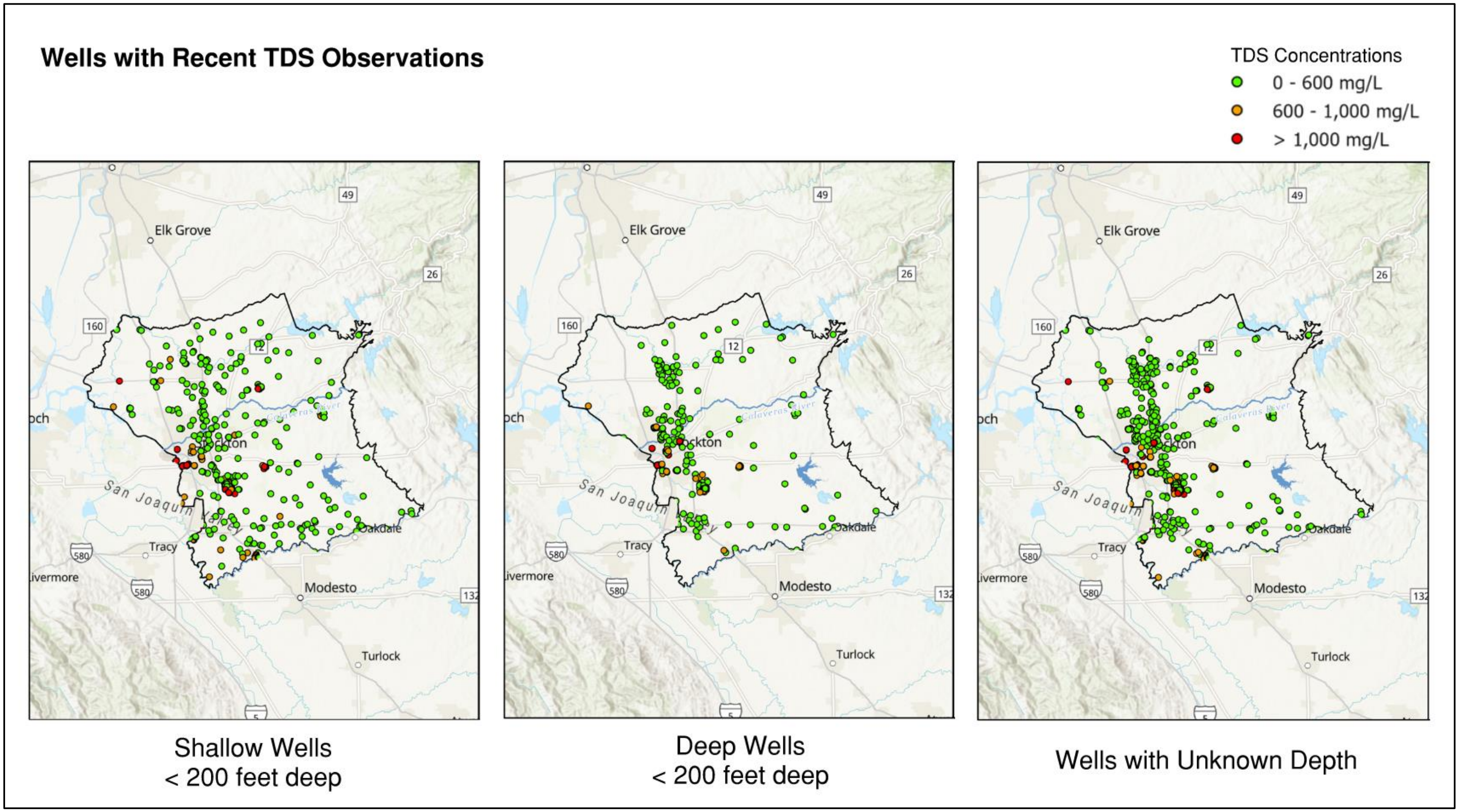
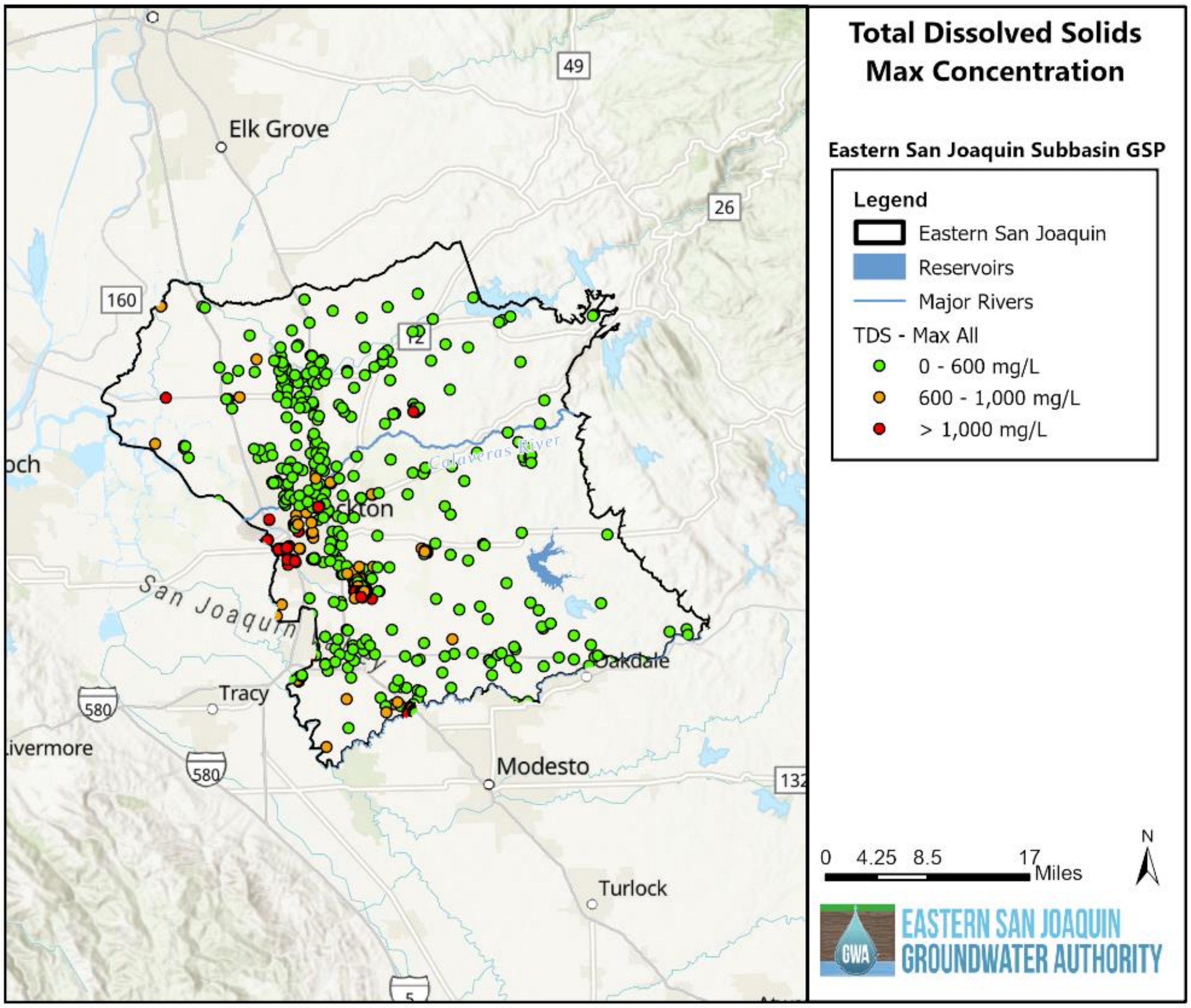


Figure 2-94: Maximum Concentrations for Wells Measuring Total Dissolved Solids



2.3.5 Land Subsidence

SGMA requires monitoring and reporting on inelastic land subsidence. In the Subbasin, subsidence concerns, if any, are focused on the non-Delta area as the Delta region contains peaty soils. Peaty soils can subside due to peaty soil oxidation. Peat oxidation occurs when the peaty soils dewater and come into contact with air, causing the soils to break down and compress, and is not a mechanism caused by groundwater overdraft.

Within the Eastern San Joaquin Subbasin, there are three primary sources of subsidence data, each with different periods of record and methods of data collection:

- CGPS vertical displacement data from the DWR SGMA Data Viewer
- InSAR subsidence rates from the SGMA Data Viewer
- Survey benchmarks from U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), California Department of Transportation (CalTrans), the San Joaquin County Department of Public Works, and local agencies.

There are no DWR or USGS extensometers in the Eastern San Joaquin Subbasin. The datasets used are detailed further below.

2.3.5.1 CGPS Data

Vertical displacement data from CGPS stations are available for download from the DWR SGMA Data Viewer (DWR, 2024). Two CGPS stations are monitored by UNAVCO and two by Scripps Orbit and Permanent Array Center (SOPAC). Of the SOPAC stations, Station P309, is the northeast region of the Subbasin north of the Calaveras River and has a period of record from March 4, 2006, to January 19, 2024. Station P273, in the northwest region of the Subbasin, has data from November 10, 2005, to December 28, 2020. P273 lies in the Delta region of the Subbasin.

The two UNAVCO CGPS stations are CNDR and MTWK. CNDR, in the western region of the Subbasin, has data from April 30, 1999, to February 14, 2006, but is no longer monitored. MTWK, in the southern region of the Subbasin south of the city of Manteca, has data from December 12, 2019, to January 19, 2024. This is the closest CGPS station to the location of the Corcoran Clay. Clay-rich zones are prioritized for monitoring since groundwater over-extraction in these areas can lead to dewatering and compression of the clay aquitards, and inelastic land subsidence.

Several additional CGPS stations from the University of Nevada Geodetic Laboratory (UNGL) are also monitored for subsidence (UNGL, 2024). Station CA15 is located north of the city of Stockton and has a continuous period of record between September 2013 and October 2021. Station CMNC is located along the southern edge of the Camanche Reservoir and has observations in 2020 and between February 2022 through January 2024. These locations also provided additional spatial coverage to the UNAVCO and SOPAC CGPS stations.

Figure 2-95 through Figure 2-98 show time series graphs of subsidence for the four CGPS stations in this analysis. Between 2015 and 2023, all of the CGPS stations showed that less than one foot of subsidence was observed throughout the Subbasin. The accuracy of GPS data is estimated to be ± 2 inches (CA DWR, 2017).

Figure 2-95 shows a time series graph of subsidence for CGPS Station MTWK. The graph indicates a slight downward trend, reflecting a small increase in subsidence in the Subbasin. From January 2023 to July 2023, subsidence increased slightly more, though overall subsidence remains minimal. The trend line's slope of -0.0295 inches per month (or -0.354 inches per year) confirms that subsidence is occurring in the Subbasin, but at insignificant levels.

Figure 2-95: CGPS Station MTWK – Subsidence Time Series

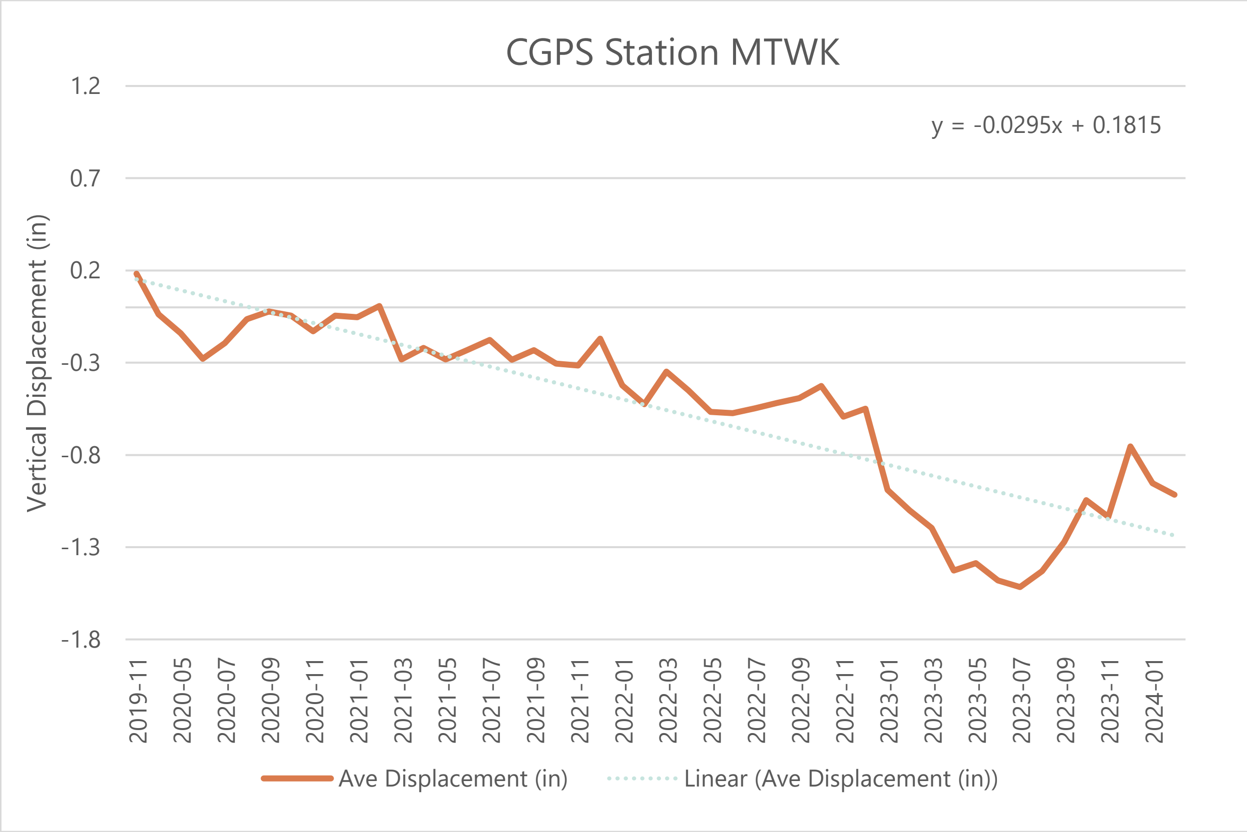


Figure 2-96 shows a time series graph of subsidence for CGPS Station P309. The graph indicates a very slight downward trend, reflecting a small increase in subsidence in the Subbasin. However, the displacement data varies to a great degree, increasing and decreasing throughout 2006 to current conditions. From June 2015 to June 2016, subsidence increased slightly more, with an overall subsidence of approximately 0.7 inches. This data point represents the largest observed subsidence across the four CGPS stations but still shows no inelastic subsidence. The trend line's slope of -0.0004 inches per month (-0.005 inches per year) confirms that subsidence occurring in this region is elastic and negligible.

Figure 2-96: CGPS Station P309 – Subsidence Time Series

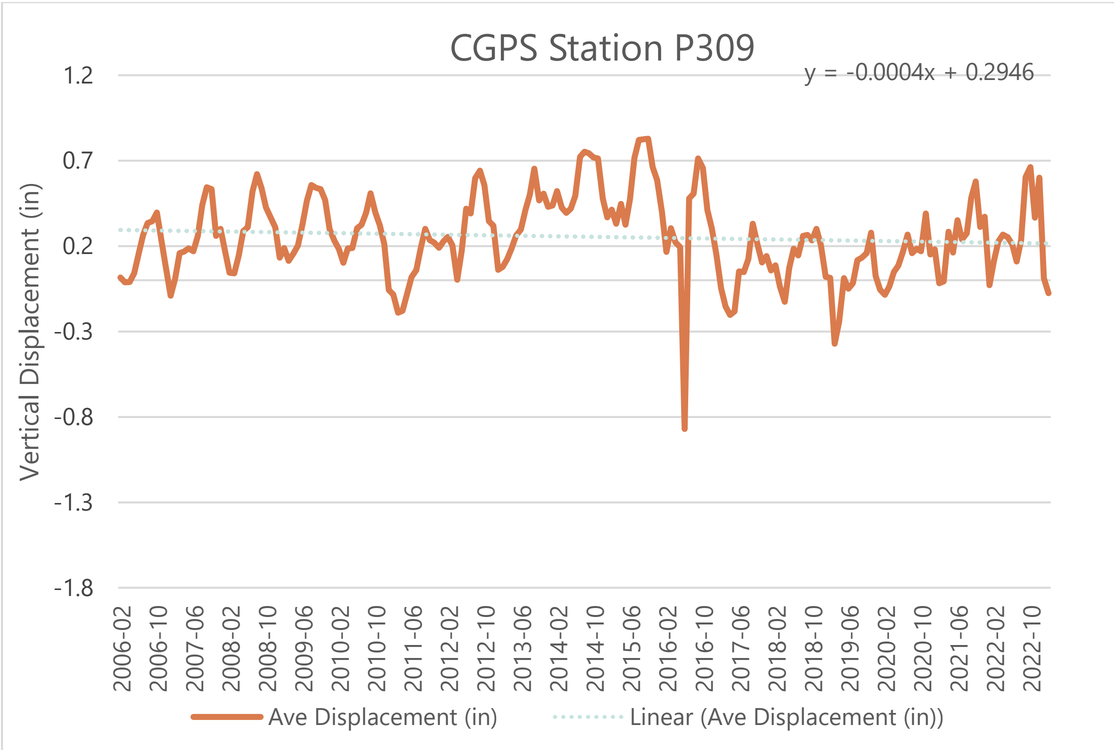


Figure 2-97 shows a time series graph of subsidence for CGPS Station CMNC, located in the northeastern region of the Subbasin, along the southern edge of the Camanche Reservoir. Overall, there is a very slight rise in ground elevation that could be due to several factors, such as swelling of clay soils in wet winters. There is no inelastic subsidence occurring at this CGPS station. As previously mentioned, CPGS Station CMNC is being monitored by UNGL and its data are subject to data gaps and discontinuous monitoring due to its academic nature. While the dataset does not have a long period of record, it supports the observation that subsidence has not historically been an issue in the Subbasin.

Figure 2-97: CGPS Station CMNC – Subsidence Time Series

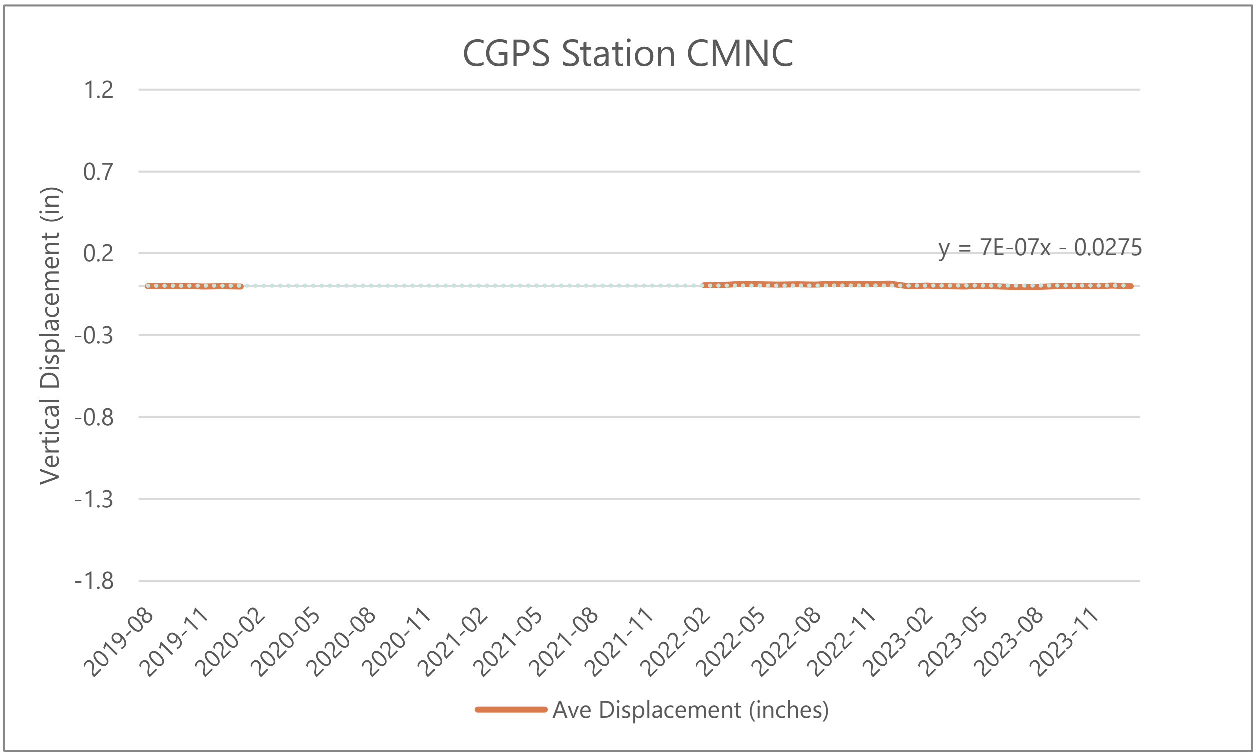
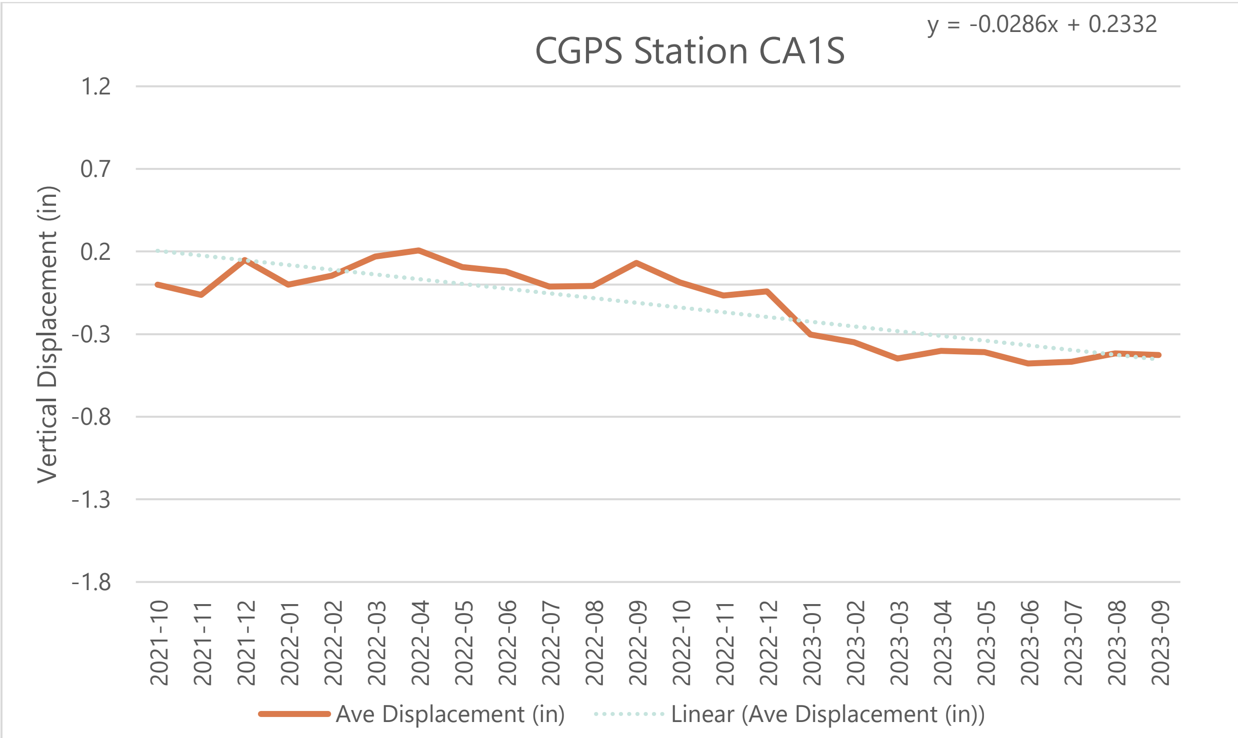


Figure 2-98 shows a time series graph of subsidence for CGPS Station CA1S, located in the western region of the Subbasin, north of the City of Stockton. The graph indicates a downward trend, reflecting a small increase in subsidence in the Subbasin. The subsidence observed for CGPS Station CA1S shows that subsidence was generally increasing in the Subbasin, and this is reflected in the slope of the trendline. The trend line's slope of -0.0286 inches per month (-0.34 inches per year) shows that the rate of subsidence at this region of the Subbasin is relatively greater than that of the other three CGPS stations but is still relatively minimal as compared to the overall accuracy of the data. The largest observed vertical displacement in this period of record was -0.261 inches, from December 2022 to January 2023, which is a small degree of subsidence. Important to note that, like CGPS Station CMNC, this dataset is obtained by UNGL and subject to data gaps and discontinuous monitoring.

Figure 2-98: CGPS Station CA1S – Subsidence Time Series

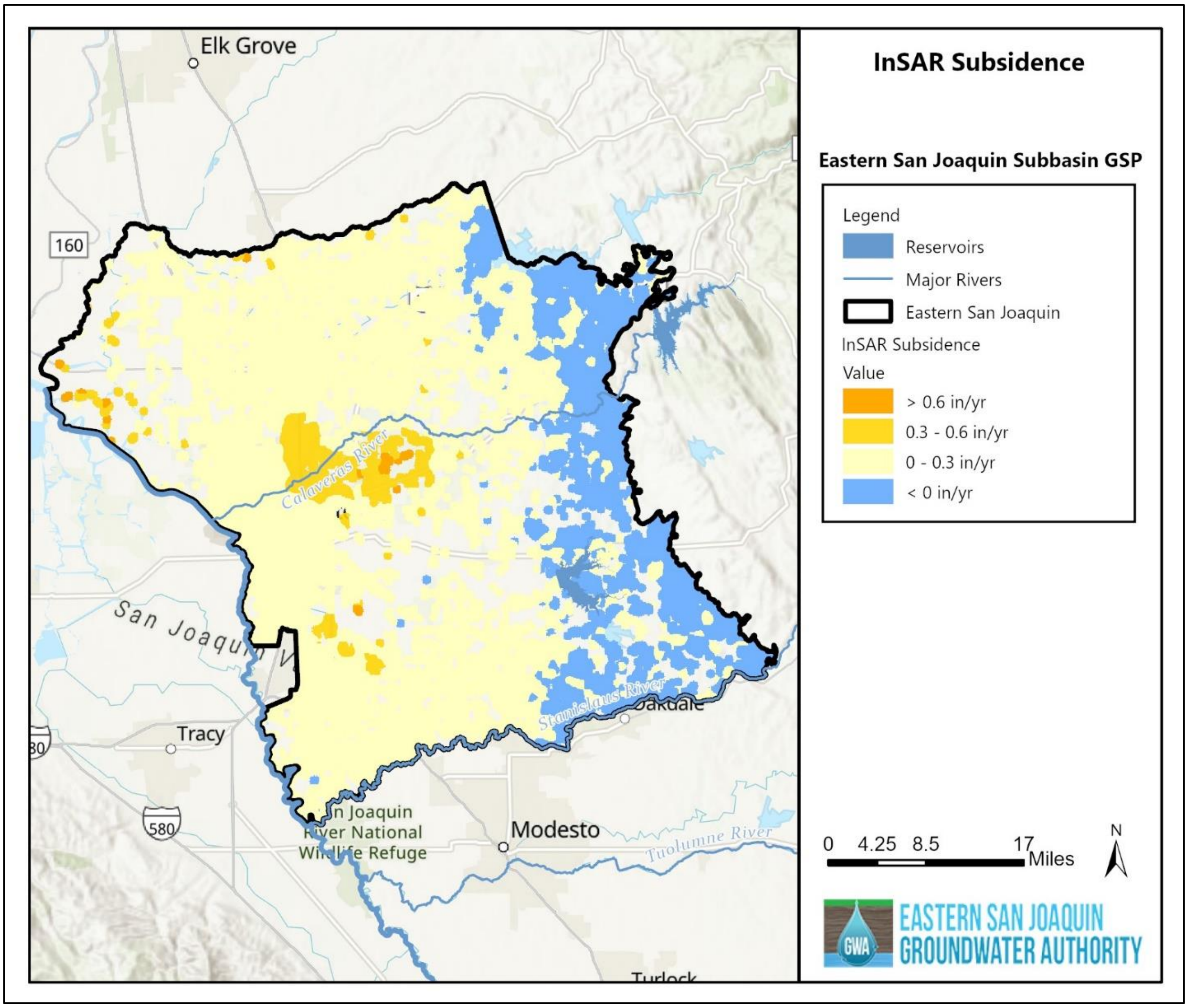


2.3.5.2 InSAR

InSAR data were collected from the SGMA Data Viewer sourced from the California Natural Resources Agency (CNRA). Included in this dataset are point data that represent average vertical displacement values for raster data for total and annual vertical displacement rates in monthly time steps. The longest period of record, at the time of analysis, was from June 13, 2015, to October 1, 2023.

The subsidence analysis using InSAR data revealed minimal subsidence rates across the Subbasin. The highest observed subsidence rate was in the central region, averaging 0.92 inches per year between 2015 and 2023. In contrast, subsidence is not occurring in the eastern region of the Subbasin; instead, the ground elevation has increased due to the swelling of clayey soil in the foothills. This observation is supported by the subsidence analysis for CGPS Station CMNC in the eastern Subbasin which showed positive vertical displacement, indicating a rise in ground elevation. The western region of the Subbasin, adjacent to the Delta, is likely experiencing land subsidence due to peat oxidation rather than groundwater extraction. Figure 2-99 illustrates that the central portion of the Subbasin in the cone of depression area is more prone to land subsidence. Despite this, overall subsidence in the Subbasin remains minimal and is not expected to cause undesirable effects.

Figure 2-99: Subsidence Rates (inches per year) Throughout the Subbasin



Note: InSAR period of the record displayed in the figure above is June 13, 2015, to October 1, 2023

While CGPS data are more accurate than InSAR vertical displacement measurements, InSAR can estimate subsidence rates over a large land area. Compared to CGPS stations, InSAR has a 16 mm vertical accuracy at a 95% confidence level and an estimated 12 mm (0.47 inches) accuracy near Eastern San Joaquin (Towill, 2020).

2.3.5.3 Survey Benchmarks

Survey benchmark data were collected from USGS, ACOE, CalTrans, the San Joaquin County Department of Public Works (DPW), and local agencies. While there is a high density of benchmarks in the Subbasin, they are not surveyed regularly.

In March 2024, Stockton East Water District (SEWD) conducted benchmark surveys for subsidence monitoring. The aim was to verify claims by the DWR that approximately 7 inches of subsidence had occurred in the area over the past seven years. SEWD surveyed the current elevations of six National Geodetic Survey (NGS) benchmarks with published elevations to compare the historical data with current measurements. These benchmarks, all established in 1962, are located along Comstock Road. The survey results indicated that the average subsidence from the published elevations (1962) to current conditions (March 2024) is approximately 9.3 inches, with a range of subsidence spanning 12.72

inches. The greatest subsidence observed was at NGS Survey Benchmark H-956, which showed a subsidence of 16.56 inches over the 62-year period, or 0.27 inches per year. Due to the temporal differences in subsidence observations, this 62-year period does not provide a precise measurement to directly compare with DWR's InSAR 8-year subsidence data from 2015 to 2023 with an average subsidence rate of 0.92 inches per year.

It is also noteworthy that the six surveyed benchmarks are all located in the central region of the Subbasin, where InSAR data indicated the highest subsidence rate of 0.92 inches per year. While the subsidence of 16.56 inches at NGS Survey Benchmark H-956 is significant, it must be considered within the context of the 62-year period. The benchmark survey results suggest that subsidence in the Subbasin is not occurring at significant levels and is not expected to cause undesirable effects.

2.3.5.4 Relationship with Groundwater Levels

Historically, the Subbasin has not had significant or undesirable effects caused by inelastic land subsidence. Examining recent CGPS vertical displacement data, less than one foot of subsidence was observed throughout the Subbasin between 2015 and 2023. While the 2020 GSP originally considered groundwater levels as a proxy for subsidence, a strong correlation was not observed.

Figure 2-100 shows a time series graph of subsidence (vertical displacement of land surface) and groundwater elevation for CGPS Station MTWK, with Manteca 18 as the respective groundwater level RMW. The graph indicates a slight downward trend in land surface elevation, reflecting a small increase in subsidence rates in the Subbasin. From January 2023 to July 2023, land surface elevations increased slightly more when groundwater levels declined, though overall subsidence remains minimal. It is important to note that, while there was a significant drop in groundwater elevations during September 2023, when groundwater levels recovered in the winter of 2024, subsidence reversed. This shows elastic subsidence that can recover with sustainable groundwater levels. Note that the historical groundwater levels in this example did not decline below MT for that RMW.

Figure 2-100: CGPS Station MTWK: Subsidence Time Series

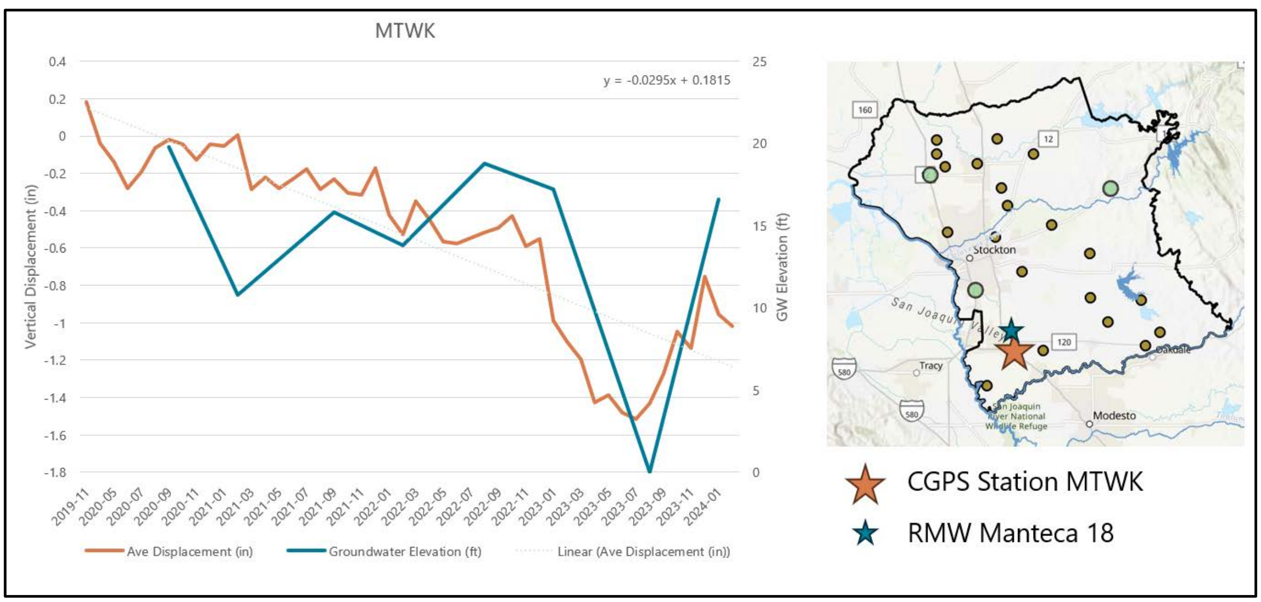
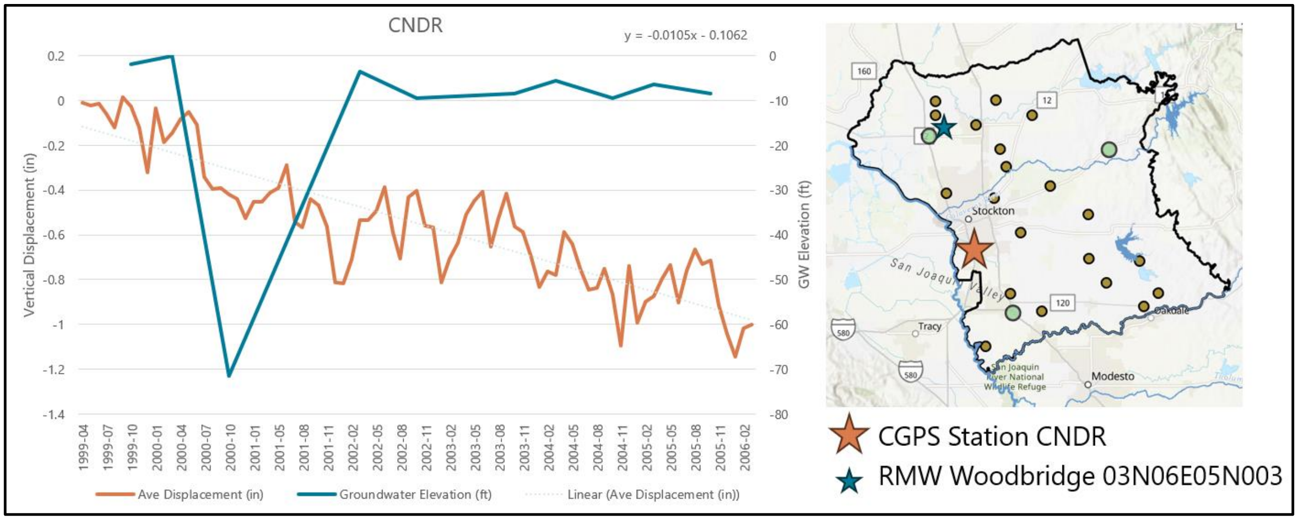


Figure 2-101 shows a time series graph of subsidence (vertical displacement of land surface) and groundwater elevations for CGPS Station CNDR, with Woodbridge 03N06E05N003 as the respective RMW. The graph indicates a slight downward trend in land surface elevations, reflecting a small increase in subsidence in the Subbasin. The trend line's slope of -0.0105 inches per month confirms that subsidence is occurring in the Subbasin, but at very low levels. There was a significant decrease of 70 feet in groundwater elevation between March 1, 2000, and November 1, 2000, at this location; however, it is important to note that while there was a sharp decline in groundwater elevation during October 2000, subsidence appears to be unaffected. The Woodbridge 03N06E05N003 groundwater level representative monitoring well was selected for analysis because it is the only representative monitoring well that has historically declined below its respective minimum threshold. CNDR CGPS station was selected because it is the only CGPS station with historical observations during the period when the groundwater levels were below minimum thresholds.

Figure 2-101: CGPS Station CNDR – Time Series of Subsidence and Groundwater Levels



2.3.6 Interconnected Surface Water Systems

2.3.6.1 Definitions

Section 2.2.6 detailed the original depletions analysis in the 2020 GSP. This section provides an update to that analysis based on guidance provided by DWR and updates to ESJWRM to reflect current conditions as of the development of this 2024 Amended GSP. More detail can be found in Attachment 3-F, including an extensive update to the historical ISW conditions analysis. As described in *Depletions of ISW: An Introduction* (CA DWR, 2024), the first of three guidance documents on ISWs released by DWR, the consideration and interpretation of ISWs can be based on five example cases of nearby groundwater elevation data (Figure 5 of *Depletions of ISW: An Introduction*). Of the examples provided, Figure 5d is most applicable to Eastern San Joaquin Subbasin due to a lack of shallow monitoring wells and associated historic data near the rivers and creeks in the Subbasin (shown in the DWR guidance document and Appendix 3-G). This lack of shallow groundwater level data near surface water courses translates to a low degree of confidence in model calibration around these surface water features and therefore uncertainty around what is or is not a connected reach or model node.

GSP regulations require the identification of ISWs within a basin (and therefore identification of the degree of connectivity) and an estimate of the timing and quantity of depletions of those systems, where depletions are defined as “conditions where groundwater pumping results in reductions in flow or water levels of ISW.” However, the DWR guidance document notes that “the definition above differs from how depletions may be defined in other hydrologic contexts, where they can refer to any surface water losses without considering the cause.” A good faith effort was conducted to isolate stream depletions in the ESJ Subbasin due solely to groundwater pumping by comparing (1) pumping and no-pumping scenarios and (2) a pumping “pulse” scenario to examine the delayed impact of pumping on stream depletions, both using the integrated Eastern San Joaquin Water Resources Model Version 3.0 (ESJWRM). However, the analyses resulted in an inconclusive understanding of depletions due to pumping since an equilibrium was not reached within the simulation period and depletions were heavily influenced by initial and boundary conditions. Therefore, the analyses relied on the standard definition of depletions as stream losses to the aquifer system regardless of cause. This allows the GSAs to have more confidence in the results and be able to manage and report depletions in future Annual Reports without limitations and uncertainties from the existing toolset. At the time of the 2024 GSP, the additional guidance documents from DWR (*Techniques for Estimating Depletions of Interconnected Surface Water* and *Examples of Approaches for Estimating Depletions of Interconnected Surface Water*) had not yet been released. The timing, location, and volume of depletions in the ESJ Subbasin will be revised at a later time in coordination with further guidance from DWR.

2.3.6.2 Stream Connectivity

Stream connectivity was analyzed by comparing monthly groundwater elevations from the historical calibration of the ESJWRM to streambed elevations along the streams represented in ESJWRM. The reaches in ESJWRM are displayed in Figure 2-102. Layer 1 groundwater levels were used since the new Layer 1 in ESJWRM represents the shallow, generally unconsolidated sediments where stream interaction is happening. Stream connectivity was also analyzed under current conditions, represented by Water Year 2020 through 2024 in the historical ESJWRM model. "75% Connected" streams were defined as Layer 1 groundwater levels at or above the streambed elevation at least 75 percent of the time. The definition of ISWs is not limited to surface waters that the ESJGWM indicates are connected to the shallowest modeled groundwater level at least 75 percent of the time. The GSAs understand that an ISW may be seasonally connected and/or connected in only wetter water year types. The GSAs currently do not have sufficient data to determine if or when streams or reaches are connected to the groundwater table with this level of granularity. The GSAs will be collecting more data with the new ISW monitoring wells to help inform this analysis going forward. Using ESJWRM Version 3.0, which was the best available tool at the time of analysis,

Figure 2-103 shows that the 75 percent connected streams are the Mokelumne River, Stanislaus River, and lower San Joaquin River. Streams that are not connected at least 75 percent of the time are Dry Creek, Calaveras River, and Mormon Slough. Other smaller creeks are not represented in ESJWRM.

Figure 2-102: Stream Reaches in ESJWRM

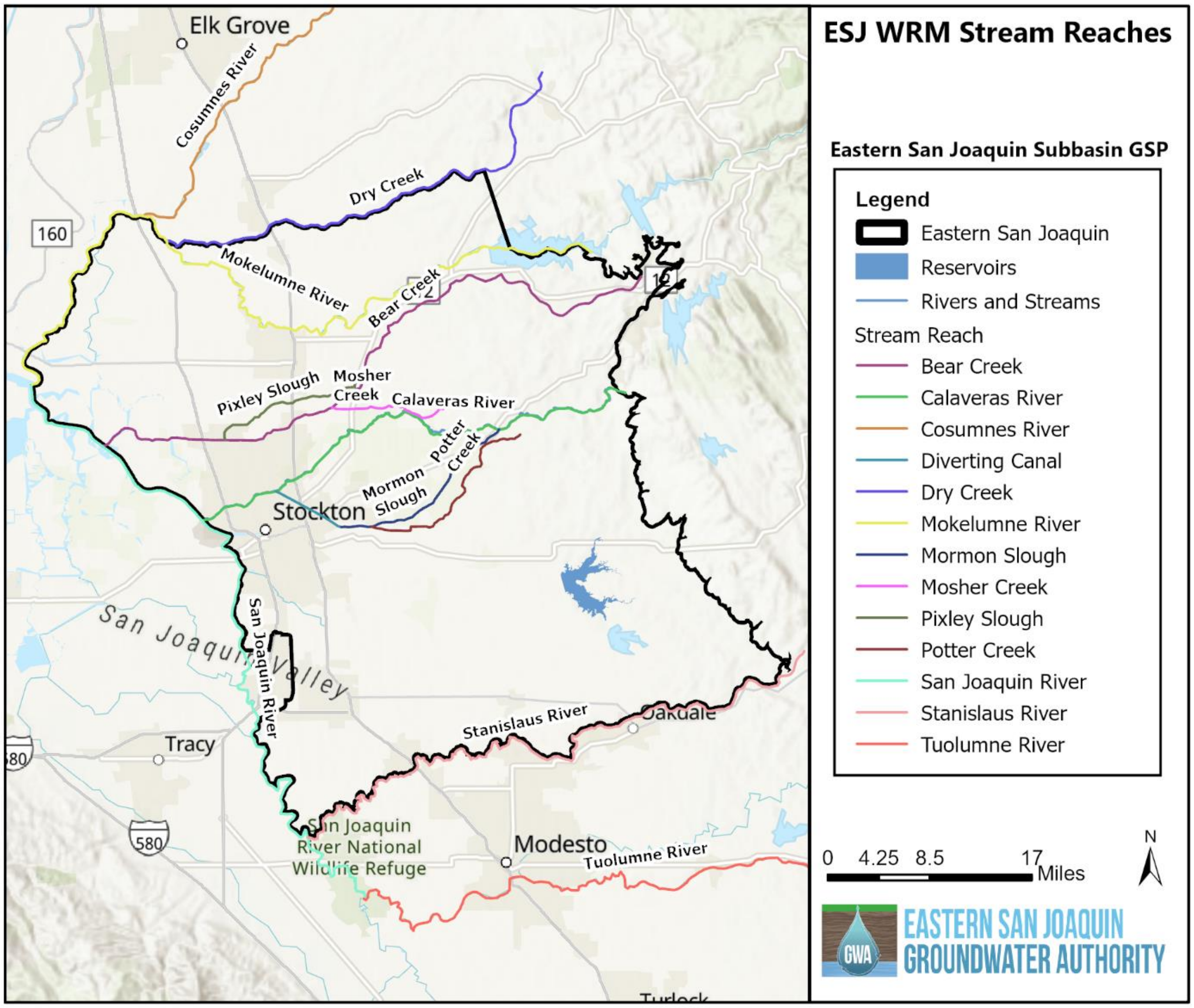
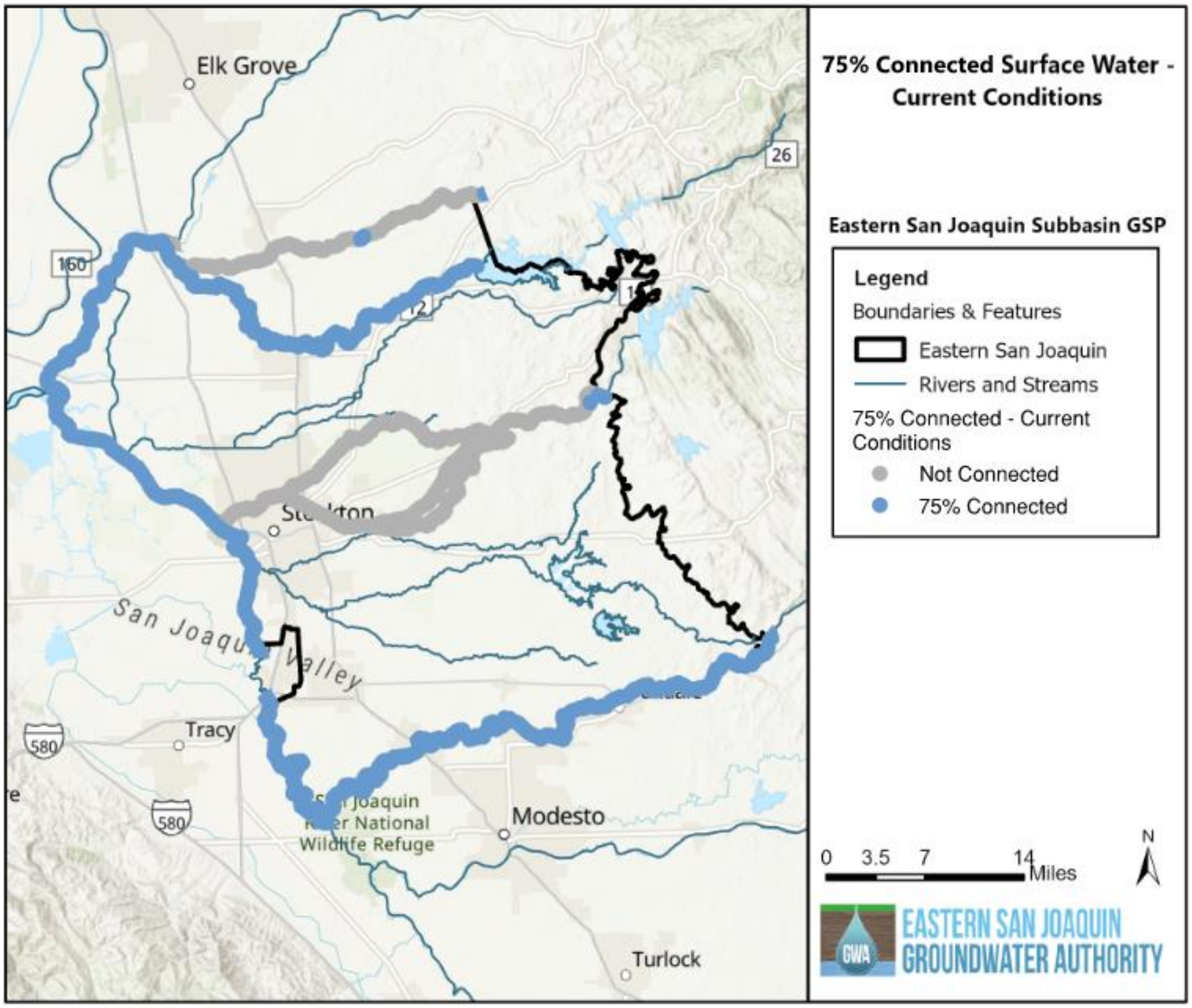


Figure 2-103: Surface Waters Connected with the Groundwater System at least 75% of All Months in ESJWRM under Current Conditions



2.3.6.3 Stream Gains and Losses

Disconnected streams will always be losing streams, but interconnected streams may be either losing or gaining, depending on the surface water and groundwater conditions. Groundwater discharge from the aquifer is primarily through groundwater pumping; however, groundwater also discharges to streams where groundwater elevations are higher than the streambed elevations and stream levels or stage. Figure 2-104, from DWR's *Depletions of ISW: An Introduction* (CA DWR, 2024), illustrates connected gaining streams (on the left) where groundwater levels are higher than the stream stage, and losing streams (on the right) where groundwater levels are lower than the stream stage.

Figure 2-104: Diagram of Gaining and Losing Connected Streams

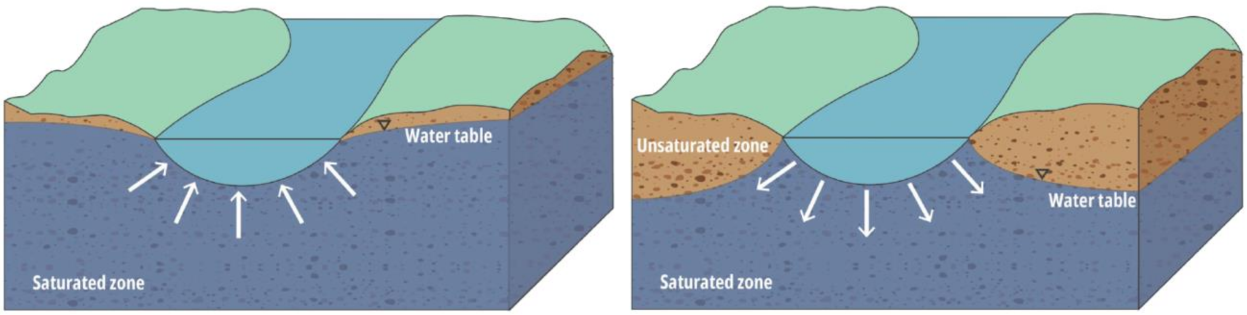
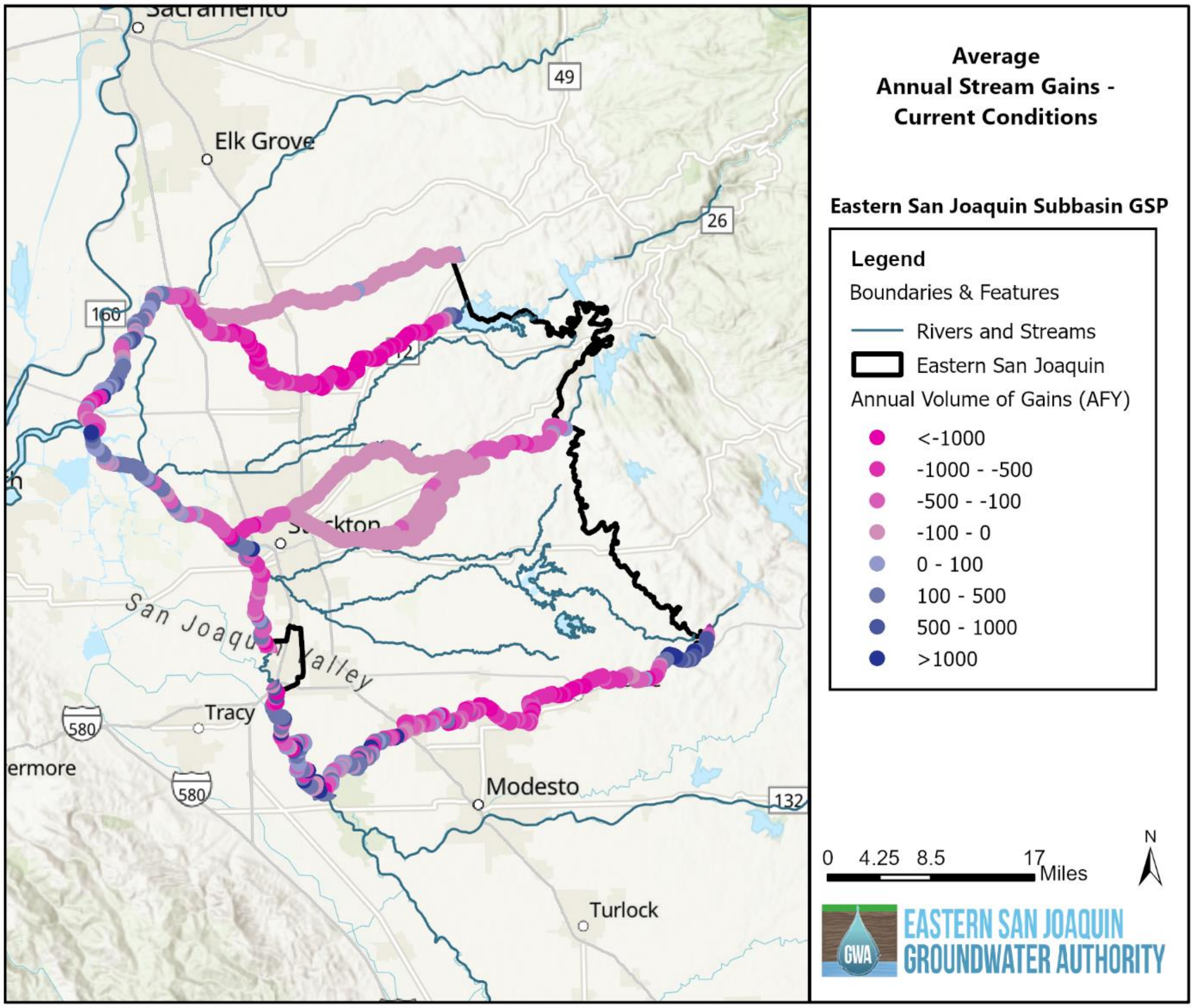


Figure 2-105 shows the average annual volume of stream gains under current conditions (Water Year 2020 through 2023). While the Mokelumne River is a connected river in most years, it is losing water from the stream to the aquifer system upstream of the Cosumnes River, and gaining water from the aquifer system downstream of the Cosumnes River, on average. The Stanislaus River has a high number of stream nodes in the center portion of the river that are losing under current conditions. The lower San Joaquin River is gaining in many sections near the confluence with the Stanislaus River, Calaveras River, and in the Delta region.

Figure 2-105: Current Conditions Average Annual Stream Gains by Stream Node



2.3.7 Groundwater-Dependent Ecosystems

In the Eastern San Joaquin Subbasin, the primary environmental beneficial users are groundwater dependent ecosystems. In the 2020 GSP, potential GDEs were mapped across the Subbasin. The mapping relied on the Natural Communities Commonly Associated with Groundwater (NCCAG) database, from which additional refinements were made to remove areas that met the following criteria:

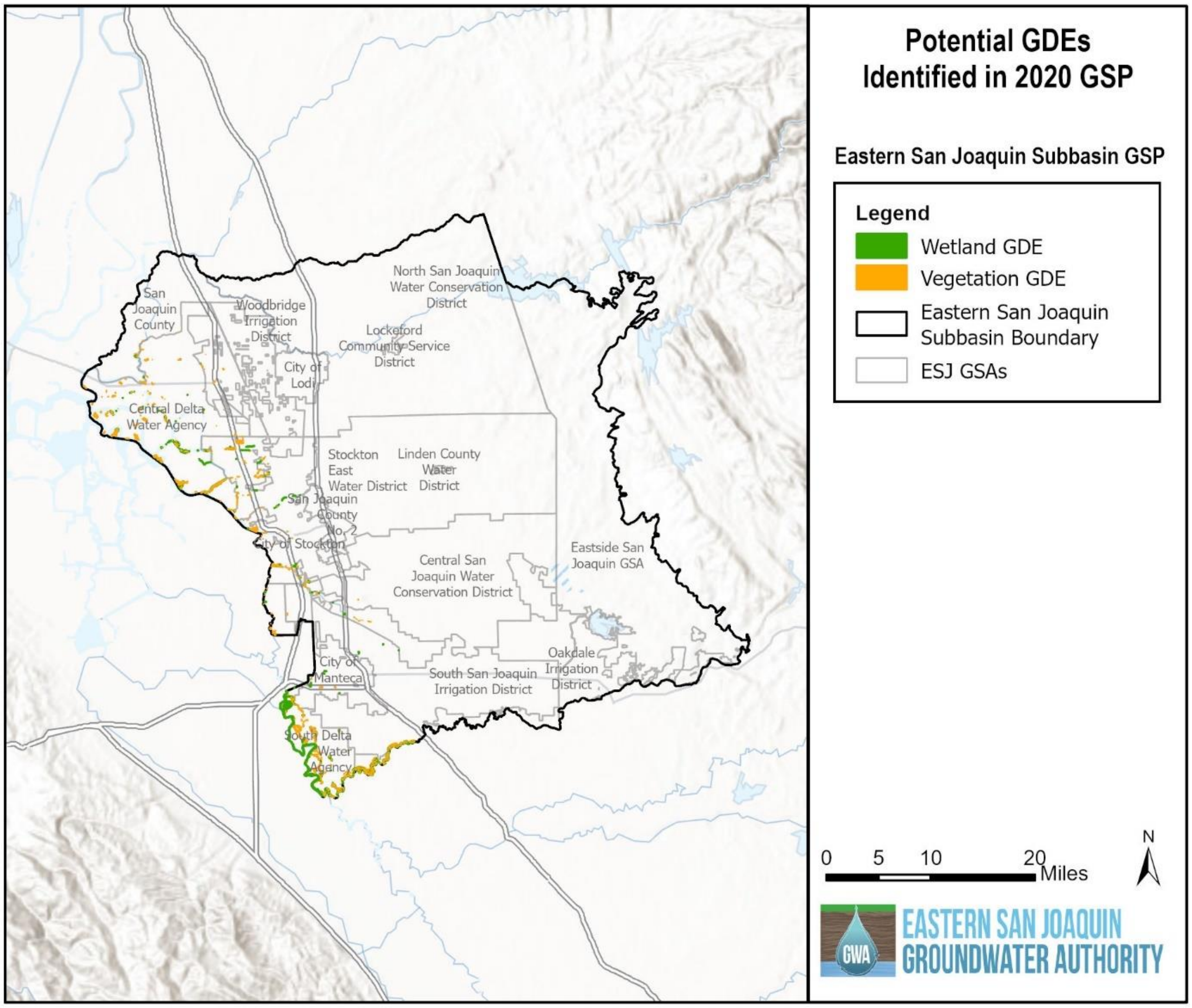
- Areas where groundwater levels were deeper than 30 feet below the ground surface (ft bgs).
- Areas with access to alternate water supplies that may not be dependent on groundwater (i.e., communities close to managed wetlands, irrigated agriculture, or perennial surface water bodies).

The resulting desktop mapping was then considered by GSA staff and technical workgroup members before inclusion in the GSP. Further detail on this approach to mapping potential GDEs is described in Appendix 3-C of this GSP Amendment.

Before conducting the analysis to evaluate the potential impacts of the groundwater level SMC on potential GDEs, it was verified that no changes to the NCCAG dataset within the ESJ Subbasin have been made since 2020. The NCCAG database still represents the most comprehensive source of potential GDEs within this Subbasin. Polygons in the NCCAG dataset were removed where the vegetative community's average maximum rooting depths do not intersect with groundwater. In other words, if the vegetation is not able to access groundwater within its rooting depth, then it is assumed that the ecosystem is not a potential GDE. This average maximum rooting depth is estimated to be 30 feet below ground surface for the majority of phreatophytes (The Nature Conservancy, 2021). The original mapping completed as part of the 2020 GSP was retained in this GSP Amendment.

The map of potential GDEs included in the 2020 GSP is shown in Figure 2-106. This mapping of potential GDEs represents a desktop analysis that will continue to be improved through field verification.

Figure 2-106: Mapping of Potential Groundwater Dependent Ecosystems

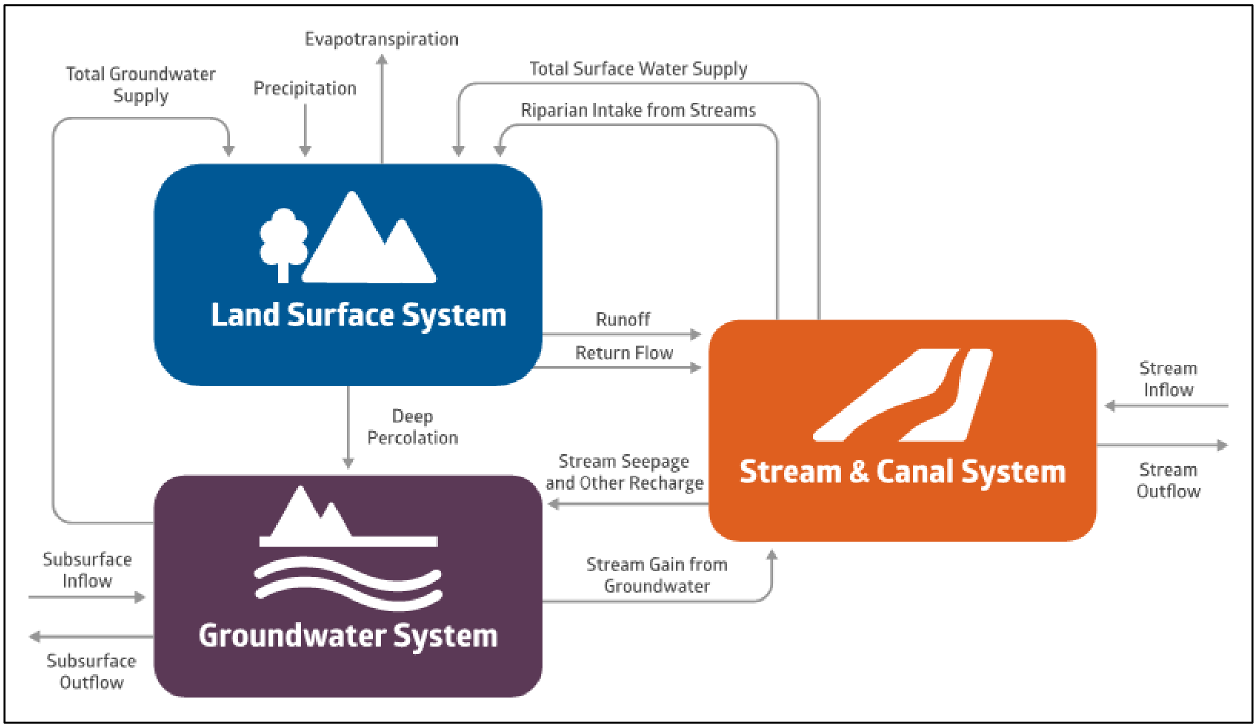


2.4 WATER BUDGETS

2.4.1 Water Budget Background Information

Water budgets are developed to provide a quantitative account of water entering and leaving the Eastern San Joaquin Subbasin. Water entering and leaving the Subbasin includes flows at the surface and in the subsurface environment. Water enters and leaves due to natural conditions, such as precipitation and streamflow, and/or through human activities, such as groundwater pumping or recharge from applied water. Additionally, interconnection between the groundwater system and rivers/streams accounts for other components of the water budget. Figure 2-107 depicts the major components of a water budget and their interconnection as presented in the context of stream, land surface, and groundwater systems.

Figure 2-107: Generalized Water Budget Diagram



Quantities presented for the water budget components of the Eastern San Joaquin Subbasin provide information on historical, current, and projected conditions as they relate to hydrology, water demand, water supply, land use, population, climate variability, groundwater and surface water interaction, and groundwater flow. This information can assist in the management of the Subbasin by identifying the relationship between different components affecting the water budget of the Subbasin, which provides context in the development and implementation of strategies and policies to achieve Subbasin groundwater sustainability conditions. Water budget quantities presented are based on the simulation results from the ESJWRM.

The ESJWRM was developed to be the primary analysis tool supporting the development of the GSP for the Subbasin. The ESJWRM is a quasi-three-dimensional finite element model developed using the Integrated Water Flow Model (IWFM) simulation code (Dogrul et al., 2024a and Dogrul et al,. 2024b). Using data from federal, state, and local resources, the ESJWRM was originally calibrated for the 20-year hydrologic period of October 1995 to September 2015 (water years 1996 through 2015) for the 2020 GSP by comparing simulated groundwater levels and streamflow records with historical observed records. Development of the model involved the study and analysis of hydrogeologic conditions, agricultural and urban water demands, agricultural and urban water supplies, and an evaluation of regional water quality conditions. The Historical ESJWRM has undergone nine updates to date, of which three were major updates:

1. Major Update: Development and Calibration of Historical ESJWRM Version 1.1 (WY 1995 through 2015) for November 2020 GSP
2. Extension of Data in Historical ESJWRM Version 1.1 from WY 2016 through 2019 for WY 2019 Annual Report
3. Extension of Data in Historical ESJWRM Version 1.1 through WY 2020 for WY 2020 Annual Report
4. Major Update: Model Update and Recalibration Resulting in Historical ESJWRM Version 2.0 (WY 1995 through 2020) for Revised June 2022 GSP
5. Extension of Data in Historical ESJWRM Version 2.0 through WY 2021 for WY 2021 Annual Report

6. Updated Monthly Agricultural Demand Distribution in Fall 2022 Resulting in Historical ESJWRM Version 2.2
7. Extension of Data in Historical ESJWRM Version 2.2 through WY 2022 for WY 2022 Annual Report
8. Extension of Data in Historical ESJWRM Version 2.2 through WY 2023 for WY 2023 Annual Report
9. Major Update: Model Update and Recalibration Resulting in Historical ESJWRM Version 3.0 for 2024 Periodic Evaluation and GSP Amendment

Only ESJWRM Version 3.0 water budget results are presented in Section 2.4. Version 3.0 development is documented in a report, "Eastern San Joaquin Water Resources Model (ESJWRM) Version 3.0 Update," published in August 2024 and available in Appendix 2-C.

Consistent with CCR Title 23 § 354.18, the water budgets presented in this document encompass the combined surface and groundwater system of the Eastern San Joaquin Subbasin. The Subbasin water budget focuses on the full water year (12 months spanning October 1 of the previous year to September 30 of the year in question), with some consideration of monthly variability.

The Regulations require that the annual water budget quantify three different conditions: historical, current, and projected. Budgets are developed to capture typical conditions during these time periods. Typical conditions are developed through selecting historical hydrologic periods that incorporate droughts, wet periods, and normal periods. By incorporating these varied conditions within the budgets, the Subbasin is analyzed under certain hydrologic conditions, such as drought or very wet events, along with long-term averages. This Plan relies on historical hydrology to identify time periods for water budget analysis and uses the ESJWRM and associated data to develop the water budget and resulting budget estimates. The water budget components developed for the Eastern San Joaquin Subbasin are based upon estimates developed from historical and projected data as well as modeling assumptions. The water budget assumptions may be refined in the future, the water budget may change, and the conclusions and recommendations derived from the water budget may also change.

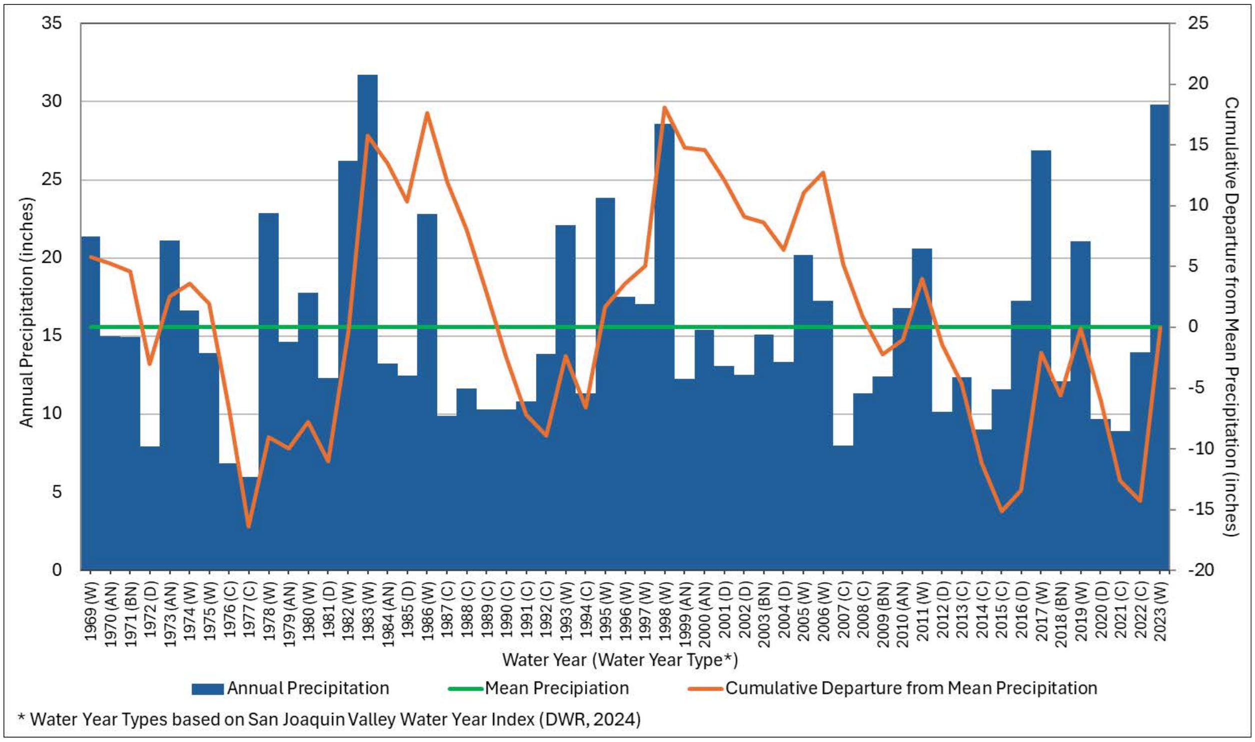
2.4.2 Identification of Hydrologic Periods

The historical hydrologic periods used in this Plan were selected to meet the requirements of developing historical, current, and projected water budgets. The Regulations require that the projected water budget reflect a 50-year hydrologic period in order to project how the Subbasin's land and groundwater systems may react under long-term average hydrologic conditions. Consistent with the Regulations, the ESJWRM Version 3.0's 55-year historical record characterizes future conditions with respect to precipitation, evapotranspiration, and streamflow. Historical precipitation or rainfall in the Eastern San Joaquin Subbasin was used to identify a hydrologic period that would provide a representation of wet and dry periods and long-term average conditions needed for water budget analyses. Rainfall data for the Subbasin are derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) dataset of the DWR's California Simulation of Evapotranspiration of Applied Water (CALSIMETAW) model. Precipitation-Elevation Regressions on Independent Slopes Model (PRISM) is a spatial estimation of rainfall data developed using monitoring network point data and interpolated using a variety of factors (Oregon State University, 2023).

Wet and dry hydrologic periods were identified by evaluating the cumulative departure from mean precipitation. Under this method, the long-term average precipitation is subtracted from annual precipitation within each water year to develop the departure from mean precipitation for each water year. Wet years have a positive departure and dry years have a negative departure; a year with exactly average precipitation would have zero departure. Starting at the first year analyzed, the departures are added cumulatively for each year. So, if the departure for Year 1 is 5 inches and the departure for Year 2 is -2 inches, the cumulative departure would be 5 inches for Year 1 and 3 inches (5 plus -2) for Year 2. Figure 2-108 graphically illustrates the cumulative departure of the spatially averaged rainfall within the Eastern San Joaquin Subbasin. The figure includes bars displaying annual precipitation for each water year from 1969 through 2023 and a horizontal line representing the mean precipitation of 15.6 inches. The cumulative departure from mean precipitation is based on these data sets and is displayed as a line that highlights wet periods with upward slopes (positive departure) and dry periods with downward slopes (negative departure). More severe events are shown by steeper slopes and greater changes. For example, the period from 1975 to 1977 illustrates a short period with dramatically dry conditions (6-inch decline per year in cumulative departure).

The PRISM estimates for rainfall in the Subbasin were confirmed by comparing the cumulative departure from mean precipitation results to the water year types in the San Joaquin Valley Water Year Hydrologic Classification (CA DWR, 2023), which classifies water years 1901 through 2023 as wet, above normal, below normal, dry, and critical based on inflows to major reservoirs or lakes. Wet (W) or Above Normal (AN) years generally show upward sloping cumulative departures, while Below Normal (BN), Dry (D), or Critical (C) water year types show downward trending cumulative departures (Figure 2-108). As the San Joaquin Valley Water Year Hydrologic Classification determines water year types based on inflows for streams throughout the entire San Joaquin Valley, a more locally relevant index to the Subbasin may be developed in the future.

Figure 2-108: 55-Year Historical Precipitation and Cumulative Departure from Mean Precipitation



2.4.3 Use of the ESJWRM and Associated Data in Water Budget Development

This Plan developed water budgets utilizing the ESJWRM, a fully integrated surface and groundwater flow model covering the Eastern San Joaquin Subbasin, as well as the Cosumnes Subbasin to the north and the Modesto Subbasin to the south. The adjacent subbasins were included in the ESJWRM boundaries to be consistent with past local modeling efforts and to better simulate boundary flows to/from the north and south of the Subbasin. This Plan provides a water budget for the Eastern San Joaquin Subbasin portion of the ESJWRM.

With the ESJWRM Version 3.0 as the underlying framework, four model scenarios were developed representing historical, current, projected, and projected with climate change conditions in the Eastern San Joaquin Subbasin, as discussed below:

- **Historical water budget** represents the historical model calibration period, which covers water years 1996 through 2023 (28 years).

- **Current water budget** represents an estimate of averaged recent historical conditions in the Subbasin, based on water years 2019 through 2023 (5 years).
- **Projected water budget** represents estimated long-term conditions of the Subbasin under the foreseeable future level of development over a long-term period of hydrologic conditions (the 55-year period represented by water years 1969 through 2023).
- **Projected water budget, with climate change** represents the projected water budget, with the impacts of climate change on streamflow, evapotranspiration, and precipitation.

2.4.4 Water Budget Definitions and Assumptions

Definitions and assumptions for the historical, current, and projected water budgets are provided in the sections below and summarized in Table 2-13: Summary of Water Budget Assumptions (Historical, Current, and Projected Periods)

Water Budget Type	Historical[5]	Current	Projected[5]	Projected with Climate Change[5]
Model Version	Historical ESJWRM Version 3.0	Historical ESJWRM Version 3.0	ESJWRM PCBL Version 3.0	ESJWRM PCBL-CC Version 3.0
Scenario	Historical Calibration	Current Conditions	Projected Conditions Baseline	Projected Conditions Baseline with Climate Change
Hydrologic Years	Water Years 1996-2023	Water Years 2019-2023	Water Years 1969-2023	Water Years 1969-2023 with perturbation
Level of Development[1]	Historical	Current	General Plan or Sphere of Influence Buildout	General Plan or Sphere of Influence Buildout
Agricultural Demand[2]	Historical	Current (average of WY 2019-2023)	Current (2022, less urban expansion)	Current (2022, less urban expansion, with increased ET)
Urban Demand[3]	Historical	Current	Projected based on UWMP data	Projected based on UWMP data
Water Supplies[4]	Historical	Current	Projected based on local information	Projected based on local information (with an adjustment for climate change impact on precipitation and streamflow)

Notes:

1 The level of development describes the footprint of the urban areas. Historical is the footprint in the historical model period (water years 1996-2023), current is the footprint at the end of the historical model period (water years 2019-2023), and projected reflects the footprint after general plan or sphere of influence urban buildout (approximately water year 2040).

2 Agricultural demand is based on historical cropping patterns and evapotranspiration rates. Projected agricultural cropping patterns are assumed to be consistent with DWR's statewide crop mapping of 2022, less urban buildout. For the current and projected water budgets, future evapotranspiration rates are assumed to remain the same as historical.

3 Historical urban demand includes actual demand and population from Urban Water Management Plans (UWMPs) or other planning efforts. Current demand is assumed to represent average demands and population between WY 2019-2023. Projected demand uses projected demand and population from UWMPs or other planning efforts and uses numbers for a buildout level of development (approximately water year 2040).

4 Historical water supplies rely on local district information and records. Projected water supplies were assumed for approximately water year 2040 and may include projects or expansions of supplies currently begun or with funding secured. Current water supplies represent water supplies averaging approximately water years 2019-2023 in the historical records.

5 For more information on historical and projected modeling, see the published model report (Appendix 2-C).

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Table 2-13: Summary of Water Budget Assumptions (Historical, Current, and Projected Periods)

Water Budget Type	Historical[5]	Current	Projected[5]	Projected with Climate Change[5]
Model Version	Historical ESJWRM Version 3.0	Historical ESJWRM Version 3.0	ESJWRM PCBL Version 3.0	ESJWRM PCBL-CC Version 3.0
Scenario	Historical Calibration	Current Conditions	Projected Conditions Baseline	Projected Conditions Baseline with Climate Change
Hydrologic Years	Water Years 1996-2023	Water Years 2019-2023	Water Years 1969-2023	Water Years 1969-2023 with perturbation
Level of Development[1]	Historical	Current	General Plan or Sphere of Influence Buildout	General Plan or Sphere of Influence Buildout
Agricultural Demand[2]	Historical	Current (average of WY 2019-2023)	Current (2022, less urban expansion)	Current (2022, less urban expansion, with increased ET)
Urban Demand[3]	Historical	Current	Projected based on UWMP data	Projected based on UWMP data
Water Supplies[4]	Historical	Current	Projected based on local information	Projected based on local information (with an adjustment for climate change impact on precipitation and streamflow)

Notes:

1 The level of development describes the footprint of the urban areas. Historical is the footprint in the historical model period (water years 1996-2023), current is the footprint at the end of the historical model period (water years 2019-2023), and projected reflects the footprint after general plan or sphere of influence urban buildout (approximately water year 2040).

2 Agricultural demand is based on historical cropping patterns and evapotranspiration rates. Projected agricultural cropping patterns are assumed to be consistent with DWR's statewide crop mapping of 2022, less urban buildout. For the current and projected water budgets, future evapotranspiration rates are assumed to remain the same as historical.

3 Historical urban demand includes actual demand and population from Urban Water Management Plans (UWMPs) or other planning efforts. Current demand is assumed to represent average demands and population between WY 2019-2023. Projected demand uses projected demand and population from UWMPs or other planning efforts and uses numbers for a buildout level of development (approximately water year 2040).

4 Historical water supplies rely on local district information and records. Projected water supplies were assumed for approximately water year 2040 and may include projects or expansions of supplies currently begun or with funding secured. Current water supplies represent water supplies averaging approximately water years 2019-2023 in the historical records.

5 For more information on historical and projected modeling, see the published model report (Appendix 2-C).

2.4.4.1 Assumptions Used in the Historical Water Budget

The historical water budget is intended to evaluate availability and reliability of past surface water supply deliveries, aquifer response to water supply, and demand trends relative to water year type. The historical calibration of the ESJWRM reflects the historical conditions in the Eastern San Joaquin Subbasin over water years 1996-2023. The hydrologic period has an average annual precipitation of approximately 15.5 inches and includes the recent 2012-2015 and 2020-2022 droughts, the wetter years of 1996-2000, 2017, and 2023, and periods of normal precipitation. Regulations require the use of a minimum of 10 years to develop the historical water budget. The entire historical calibration period of the ESJWRM was used to be inclusive of all the data used in developing the ESJWRM and to average over a broader range of different hydrologic conditions. The historical water budget applied an evolving level of development and agricultural demand throughout a 28-year historical hydrology.

Additional details of the data used in the development of the historical calibration can be found in the published model report (Appendix 2-C).

The historical calibration includes the following:

- Hydrologic period: Water Years 1996-2023 (28-year hydrology)
- Stream Flows for Water Years 1996-2023:
    - Dry Creek: No streamflow gaging stations were available for Dry Creek; as such, flow estimates from the DWR's California Central Valley surface and groundwater Model (C2VSim-FG v1.01) were used for water years 1996-2015 . For 2015-2023, an average of historical data by month and water year type was used.
    - Mokelumne River: Historical records from USGS (Mokelumne River below Camanche Dam, CA)
    - Calaveras River: New Hogan Dam releases
    - Stanislaus River: Historical records from USGS (Stanislaus River below Goodwin Dam near Knights Ferry, CA)
    - San Joaquin River: Historical records from USGS (San Joaquin River near Vernalis, CA)
- Reservoir Operations: Upstream reservoirs regulating streamflows into the Subbasin include Pardee Reservoir and Camanche Reservoir on the Mokelumne River; New Hogan Reservoir on the Calaveras River; and New Melones Reservoir, Tulloch Reservoir, and Goodwin Reservoir on the Stanislaus River. As reservoir releases are regulated, no changes to the historical operations of the reservoirs are assumed. In addition, two other local reservoirs are included in the model: Woodward and Farmington. The model estimates seepage contributions from these reservoirs to the groundwater system. Water supply deliveries from these reservoirs are based on records provided by the agencies responsible for operation of these reservoirs.
- Land use and cropping patterns are based on the DWR land use surveys (assumed to represent water year 1995), and the recent, comprehensive, and Subbasin-wide land use survey from DWR as prepared by Land IQ from 2016-2022 (CA DWR, 2014). Local data and information were also utilized to refine and update the cropping patterns, as needed. To fill the gap between 1995 and 2016, all land use and crop categories were interpolated at the spatial resolution level of the model elements to simulate the geographic distribution of various crops.
- Urban water demand is calculated for all the urban areas in the model. Urban centers in Eastern San Joaquin Subbasin are City of Escalon, Linden, Lockeford, City of Lodi, City of Manteca, City of Ripon, and City of Stockton. Demands for other domestic areas are estimated based on rural population. Urban water demand is based on:
    - Urban water use from 2020 Urban Water Management Plans (Cal Water; Calaveras County Water District [CCWD], Cities of Lodi, Manteca, and Stockton; Stockton East Water District [SEWD]; and South San Joaquin Irrigation District [SSJID]) or municipal pumping records, used to calculate the per capita water use for each urban center.
    - Urban center population from Urban Water Management Plans (UWMPs), United States Census Bureau, or the California Department of Finance.
- Surface Water Deliveries:

  - Deliveries to agricultural areas: Obtained from agricultural entities in the Subbasin, including Central San Joaquin Water Conservation District (CSJWCD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), SEWD, SSJID, and Woodbridge Irrigation District (WID)
  - Deliveries to urban areas: Cities of Lodi, Manteca, and Stockton (including Cal Water and City of Stockton service areas, and unincorporated San Joaquin County areas)
  - Recharge projects: SEWD's Farmington Groundwater Recharge Program; NSJWCD's Tracy Lakes Recharge Project; NSJWCD's CALFED groundwater recharge project; Tecklenburg Recharge Project; and NSJWCD's FloodMAR recharge projects
  - Riparian diversions: CCWD, Delta areas, and data from C2VSim-FG for riparian diversions off major streams (Dry Creek, Mokelumne River, Calaveras River and related streams, Stanislaus River, San Joaquin River) (C2VSim-FG v1.01)
- Groundwater Pumping:
  - District pumping for agricultural/landscape uses: City of Manteca, OID, City of Ripon, and SSJID
  - District pumping for urban uses: Cal Water, City of Escalon, Linden County WD, Lockeford CSD, City of Lodi, City of Manteca, City of Ripon, SEWD, and City of Stockton
  - Data on private pumping was not available on a consistent basis across the model, so private pumping was estimated as that which would be required to meet agricultural and rural residential water needs as calculated by the ESJWRM model based on consumptive use methodology (Refer to the ESJWRM documentation for details).

2.4.4.2 Assumptions Used in the Current Water Budget

A current conditions estimate using the Historical ESJWRM Version 3.0 was developed for use in estimating the current water budget. The current conditions estimate is comprised of the average of historical model water years 2019-2023 in order to estimate current inflows and outflows for the Subbasin. Current conditions are not necessarily indicative of one year and are instead a compilation of data assumed representative of Subbasin recent conditions. The definition of current conditions, by nature, will continuously change. The current water budget represents the current conditions as of the time of the 2024 GSP.

2.4.4.3 Assumptions Used in the Projected Water Budget

The projected water budget is intended to assess the conditions of the Subbasin under future conditions of water supply and agricultural and urban demand, including quantification of uncertainties in the components. The projected conditions scenario applies future land and water use conditions and uses the 55-year hydrologic period of water years 1969-2023. Projections are assumed to represent a buildout level of development (approximately year 2040) and are represented using projected population, land use, and water demand and supply projections. Results of the projected conditions scenario under potential climate change conditions (changes to precipitation, stream flows, and evapotranspiration) are presented in Section Error! Reference source not found..

The projected conditions scenario includes the following conditions:

- Hydrologic Period: Water Years 1969-2023 (55-year hydrology)
- Stream Flows for Water Years 1969-2023:
    - Dry Creek: No streamflow gaging stations were available for Dry Creek; as such, flow estimates from the DWR's C2VSim-FG were used (C2VSim-FG v1.01)
    - Mokelumne River: Historical records from USGS (Mokelumne River below Camanche Dam, CA)
    - Calaveras River: Historical records from USGS (Calaveras River below New Hogan Dam near Valley Springs, CA) and New Hogan Dam releases
    - Stanislaus River: Historical records from USGS (Stanislaus River below Goodwin Dam near Knights Ferry, CA)
    - San Joaquin River: Historical records from USGS (San Joaquin River near Vernalis, CA)
- Reservoir Operations: Upstream reservoirs regulating streamflows into the Subbasin include Pardee Reservoir and Camanche Reservoir on the Mokelumne River; New Hogan Reservoir on the Calaveras River; and New Melones Reservoir, Tulloch Reservoir, and Goodwin Reservoir on the Stanislaus River. The projected conditions scenario assumes that the historical operations of the reservoirs over the 50-year hydrologic records were in place and no changes are made.
- Land use and cropping patterns are based on the most recent, comprehensive, and Subbasin-wide land use survey from DWR as prepared by Land IQ (CA DWR, 2014), with adjustments based on local information and input. Urban areas expand to either the sphere of influence or general plan boundaries and are held constant during the simulation. Cropping acreage is reduced only where urban expansion occurs.
- Urban water demands are calculated for all the urban areas in the model. Urban centers in Eastern San Joaquin Subbasin are City of Escalon, Linden, Lockeford, City of Lodi, City of Manteca, City of Ripon, and City of Stockton. Demands for other domestic areas are estimated based on rural population. Urban water demand is based on:
    - Urban water use estimated from projections in the 2020 Urban Water Management Plans (Cal Water; CCWD, Cities of Lodi, Manteca, Ripon, and Stockton; SEWD; and SSJID) or municipal pumping records, used to calculate the per capita water use for each urban center in the future (approximately 2040 or 2045).
    - Urban center population projections from the San Joaquin Council of Governments.
- Surface water delivery projections for the 55-year period were estimated based on the historical records of diversions by water year type, surface water rights or agreements, and potential planned changes/upgrades to the surface water diversion facilities. Surface water diversion estimates reflecting projected conditions using currently available information and knowledge were provided to each GSA for review and comment, and appropriate adjustments were made to the estimated record to reflect the surface water diversion projections for each entity. Surface water deliveries include:
    - Deliveries to agricultural areas: CSJWCD, NSJWCD, OID, SEWD, SSJID, and WID
    - Deliveries to urban areas: Cities of Lodi, Manteca, and Stockton (including Cal Water and City of Stockton service areas, and unincorporated San Joaquin County areas)

- Recycling or recharge projects: Recycled water for Cities of Lodi and Manteca; SEWD's Farmington Groundwater Recharge Program; NSJWCD's Tracy Lakes Recharge Project; and NSJWCD's CALFED groundwater recharge project

- Riparian: CCWD, Delta areas, and data from C2VSim for riparian diversions off major streams (Dry Creek, Mokelumne River, Calaveras River, Stanislaus River, and San Joaquin River)

- As private groundwater pumping was estimated by ESJWRM in the historical calibration, there is no local estimate of projected private groundwater pumping available on a consistent basis across the model. Therefore, groundwater pumping to meet agricultural and rural residential needs is calculated by the model based on meeting remaining demands after surface water deliveries are made. Demand in areas with no access to surface water is completely met by groundwater pumping. Additional details on the estimation of private groundwater pumping in ESJWRM can be found in the published model report (Appendix 2-A).

Additional details of the data used in the development of the projected conditions baseline can be found in the published model report (Appendix 2-C).

2.4.4.4 Assumptions Used in the Projected Water Budget, with Climate Change

The projected water budget with climate change is intended to assess the conditions of the Subbasin under future conditions of water supply and agricultural and urban demand, with the additional impact of climate change on the available water supply and agricultural demand. The projected conditions scenario with climate change is based on the projected conditions scenario without climate change and therefore all assumptions listed in Section **Error! Reference source not found.** remain, except where noted below. A future scenario of 2070 climate forecasts was evaluated in this analysis, consistent with DWR guidance. DWR combined 10 global climate models (GCMs) for two different representative climate pathways (RCPs) to generate the central tendency scenarios in the datasets used in this analysis. The "local analogs" method (LOCA) was used to downscale these 20 different climate projections to a scale usable for California (DWR, 2018a). The 2070 central tendency (2070 CT) among these projections serves to assess impacts of climate change over the long-term planning and implementation period.

The following model inputs were adjusted in the 2070 CT climate change scenario:

- Stream Flow: Flows for Central Valley rivers are divided into impaired and unimpaired. In the Subbasin, Dry Creek and Mokelumne River are unimpaired rivers. Projected conditions scenario stream flows are modified by applying perturbation factors provided by DWR. Calaveras, San Joaquin, and Stanislaus Rivers are all impaired rivers. CalSim II estimated flows, also provided by DWR, were used to simulate stream flows under climate change for impaired rivers.

- Precipitation: Precipitation was modified using the perturbation factors provided by DWR, where available.

- Evapotranspiration: Evapotranspiration (ET) was modified using the perturbation factors provided by DWR, where available.

Additional details of the data used in the development of the projected conditions with climate change scenario can be found in the published model report (Appendix 2-C).

2.4.4.5 Updates to Water Budgets

Following submittal of the Eastern San Joaquin Subbasin GSP in January of 2020, the ESJWRM was revised to correct data relating to historical surface water deliveries and to include additional data for Water Year (WY) 2016 through WY 2023. Specifically, the following data sets were updated in ESJWRM:

- The hydrologic period was extended to include WY 2016-2023 with the precipitation data mapped accordingly.
- Model layering was updated based on Airborne Electromagnetic (AEM) data
- Changes to land use were made with the simulated land uses mapped to the statewide crop mapping released by DWR in 2016 through 2022. USDA CropScape data was removed from the model and interpolation was updated from 1995 to 2016 datasets.
- Stream inflows were extended through WY 2023 using the same data sources as in the original version.
- Populations were updated for WY 2016 through 2023, and urban demands revised accordingly. Rural residential urban demand was updated to use
- Surface water deliveries were extended to WY 2023 and additional surface water deliveries that were not previously simulated were added to the model, including Farmington Reservoir seepage.
- Groundwater pumping volumes were extended to WY 2023 and the Modesto Subbasin wells, additional OID, Cal Water, Manteca, and SSJID wells were added to the model.
- Agricultural water operations were updated to extend through WY 2023.

The ESJWRM simulation period was extended to simulate Water Years 1995 through 2023 and the model recalibrated for the extended period. As a result of the two major model updates, both the historical and projected water budgets were revised in 2021 and 2024 to reflect the new data sets used in the model. See Appendix 2-C for additional details on the updates made to the ESJWRM.

2.4.5Water Budget Estimates

The ESJWRM simulates the major hydrologic processes that affect the land surface, stream, and groundwater systems in the Eastern San Joaquin Subbasin. The major hydrologic processes can be represented by separate water budgets which detail inflows and outflows occurring at the stream scale (budget on surface water flows occurring in the Subbasin), land surface scale (budget balancing how demands on urban, agricultural, and native lands are met by rainfall, surface water deliveries, or groundwater pumping), and groundwater scale (budget detailing flows occurring within the groundwater aquifers of the Subbasin).

The primary components of the stream system are:

- Inflows:
  - Stream inflows
  - Stream gain from the groundwater system
  - Runoff to the stream system from precipitation
  - Return flow to the stream system from irrigation water
- Outflows:

- Stream outflows
- Stream seepage (i.e., losses to the groundwater system)
- Surface water diversions
- Riparian intake from streams

The primary components of the land surface system are:

- Inflows:
  - Precipitation
  - Surface water supplies to meet agricultural or urban and industrial uses
  - Groundwater pumping (i.e., groundwater supplies to meet agricultural or urban and industrial uses)
  - Riparian intake from streams
- Outflows:
  - Evapotranspiration
  - Runoff to the stream system
  - Return flow to the stream system
  - Deep percolation from precipitation, applied water (surface water and groundwater) for agricultural lands, and applied water (surface water and groundwater) for outdoor use in the urban areas or industrial purposes

The primary components of the groundwater system are:

- Inflows:
  - Deep percolation from precipitation, applied water (surface water and groundwater) for agricultural lands, and applied water (surface water and groundwater) for outdoor use in the urban areas or industrial purposes
  - Stream seepage (i.e., losses to the groundwater system)
  - Other recharge (including unlined canals/reservoir seepage, local tributaries seepage, and Managed Aquifer Recharge [MAR] projects)
  - Subsurface inflow
- Outflows:
  - Groundwater outflow to streams (i.e., stream gain from the groundwater system)
  - Groundwater pumping
  - Subsurface outflow

- Change in Groundwater Storage (Inflows Minus Outflows): This reflects average annual change in groundwater storage

The revised ESJWRM Version 3.0 estimated water budgets for the historical, current conditions, projected conditions, and projected conditions with climate change scenarios are provided below, with results summarized in **Error! Reference source not found.** through **Error! Reference source not found.**. Differences between the original and revised scenarios are discussed further in the documentation in Appendix 2-C.

Table 2-14: Average Annual Water Budget for Revised ESJWRM (Version 3.0) – Stream System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Model Version	Historical ESJWRM Version 3.0	Historical ESJWRM Version 3.0	ESJWRM PCBL Version 3.0	ESJWRM PCBL-CC Version 3.0
Hydrologic Period	Water Years 1996-2023 (28-Year period)	Water Years 2019-2023 (5-Year average)	Water Years 1969- 2023 (55-Year period)	Water Years 1969- 2023 (55-Year period)
Inflows				
Stream Inflows[1]	4,221,000	4,224,000	4,519,000	4,929,000
Stream Gain from Groundwater[2]	145,000	130,000	121,000	115,000
Eastern San Joaquin Subbasin	75,000	63,000	57,000	53,000
Dry Creek[11]	0	0	0	0
Mokelumne River	14,000	13,000	10,000	8,000
Calaveras River	1,000	1,000	1,000	1,000
Stanislaus River	28,000	18,000	17,000	16,000
San Joaquin River	31,000	31,000	29,000	27,000
Other Subbasins[4]	70,000	67,000	65,000	62,000
Dry Creek	23,000	29,000	28,000	27,000
Mokelumne River	0	0	0	0
Stanislaus River	27,000	19,000	17,000	16,000
San Joaquin River	20,000	20,000	19,000	18,000
Runoff to the Stream System[5]	629,000	741,000	656,000	753,000
Return Flow to Stream System[6]	96,000	95,000	111,000	112,000
Total Inflow[10]	5,092,000	5,190,000	5,407,000	5,908,000
Outflows				
Stream Outflows[7]	4,426,000	4,469,000	4,655,000	5,108,000
Stream Seepage[2]	284,000	331,000	374,000	420,000
Eastern San Joaquin Subbasin	236,000	267,000	298,000	330,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	125,000	135,000	150,000	160,000
Calaveras River	37,000	37,000	39,000	41,000
Stanislaus River	36,000	55,000	67,000	82,000
San Joaquin River	37,000	37,000	40,000	45,000

Other Subbasins[4]	47,000	65,000	76,000	90,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	3,000	3,000	3,000	4,000
Stanislaus River	30,000	47,000	56,000	69,000
San Joaquin River	12,000	12,000	14,000	14,000
Surface Water Diversions[8]	340,000	353,000	340,000	340,000
Riparian Intake from Streams[9]	42,000	37,000	37,000	40,000
Total Outflow[10]	5,092,000	5,190,000	5,407,000	5,908,000

Notes:

1 Stream inflows into Eastern San Joaquin Subbasin include flows from Dry Creek, Mokelumne River, Calaveras River, Stanislaus River, San Joaquin River, and estimated tributary flows. Differences between historical and current/projected flows are due to differing hydrologic periods.

2 Stream gain from groundwater and stream seepage represent the interaction of surface water and groundwater. Differences between the scenarios are related to differences in streamflows and long-term average groundwater elevations. Projected scenarios and even current condition averages represent lower groundwater levels, causing less stream interaction.

3 Local tributaries include Bear Creek and related streams, Little Johns Creek, Duck Creek, and Lone Tree Creek.

4 Other subbasins include the Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy Subbasins. Stream-aquifer interaction with the other subbasins was included for streams on the boundaries of the Eastern San Joaquin Subbasin.

5 Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff of precipitation (due to more paved areas), the changes in runoff between the model scenarios are due to differences in the urban areas in the scenarios, as well as the amount of precipitation occurring. The historical calibration, with both less precipitation (due to more dry years than wet in the 28-year period) and smaller urban areas, has a corresponding smaller runoff. The current conditions scenario uses urban areas at the end of the historical calibration, while the projected scenario includes urban buildout to sphere of influence or general plan boundaries and therefore has more runoff.

6 Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural or municipal purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand and therefore correspondingly higher applied water to meet that demand resulting in greater urban return flows (i.e., discharge of treated wastewater).

7 Stream outflows occur at the edge of Eastern San Joaquin Subbasin at the confluence of the San Joaquin and Mokelumne Rivers.

8 Surface water diversions shown in this table are the volumes of water taken directly off the river prior to any losses due to evaporation or canal seepage. These numbers do not include surface water directly diverted from simulated stream nodes (i.e., water taken off Stanislaus River occurs just upstream in the Subbasin). Differences between scenarios are due to differences in historical, current, and planned surface water diversions.

9 Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by streamflows. Differences between scenarios may be due to availability of streamflows or extent of riparian vegetation, which may be affected by growth in urban areas.

10 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

11 Values smaller than 500 AF/year are represented by a dash (-).

Table 2-15: Average Annual Water Budget for Revised ESJWRM – Land Surface System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Model Version	Historical ESJWRM Version 3.0	Historical ESJWRM Version 3.0	ESJWRM PCBL Version 3.0	ESJWRM PCBL-CC Version 3.0
Hydrologic Period	Water Years 1996-2023 (28-Year period)	Water Years 2019-2023 (5-Year average)	Water Years 1969- 2023 (55-Year period)	Water Years 1969- 2023 (55-Year period)
Inflows				
Precipitation[1] (Precipitation, inches)	988,000 (15.5)	1,063,000 (16.7)	992,000 (15.6)	1,087,000 (17.1)
Total Surface Water Supply[2]	568,000	562,000	525,000	525,000
Agricultural	512,000	497,000	452,000	452,000
Urban and Industrial	56,000	65,000	73,000	73,000
Total Groundwater Supply[3]	732,000	830,000	799,000	879,000
Agricultural	666,000	777,000	732,000	812,000
Urban and Industrial	66,000	53,000	67,000	67,000
Riparian Intake from Streams[4]	30,000	26,000	26,000	29,000
Total Inflow[10]	*2,318,000*	*2,481,000*	*2,342,000*	*2,521,000*
Outflows				
Evapotranspiration[5]	1,309,000	1,352,000	1,302,000	1,384,000
Agricultural	1,006,000	1,080,000	999,000	1,089,000
Municipal and Domestic	59,000	58,000	80,000	81,000
Refuge, Native, and Riparian	243,000	213,000	214,000	214,000
Runoff to the Stream System[6]	629,000	741,000	656,000	753,000
Return Flow to the Stream System[7]	96,000	95,000	111,000	112,000
Agricultural	22,000	22,000	25,000	26,000
Municipal and Domestic	75,000	73,000	86,000	86,000
Deep Percolation[8]	275,000	284,000	270,000	268,000
Precipitation	60,000	53,000	55,000	52,000
Applied Surface Water – Agricultural	85,000	82,000	73,000	70,000
Applied Surface Water – Urban and Industrial	9,000	11,000	12,000	11,000
Applied Groundwater – Agricultural	111,000	129,000	119,000	125,000
Applied Groundwater – Urban and Industrial	11,000	9,000	11,000	10,000
Other Flows[9]	8,000	9,000	4,000	5,000
Total Outflow[10]	*2,318,000*	*2,481,000*	*2,342,000*	*2,521,000*

Notes:

[1] Precipitation is discussed in the identification of the hydrologic periods in 2.4.2. The projected conditions scenarios utilize the same 55 years of hydrology (water years 1969-2023) with perturbations in the climate change scenario causing more precipitation. The historical calibration has a shorter hydrologic period (28 years from 1996-2023) with slightly less precipitation on average. Current conditions represent recent years with 2 wet years (2019 and 2023) and 3 dry or critical years (2020, 2021, and 2022).

[2] Total surface water supply shown in this table is the volume of surface water diverted or transported to meet agricultural and urban demands minus estimated losses due to evaporation or canal seepage. Differences between scenarios are due to differences in historical, current, and planned surface water deliveries.

[3] Total groundwater supply in the scenarios is calculated based on meeting remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.

[4] Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by streamflows. Differences between scenarios may be due to availability of streamflows or extent of riparian vegetation, which may be affected by growth in urban areas.

[5] Evapotranspiration is the demand required by agricultural land (i.e., crops); municipal and domestic areas (i.e., industrial and urban demands); and refuge, native and riparian areas. Differences in evapotranspiration are largely related to differences in urban areas between the scenarios and the loss of agricultural or native/riparian land as urban growth occurs.

[6] Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff (e.g., more paved areas), the changes in runoff between the model scenarios are due to differences in the urban areas in the scenarios, as well as the amount of precipitation occurring. The historical calibration, with both less precipitation and smaller urban areas, has a corresponding smaller runoff. The current conditions scenario uses urban areas at the end of the historical calibration, while the projected scenario includes urban buildout to sphere of influence or general plan boundaries and therefore has more runoff.

[7] Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural or municipal purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand and therefore correspondingly higher applied water to meet that demand.

[8] Deep percolation is the amount of infiltrated water ultimately reaching the groundwater aquifer. The source of the water may be from precipitation or either applied surface water or groundwater used for agricultural or urban and industrial purposes. Differences between scenarios are related to differences between these sources of water and differences in the infiltration parameters related to land use.

[9] Other Flows captures the gains and losses due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones.

[10] Summations in table may not match the numbers in the table. This is due to the rounding of model results.

Table 2-16: Average Annual Water Budget for Revised ESJWRM – Groundwater System (AF/year)

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Model Version	Historical ESJWRM Version 3.0	Historical ESJWRM Version 3.0	ESJWRM PCBL Version 3.0	ESJWRM PCBL-CC Version 3.0
Hydrologic Period	Water Years 1996-2023 (28-Year period)	Water Years 2019-2023 (5-Year average)	Water Years 1969- 2023 (55-Year period)	Water Years 1969- 2023 (55-Year period)
Inflows				
Deep Percolation[1]	275,000	284,000	270,000	268,000
Precipitation	60,000	53,000	55,000	52,000
Applied Surface Water – Agricultural	85,000	82,000	73,000	70,000
Applied Surface Water – Urban and Industrial	9,000	11,000	12,000	11,000
Applied Groundwater – Agricultural	111,000	129,000	119,000	125,000
Applied Groundwater – Urban and Industrial	11,000	9,000	11,000	10,000
Stream Seepage[2]	236,000	267,000	298,000	330,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	125,000	135,000	150,000	160,000
Calaveras River	37,000	37,000	39,000	41,000
Stanislaus River	36,000	55,000	67,000	82,000
San Joaquin River	37,000	37,000	40,000	45,000
Other Recharge	170,000	174,000	165,000	168,000
Carriage/Canal Recharge	103,000	109,000	98,000	98,000
Managed Aquifer Recharge	5,000	9,000	11,000	11,000
Reservoir Seepage	17,000	14,000	14,000	14,000
Ungauged Watershed Drainage	45,000	42,000	45,000	48,000
Subsurface Inflow[3]	176,000	188,000	204,000	222,000
Cosumnes Subbasin	28,000	34,000	35,000	35,000
Sierra Nevada Mountains	55,000	54,000	57,000	55,000
Modesto Subbasin	30,000	32,000	37,000	41,000
South American Subbasin	3,000	4,000	5,000	6,000
Solano Subbasin	19,000	19,000	22,000	27,000
East Contra Costa Subbasin	9,000	10,000	11,000	13,000
Tracy Subbasin	31,000	34,000	37,000	44,000
Total Inflow[5]	**857,000**	**912,000**	**937,000**	**988,000**
Outflows				
Groundwater Outflow to Streams[2]	75,000	63,000	57,000	53,000
Dry Creek[6]	0	0	0	0
Mokelumne River	14,000	13,000	10,000	8,000
Calaveras River	1,000	1,000	1,000	1,000
Stanislaus River	28,000	18,000	17,000	16,000
San Joaquin River	31,000	31,000	29,000	27,000
Groundwater Pumping[4]	732,000	830,000	799,000	879,000
Agricultural	666,000	777,000	732,000	812,000
Urban and Industrial	66,000	53,000	67,000	67,000
Subsurface Outflow[3]	96,000	104,000	110,000	111,000
Cosumnes Subbasin	27,000	32,000	36,000	37,000
Modesto Subbasin	40,000	44,000	44,000	46,000

Component	Historical Calibration (AF/year)	Current Conditions (AF/year)	Projected Conditions (AF/year)	Projected Conditions with Climate Change (AF/year)
Model Version	Historical ESJWRM Version 3.0	Historical ESJWRM Version 3.0	ESJWRM PCBL Version 3.0	ESJWRM PCBL-CC Version 3.0
Hydrologic Period	Water Years 1996-2023 (28-Year period)	Water Years 2019-2023 (5-Year average)	Water Years 1969- 2023 (55-Year period)	Water Years 1969- 2023 (55-Year period)
South American Subbasin[6]	1,000	1,000	0	0
Solano Subbasin	11,000	11,000	11,000	10,000
East Contra Costa Subbasin	2,000	2,000	2,000	2,000
Tracy Subbasin	16,000	14,000	17,000	16,000
Total Outflow[5]	903,000	997,000	965,000	1,043,000
Change in Groundwater Storage (Inflows Minus Outflows)				
Change in Groundwater Storage[5]	(48,000)	(89,000)	(30,000)	(56,000)

Notes:

1 Deep percolation is the amount of infiltrated water ultimately reaching the groundwater aquifer. The source of the water may be from precipitation, as well as either applied surface water or groundwater used for agricultural or urban and industrial purposes. Differences between scenarios are related to differences between these sources of water and differences in urban versus agricultural land use totals.

2 Stream gain from groundwater and stream seepage represent the interaction of surface water and groundwater. Differences between the scenarios are related to differences in streamflows and long-term average groundwater elevations.

3 The goal of projecting inter-basin flows is to maintain a reasonable balance between the neighboring groundwater subbasins. The resulting projected conditions scenario flows are within 10-15% of historical calibration flows, considered a reasonable range given the availability of projected land use, population, surface water delivery, and groundwater production data from areas outside of the Eastern San Joaquin Subbasin. Continuing inter-basin coordination may refine these numbers.

4 Groundwater pumping is estimated by the ESJWRM based on the need for additional water to meet remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.

5 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

6 Values smaller than 500 AF/year are represented by a dash (-).

2.4.5.1 Historical Water Budget Estimates (Historical ESJWRM Version 3.0)

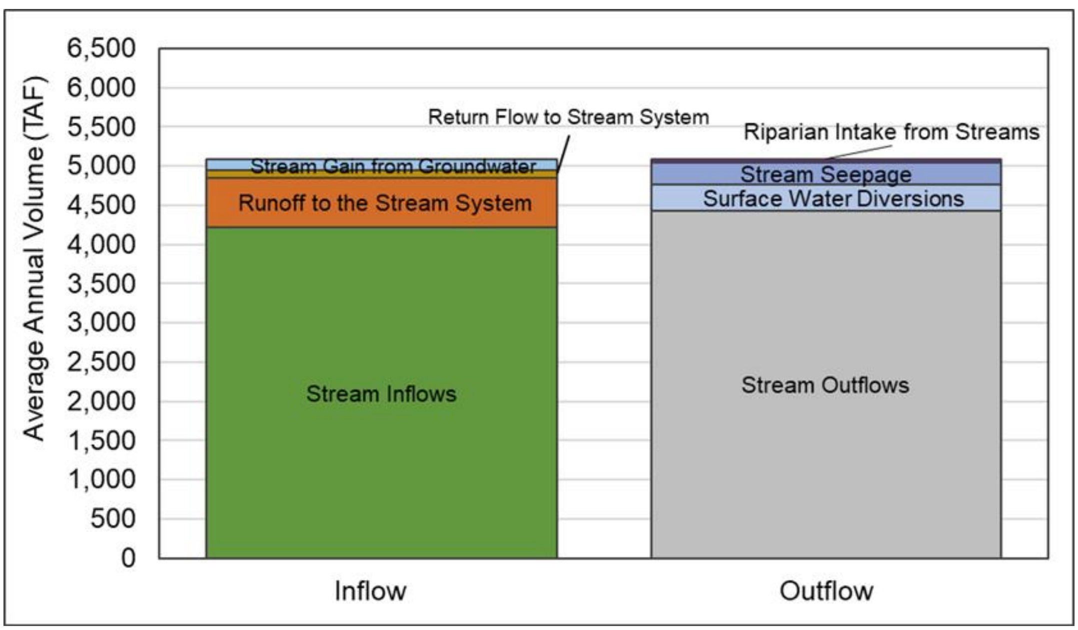
The historical water budget is a quantitative tabulation of the historical surface and groundwater supply represented in the historical calibration of the ESJWRM covering the 28-year period of water years 1996-2023. The ESJGWA selected this period as the representative hydrologic period to calibrate and reduce the uncertainty of the ESJWRM. Proper analysis and calibration of water budgets using the ESJWRM assures the hydrologic characteristics of the groundwater basin are well simulated. The historical calibration is discussed in detail in the historical model documentation (Appendix 2-A). CCR Title 23 § 354.18, the water budget includes estimates for supply and demand, while summarizing flows within the Subbasin, including the movement of all primary sources of water such as precipitation, agricultural water supplies, streamflow, and subsurface flows.

Subsequent to completion and submittal of the GSP in January of 2020, the ESJWRM was updated to include new data sets extending the simulation period to encompass WY 1996 through 2020. It was then updated again in 2024 to extend the simulation period from WY 1996 through 2023. These model updates, recalibration, and the associated results are documented in Appendix 2-C of this GSP.

The existing stream network supplies water to multiple agricultural water users and municipalities in the Eastern San Joaquin Subbasin. When analyzing the water budget for the stream system, it is important to note potentially significant effects due to the interactions and managed operations of adjacent groundwater subbasins on streams coinciding with the boundaries of the Subbasin (i.e., Dry Creek, portions of the Mokelumne River, San Joaquin River, and Stanislaus River). The summary of water budget assumptions presented in Table 2-13 and Figure 2-109 not only quantifies the surface water system within the Subbasin, but also estimates contributions from adjoining subbasins.

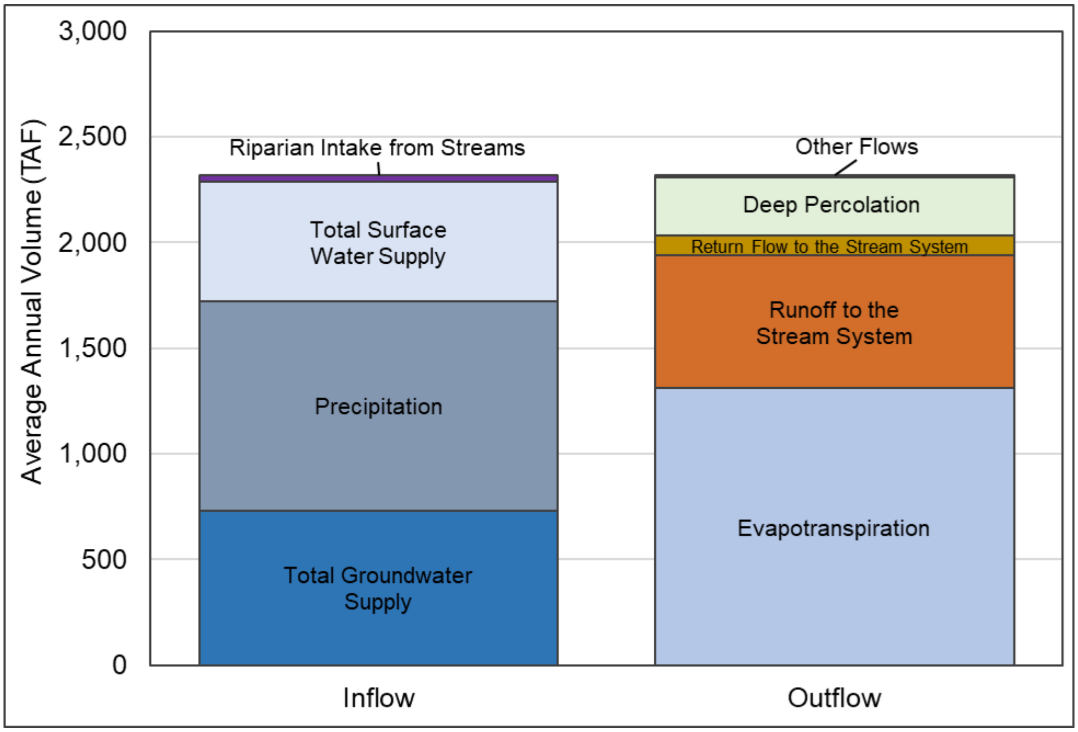
The stream system inflows through or along the Subbasin boundary simulated in the historical calibration average is 5.1 MAF/year. The majority of these flows, almost 4.2 MAF/year, enter the Subbasin as stream inflows to the Subbasin. Three other surface water inflows are estimated stream gains from the groundwater system (145,000 AF/year), runoff of precipitation to the stream system (629,000 AF/year), and return flow of applied water to the stream system (96,000 AF/year). Outflows of the Eastern San Joaquin Subbasin stream system total 5.1 MAF/year and include downstream outflows leaving the Subbasin (almost 4.4 MAF/year), stream seepage to the groundwater system (284,000 AF/year), surface water diversions (340,000 AF/year), and riparian vegetation intake from streams (42,000 AF/year).

Figure 2-109: Historical Average Annual Water Budget – Stream System



The land surface system water budget in the historical calibration of the Eastern San Joaquin Subbasin, shown below in Figure 2-110, estimates almost 2.3 MAF/year of inflows, a combination of precipitation (988,000 AF/year), surface water supply (568,000 AF/year), groundwater supply (732,000 AF/year), and riparian intake from streams (30,000 AF/year). The outflow from the land surface system in the historical calibration estimates evapotranspiration (close to 1.3 MAF/year), runoff of precipitation to the stream system (629,000 AF/year), return flow of applied water to the stream system (96,000 AF/year), deep percolation of precipitation or applied water (275,000 AF/year), and a small component representing other flows (8,000 AF/year), which includes uncertainties in other components due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones.

Figure 2-110: Historical Average Annual Water Budget – Land Surface System

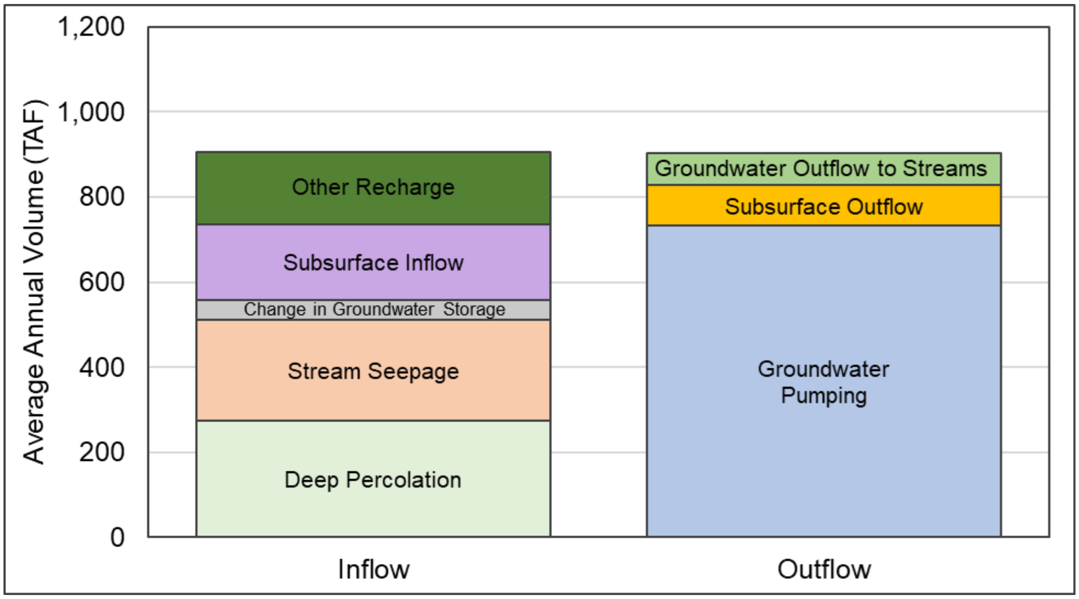


The groundwater system of the Eastern San Joaquin Subbasin includes 905,000 AF/year of inflows in the historical calibration (not including change in groundwater storage), of which 275,000 AF/year is deep percolation of precipitation or applied water. There is also stream seepage (236,000 AF/year), other recharge (170,000 AF/year), and subsurface inflows (176,000 AF/year) from the Sierra Nevada Mountains and the neighboring groundwater subbasins of Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy. On average, the inflows do not meet the entire groundwater demand. The primary outflow from the groundwater system is pumping (732,000 AF/year), followed by groundwater outflow to streams (75,000 AF/year), and subsurface outflow to the neighboring groundwater subbasins (96,000 AF/year).

The Eastern San Joaquin Subbasin average historical groundwater budget has greater outflows than inflows, leading to an estimated average annual decrease in groundwater storage of approximately 48,000 AF/year. Figure 2-111 summarizes the average historical calibration groundwater inflows and outflows of the Eastern San Joaquin Subbasin.

A groundwater change in storage, or overdraft, estimate of 48,000 AF/year represents a refinement over previous efforts which have estimated levels of overdraft for the Subbasin to be between 70,000 AF and 150,000 AF annually. Such previous efforts include the DWR's 2003 Bulletin 118 study (CA DWR, 2003) and modeling conducting as part of the SJCFCWCD's 2001 Water Management Plan (SJCFCWCD, 2001) and presented in the 2004 Eastern San Joaquin Groundwater Basin Groundwater Management Plan (NSJCGBA, 2004). The analysis presented in this Plan represents the best available information to date. These estimates, which are the result of several years of collaboration between agencies prior to Plan development, utilize new data and modeling capabilities not captured in prior modeling efforts. A portion of the reduction seen in the overdraft estimate is also the result of converting from groundwater use to surface water supplies that has occurred since the development of previous estimates. For additional discussion of refinements that occurred in the development of the ESJWRM (Woodard & Curran, 2018), see Appendix 2-A.

Figure 2-111: Historical Average Annual Water Budget Estimates – Groundwater System



Historical inflows and outflows change by water year type as defined by the San Joaquin Valley Water Year Hydrologic Classification (CA DWR, 2018a). In wet years, precipitation meets more of the water demand and greater availability of surface water reduces the need for groundwater pumping. However, in dry years, more groundwater is pumped to meet the demand not met by surface water or precipitation. This may lead to an increase in groundwater storage in wet years and a decrease in dry years. Table 2-17breaks down the average historical water supply and demand by water year type.

The historical calibration focuses on representing changing conditions and operations, such as new agricultural land or crop types, new surface water diversions, and population growth. The timing of these changes is often independent of the hydrologic conditions of the year in question; therefore, looking at supplies and demands averaged by water year type does not necessarily present clear results. Furthermore, the 28 years represented in the historical calibration do not include an equal number of each water year type, making averages less reliable to gather historical trends. As the projected conditions scenario considered the water year type in some of the model inputs and the 55-year hydrologic period allows for greater repetition of the water year types, the projected conditions results presented later in Section 2.4.5.3 are more consistent with the trends expected when averaging by water year type.

Table 2-17: Average Annual Values for Key Components of Historical Water Budget by Year Type

Component	Water Year Type (San Joaquin River Index)					
	Wet	Above Normal	Below Normal[1]	Dry	Critical	28-Year
Number of Years[2]	9	3	2	7	7	28
Precipitation, AF/year (Precipitation, inches)	1,409,000 (22.1)	944,000 (14.8)	867,000 (13.6)	805,000 (12.6)	684,000 (10.7)	988,000 (15.5)
Water Demand (AF/year)						
Ag Demand[3]	1,143,000	1,114,000	1,168,000	1,167,000	1,225,000	1,168,000
Urban Demand[4]	117,000	122,000	122,000	125,000	123,000	122,000
Total Demand[7]	*1,260,000*	*1,236,000*	*1,290,000*	*1,293,000*	*1,348,000*	*1,290,000*
Water Supply (AF/year)						
Total Surface Water Supply[5]	556,000	597,000	557,000	572,000	569,000	568,000
Agricultural	503,000	544,000	501,000	517,000	507,000	512,000
Urban and Industrial	53,000	53,000	56,000	55,000	62,000	56,000
Total Groundwater Supply[6]	713,000	648,000	741,000	731,000	791,000	732,000
Agricultural	648,000	578,000	675,000	660,000	728,000	666,000
Urban and Industrial	65,000	70,000	67,000	71,000	62,000	66,000
Total Supply (AF/year)[7]	*1,268,000*	*1,245,000*	*1,298,000*	*1,303,000*	*1,360,000*	*1,300,000*
Change in Groundwater Storage (AF/year)[7]	*78,000*	*13,000*	*-82,000*	*-105,000*	*-170,000*	*-48,000*

Notes:

1 There was only two below normal water yeas in the historical calibration (water year 2003 and 2018), so averages are just based on model results for two water years. Since there weren't any more below normal years to use in the average, results for the below normal water year type may not follow expected trends.

2 List of historical water budget water years by water year type:
Wet: 1996, 1997, 1998, 2005, 2006, 2011, 2017, 2019, 2023
Above Normal: 1999, 2000, 2010
Below Normal: 2003, 2018
Dry: 2001, 2002, 2004, 2009, 2012, 2016, 2020
Critical: 2007, 2008, 2013, 2014, 2015, 2021, 2022

3 Agricultural demand is based on evapotranspiration by crop and acreages by crop. As agricultural land use changes over the historical calibration through changes in crop types and urbanization, averaging of the resulting agricultural demand is less a function of water year type than of the time in the simulation when that year type fell.

4 Urban demands in the historical water budget are reported values from cited sources. Averaging urban demands by water year type may not explicitly depict urban growth patterns during the historical calibration period.

5 Total surface water supply is based on information received from local entities and varied historically based on when surface water rights or agreements occurred. As some entities received new surface water sources during the historical calibration period, averaging by water year type depends more on when the water year types occurred in the simulation.

6 Total groundwater supply is pumping as estimated by the ESJWRM is a function of demand, precipitation, and surface water. Differences between water year types for groundwater pumping are more related to differences in these components.

7 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

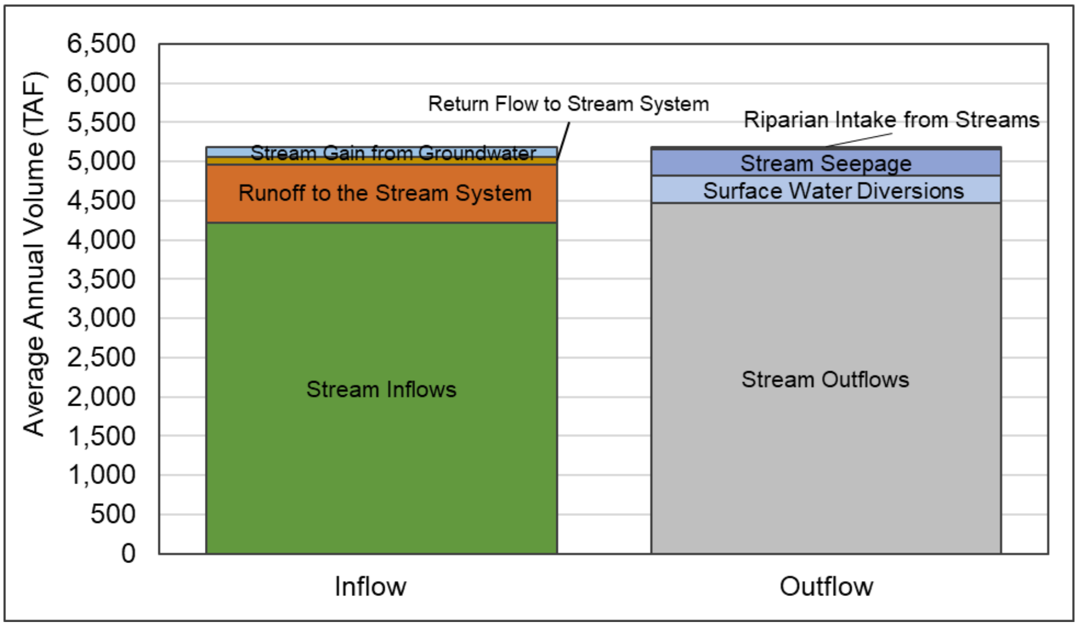
2.4.5.2 Current Water Budget Estimates (Historical ESJWRM Version 3.0)

The current water budget quantifies inflows to and outflows from the Subbasin using the most recent 50 years of hydrology, water supply, water demand, and land use information.

The outflows from the stream system in the current conditions scenario include 353,000 AF/year of surface water diversions occurring in the Subbasin from simulated streams. In addition, on average, over 4.5 MAF/year leaves the Subbasin's stream system as downstream outflow of the San Joaquin River and Mokelumne River, 331,000 AF/year is lost as stream seepage to the groundwater system, and 37,000 AF/year is used by riparian vegetation as riparian intake from streams.

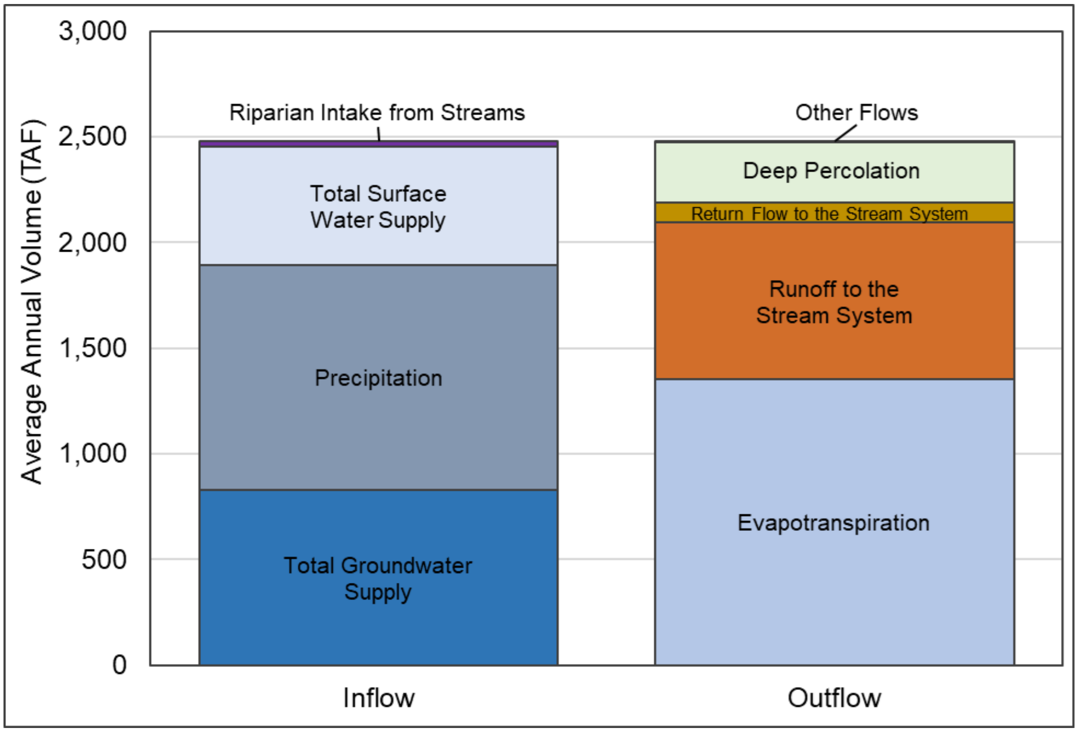
These demands are met by an estimated 4.2 MAF/year of stream inflows, 741,000 AF/year of runoff of precipitation to the stream system, 95,000 AF/year of return flow of applied water to the stream system, and 130,000 AF/year of stream gain from the groundwater system. Figure 2-112 summarizes the average annual inflows and outflow of the current conditions scenario in the Eastern San Joaquin Subbasin stream network.

Figure 2-112: Current Average Annual Water Budget Estimates – Stream System



Over the 5-year recent hydrologic period, the current conditions land surface water budget shows average annual inflows of almost 2.5 MAF/year, including 1.1 MAF/year of precipitation, 1.4 MAF/year of applied water (562,000 AF/year of surface water supply and 830,000 AF/year of groundwater supply), and 26,000 AF/year of riparian intake from the stream system. Approximately 2.5 MAF/year of outflows include evapotranspiration (1.4 MAF/year), runoff to the stream system of precipitation (741,000 AF/year), return flow to the stream system of applied water (95,000 AF/year), deep percolation (284,000 AF/year), and other flows due to land expansion and temporary storage in the root-zone and vadose zones (9,000 AF/year). Figure 2-113 summarizes the average annual current conditions inflows and outflows in the land surface budget for the Eastern San Joaquin Subbasin.

Figure 2-113: Current Average Annual Water Budget Estimates – Land Surface System

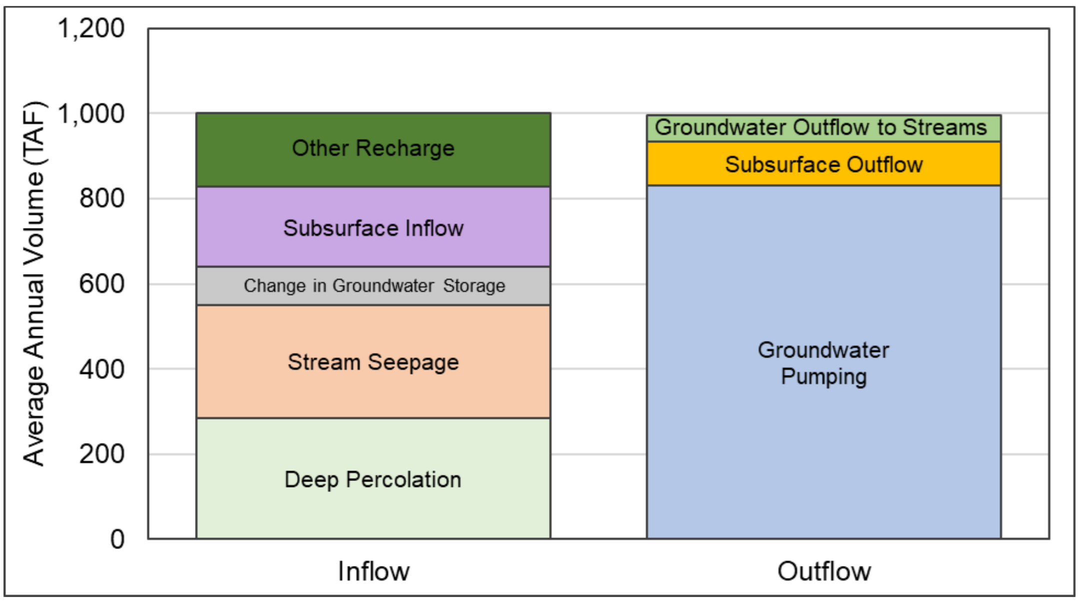


The current conditions scenario averages 5 years of recent hydrology with conditions approximately reflective of current Subbasin management and activities., The current conditions groundwater system water budget shows average annual inflows of 1 MAF/year, including 284,000 AF/year of deep percolation, 267,000 AF/year of stream seepage, 174,000 AF/year of other recharge (including canal and reservoir seepage and MAR projects), and subsurface inflows from surrounding subbasins and the Sierra Nevada Mountains totaling 188,000 AF/year.

Similar to the historical water budget, average groundwater system outflows exceed the inflows under current conditions. Groundwater pumping (830,000 AF/year) remains the largest portion of aquifer discharge, with subsurface outflows to surrounding subbasins (104,000 AF/year) and groundwater outflow or losses to the stream system (63,000 AF/year), bringing the total system outflows to under 1 MAF/year.

The Eastern San Joaquin Subbasin's current conditions groundwater budget has greater outflows than inflows, resulting in an average annual decline in groundwater storage of 89,000 AF/year. Figure 2-114 summarizes the average current conditions groundwater inflows and outflows in the Eastern San Joaquin Subbasin.

Figure 2-114: Current Average Annual Water Budget Estimates – Groundwater System



2.4.5.3 Projected Water Budget Estimates (ESJWRM PCBL Version 3.0)

The projected water budget is used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation. The projected conditions scenario of the ESJWRM is used to evaluate the projected conditions water budget assuming a 2040 level of development and using hydrology from water years 1969-2023. Results of the projected conditions scenario under potential climate change conditions (changes to precipitation, stream flows, and evapotranspiration) are presented in Section **Error! Reference source not found.**.

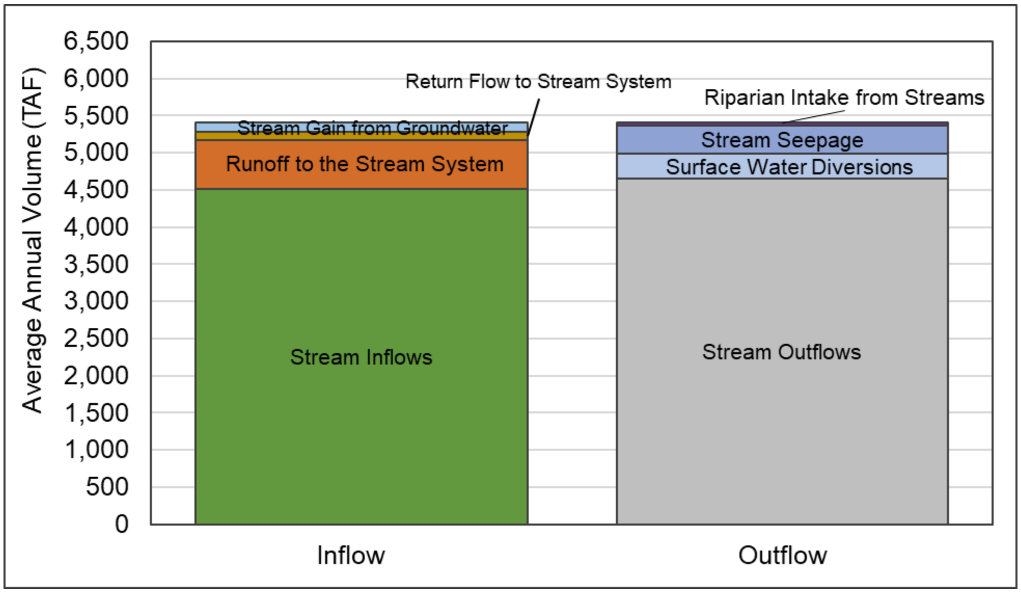
Subsequent to completion and submittal of the GSP in January of 2020, refinements and enhancements were made to the historical data for the updated historical ESJWRM, which in turn, required an update to the projected conditions baseline ESJWRM. The updated version of the Projected Conditions Baseline (PCBL) used the extended dataset and calibration results, along with updated data sources and assumptions for projected conditions, representing approximately WY 2040 conditions. This projected water budget update and the associated results are documented in Appendix 2-C of this revised GSP.

Development of the projected water demand is based on population growth trends reported by the San Joaquin Council of Governments, urban per capita water use consistent with projections in 2020 UWMPs, and urban area expansion from general plans or sphere of influence boundaries. An important assumption made in the projected water budget analysis is that due to projected urban growth, agricultural acreage is expected to decrease by approximately 22,000 acres. While there is agricultural growth anticipated in the eastern areas of the Subbasin and potential conversion of existing agricultural land to permanent irrigated crops, no reliable projections were available to include in the simulation; therefore, no additional agricultural land growth was added to the projected conditions scenario. An analysis of county agricultural reports can be performed to assess agricultural trends in future scenarios of the ESJWRM.

Average annual surface water inflows to the Eastern San Joaquin Subbasin's stream system total an average of over 5.4 MAF/year in the projected conditions scenario. Under projected conditions, stream inflows of almost 4.5 MAF/year are augmented by stream gains from groundwater of 121,000 AF/year and runoff of precipitation to the stream system (656,000 AF/year) and return flow of applied water to the stream system (111,000 AF/year). Of these inflows, it is anticipated that 340,000 AF/year will be distributed to local growers to meet agricultural demand as surface water diversions and the remaining amount will leave the system in the form of San Joaquin River and Mokelumne River outflows (over 4.6 MAF/year), stream seepage (374,000 AF/year), and riparian intake from streams (37,000 AF/year).

Figure 2-115 summarizes the average projected inflows and outflows in the Eastern San Joaquin Subbasin stream system.

Figure 2-115: Projected Average Annual Water Budget Estimates – Stream System



The land surface water budget for the projected conditions scenario has annual average inflows and outflows of 2,342,000 AF/year. Inflows consist of precipitation (992,000 AF/year), surface water supply (525,000 AF/year), groundwater supply (799,000 AF/year), and riparian intake from streams (26,000 AF/year). The balance of this is the summation of average annual evapotranspiration (1,302,000 AF/year), runoff of precipitation to the stream system (656,000 AF/year), return flow of applied water to the stream system (111,000 AF/year), deep percolation (270,000 AF/year), and other flows due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones (4,000 AF/year). A summary of these flows can be seen below in Figure 2-116.

Figure 2-116: Projected Average Annual Water Budget Estimates – Land Surface System

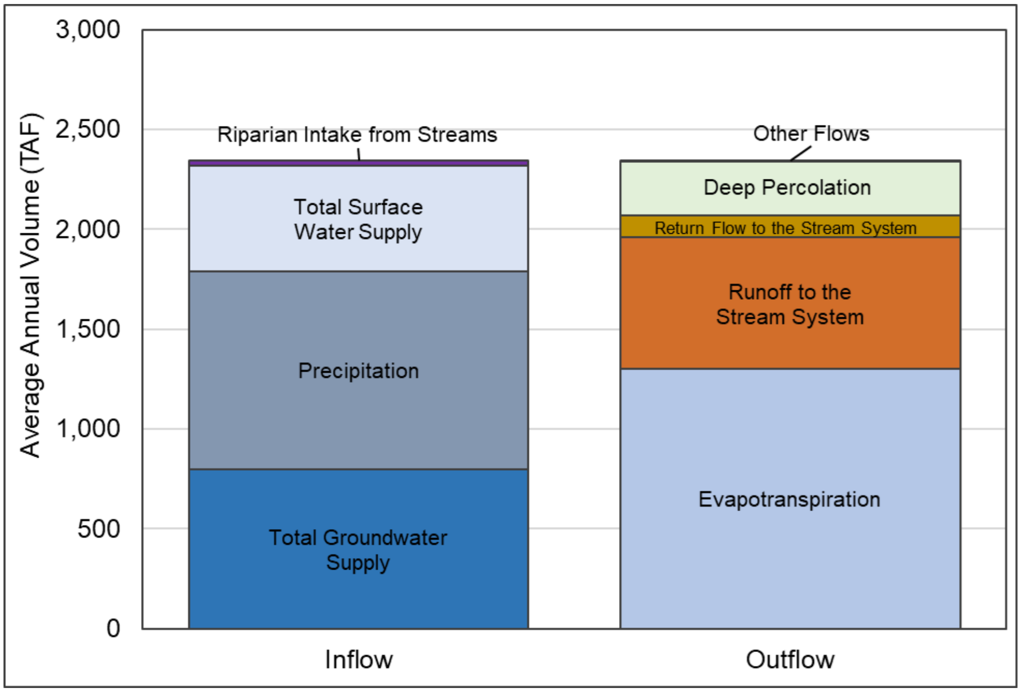
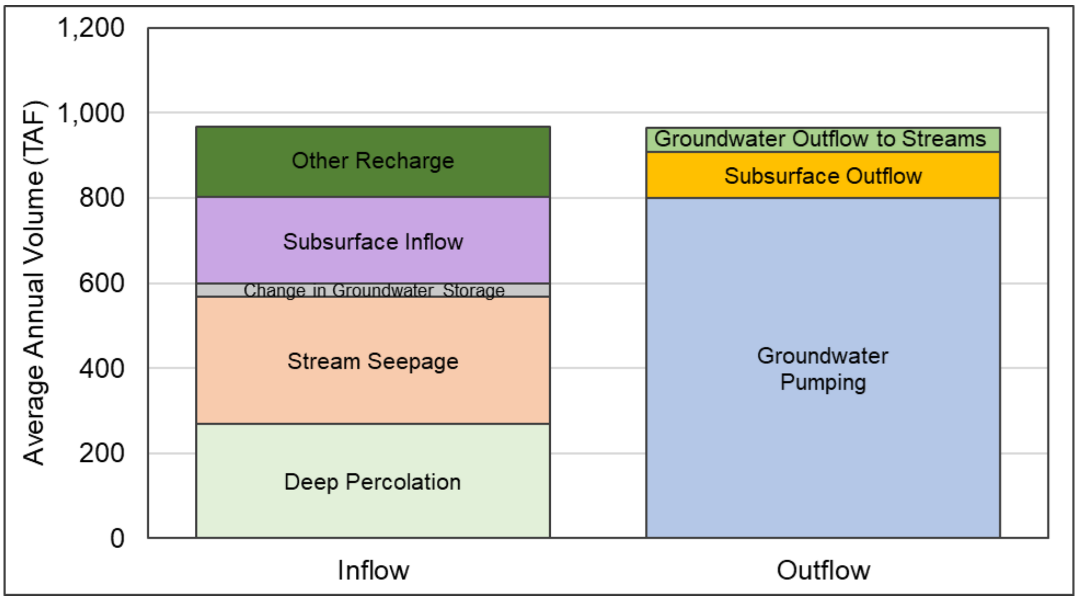


Figure 2-117 below shows how anticipated expansion in surface water supplies is reflected by decreases to groundwater pumping (799,000 AF/year) relative to historical conditions estimates. Subsurface outflow to neighboring subbasins (57,000 AF/year) and stream gain from groundwater (110,000 AF/year) bring the total Subbasin discharges to 966,000 AF/year.

Under projected conditions, the groundwater system of the Eastern San Joaquin Subbasin experiences an average of 967,000 AF/year of inflows each year, of which 270,000 AF/year is deep percolation. There is also stream seepage (298,000 AF/year), as well as other recharge which includes recharge from canals, reservoirs, and MAR projects (165,00 AF/year), and subsurface inflows (204,000 AF/year) from the Sierra Nevada Mountains and the neighboring subbasins of Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy.

The projected water budget has greater outflows than inflows, resulting in an average annual decline in groundwater storage of 30,000 AF/year. Figure 2-117 summarizes the average projected groundwater inflows and outflows in the Eastern San Joaquin Subbasin.

Figure 2-117: Projected Average Annual Water Budget Estimates – Groundwater System



As seen previously in Table 2-17 for the historical calibration, Table 2-18 shows the projected conditions water demands, supplies, and change in groundwater storage averaged based on the San Joaquin Valley Water Year Hydrologic Classification or water year type. As expected, in wet years there is more precipitation and surface water to meet more of the water demand, reducing the need for groundwater pumping and increasing groundwater storage. However, in dry years, more groundwater is pumped to meet the demand not met by surface water or precipitation, which leads to a decrease of groundwater storage. Unlike the historical calibration, the 55-year period allows for enough of each water year type to calculate meaningful averages, and the changes in supplies and demands are consistent with expectations for each water year type.

Table 2-18: Average Annual Values for Key Components of Projected Water Budget by Year Type

Component	Water Year Type (San Joaquin River Index)					
	Wet	Above Normal	Below Normal	Dry	Critical	55-Year
Number of Years[1]	19	7	3	10	16	55
Precipitation, AF/year (Precipitation, inches)	1,402,000 (22.0)	987,000 (15.5)	895,000 (14.0)	772,000 (12.1)	662,000 (10.4)	992,000 (15.6)
Water Demand (AF/year)						
Ag Demand	1,156,000	1,186,000	1,183,000	1,178,000	1,182,000	1,173,000
Urban Demand	138,000	137,000	137,000	142,000	145,000	140,000
Total Demand[2]	*1,293,000*	*1,323,000*	*1,319,000*	*1,320,000*	*1,327,000*	*1,313,000*
Water Supply (AF/year)						
Total Surface Water Supply	564,000	562,000	567,000	518,000	460,000	525,000
Agricultural	478,000	476,000	481,000	448,000	407,000	452,000
Urban and Industrial	86,000	86,000	86,000	70,000	53,000	73,000
Total Groundwater Supply	736,000	769,000	761,000	817,000	883,000	799,000
Agricultural	685,000	719,000	709,000	740,000	787,000	732,000
Urban and Industrial	52,000	52,000	52,000	74,000	94,000	67,000
Total Supply (AF/year)[2]	*1,300,000*	*1,331,000*	*1,328,000*	*1,335,000*	*1,343,000*	*1,324,000*
Change in Groundwater Storage (AF/year)[2]	*165,000*	*-24,000*	*-4,000*	*-125,000*	*-209,000*	*-30,000*

Notes:

[1] List of projected water budget water years by water year type:
Wet: 1969, 1974, 1975, 1978, 1980, 1982, 1983, 1986, 1993, 1995, 1996, 1997, 1998, 2005, 2006, 2011, 2017, 2019, 2023
Above Normal: 1970, 1973, 1979, 1984, 1999, 2000, 2010
Below Normal: 1971, 2003, 2018
Dry: 1972, 1981, 1985, 2001, 2002, 2004, 2009, 2012, 2016, 2020
Critical: 1976, 1977, 1987, 1988, 1989, 1990, 1991, 1992, 1994, 2007, 2008, 2013, 2014, 2015, 2021, 2022

[2] Summations in table may not match the numbers in the table. This is due to the rounding of model results.

2.4.5.4 Projected Water Budget with Climate Change Estimates (ESJWRM PCBL-CC Version 3.0)

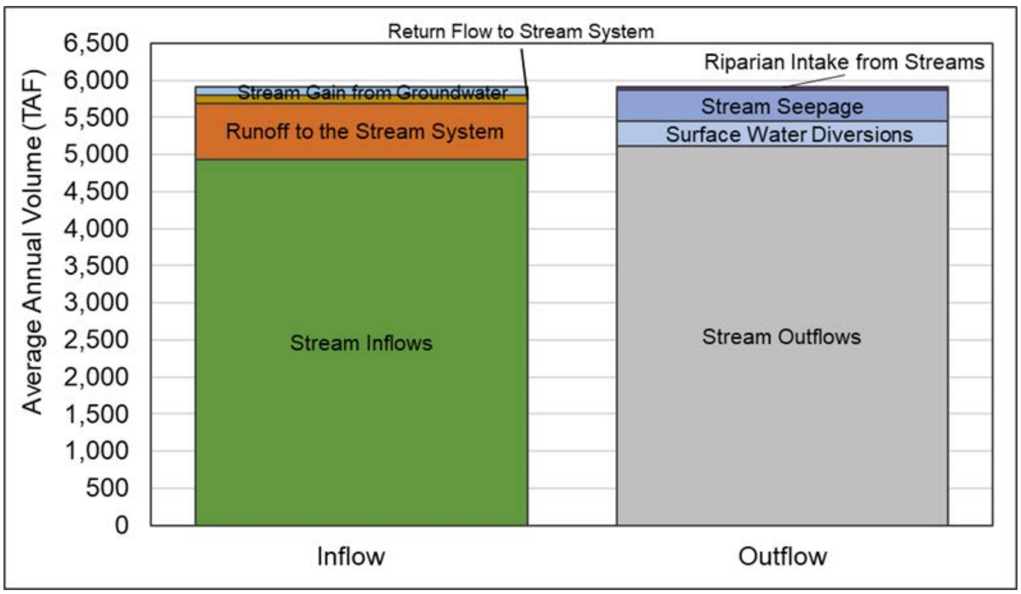
The projected water budget with climate change is used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, with the additional effects of climate change on available water supply and increasing agricultural demand. The projected conditions scenario with climate change in the ESJWRM is used to evaluate the water budget assuming a 2040 level of development and using hydrology from water years 1969-2023, adjusted for climate change impacts.

Subsequent to completion and submittal of the GSP in January of 2020, refinements and enhancements were made during two major updates to the historical data for the updated historical ESJWRM, which in turn, required updates to the projected conditions baseline ESJWRM. As in all previous sections, ESJWRM Version 3.0 water budgets are included in the following section. This projected water budget with climate change updates and the associated results are documented in Appendix 2-C of this revised GSP.

Average annual surface water inflows to the Eastern San Joaquin Subbasin's stream system total an average of just under 6.0 MAF/year in the projected conditions with climate change scenario. Under projected conditions with climate change, stream inflows of 4.9 MAF/year are augmented by stream gains from groundwater of 115,000 AF/year and runoff of precipitation to the stream system (753,000 AF/year) and return flow of applied water to the stream system (112,000 AF/year). Of these inflows, it is anticipated that 340,000 AF/year will be distributed to local growers to meet agricultural demand as surface water diversions and the remaining amount will leave the system in the form of San Joaquin River and Mokelumne River outflows (5.1 MAF/year), stream seepage (420,000 AF/year), and riparian intake from streams (40,000 AF/year).

Figure 2-115 summarizes the average projected inflows and outflows in the Eastern San Joaquin Subbasin stream system.

Figure 2-118: Projected Average Annual Water Budget Estimates with Climate Change – Stream System



The land surface water budget for the projected conditions with climate change scenario has annual average inflows and outflows of 2,520,000 AF/year. Inflows consist of precipitation (1,087,000 AF/year), surface water supply (525,000 AF/year), groundwater supply (879,000 AF/year), and riparian intake from streams (29,000 AF/year). The balance of this is the summation of average annual evapotranspiration (1,384,000 AF/year), runoff of precipitation to the stream system (753,000 AF/year), return flow of applied water to the stream system (112,000 AF/year), deep percolation (268,000 AF/year), and other flows due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones (5,000 AF/year). A summary of these flows can be seen below in Figure 2-116.

Figure 2-119: Projected Average Annual Water Budget Estimates with Climate Change – Land Surface System

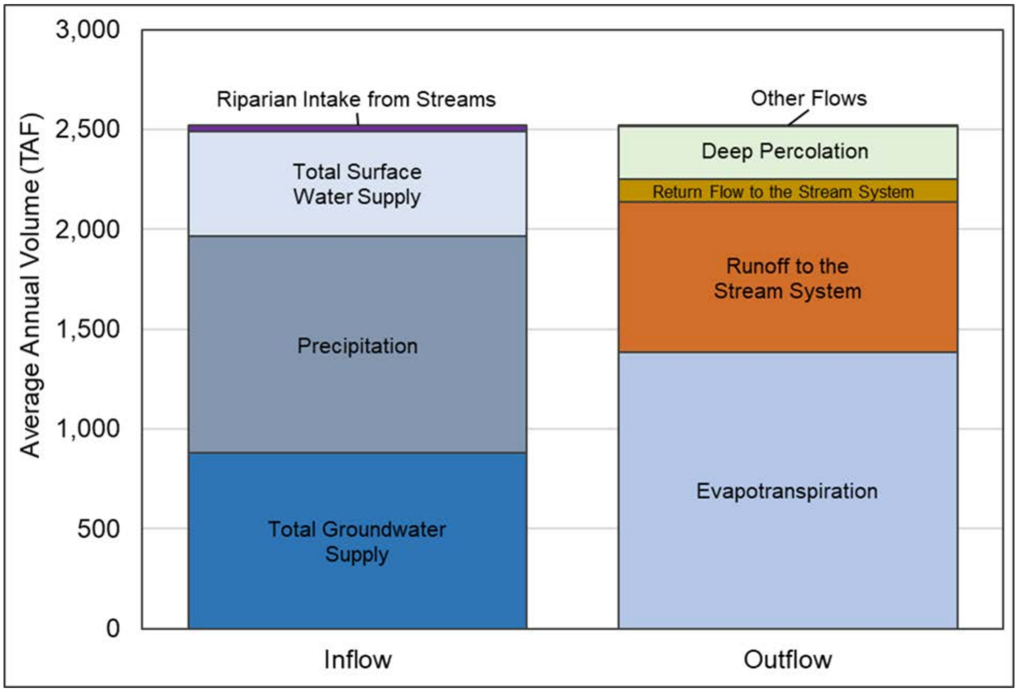


Figure 2-120 below shows how effects due to climate change are reflected by increases to groundwater pumping (879,000 AF/year) relative to the project conditions scenario. Subsurface outflow to neighboring subbasins (111,000 AF/year) and stream gain from groundwater (53,000 AF/year) bring the total Subbasin discharges to 1,043,000 AF/year.

Under projected conditions with climate change, the groundwater system of the Eastern San Joaquin Subbasin experiences an average of 1,044,000 AF/year of inflows each year, of which 268,000 AF/year is deep percolation. There is also stream seepage (330,000 AF/year), as well as other recharge which includes recharge from canals, reservoirs, and MAR projects (168,00 AF/year), and subsurface inflows (222,000 AF/year) from the Sierra Nevada Mountains and the neighboring subbasins of Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy.

The projected water budget has greater outflows than inflows, resulting in an average annual decline in groundwater storage of 56,000 AF/year. Figure 2-120 summarizes the average projected groundwater inflows and outflows in the Eastern San Joaquin Subbasin.

Figure 2-120: Projected Average Annual Water Budget Estimates with Climate Change – Groundwater System

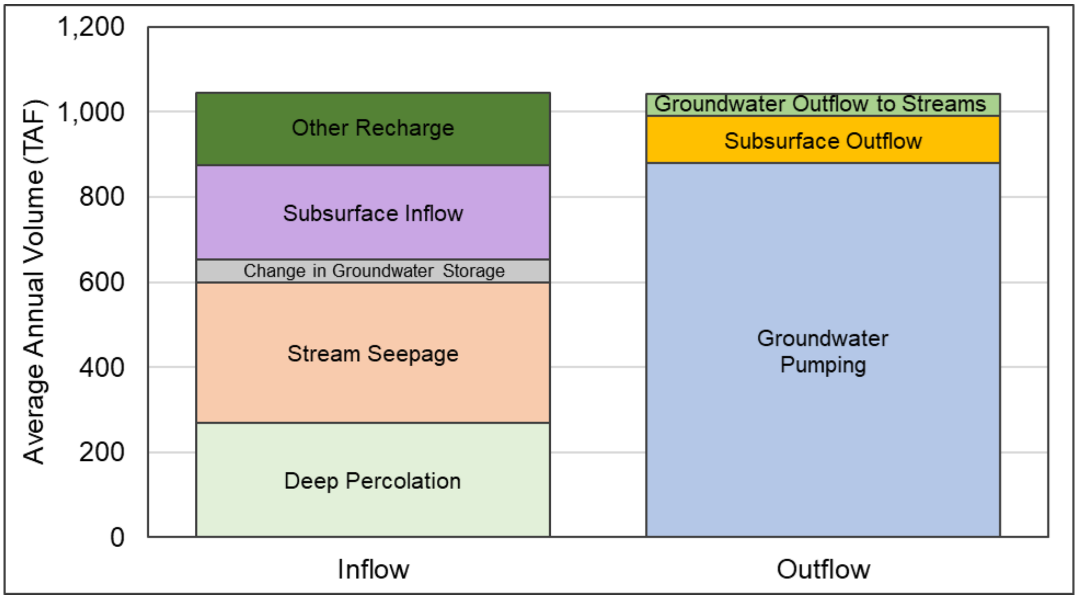


Table 2-19 shows the projected conditions with climate change's water demands, supplies, and change in groundwater storage averaged based on the San Joaquin Valley Water Year Hydrologic Classification or water year type. As expected, in wet years there is more precipitation and surface water to meet more of the water demand, reducing the need for groundwater pumping and increasing groundwater storage. However, in dry years, more groundwater is pumped to meet the demand not met by surface water or precipitation, which leads to a decrease of groundwater storage.

Table 2-19: Average Annual Values for Key Components of Projected Conditions with Climate Change Water Budget by Year Type

Component	Water Year Type (San Joaquin River Index)					
	Wet	Above Normal	Below Normal	Dry	Critical	55-Year
Number of Years[1]	19	7	3	10	16	55
Precipitation, AF/year (Precipitation, inches)	1,547,000 (24.3)	1,124,000 (17.6)	952,000 (14.9)	829,000 (13.0)	712,000 (11.2)	1,087,000 (17.1)
Water Demand (AF/year)						
Ag Demand	1,238,000	1,261,000	1,262,000	1,258,000	1,263,000	1,253,000
Urban Demand	138,000	137,000	136,000	142,000	145,000	139,000
Total Demand[2]	*1,376,000*	*1,398,000*	*1,398,000*	*1,400,000*	*1,408,000*	*1,392,000*
Water Supply (AF/year)						
Total Surface Water Supply	564,000	562,000	566,000	518,000	459,000	525,000
Agricultural	478,000	476,000	481,000	448,000	407,000	452,000
Urban and Industrial	86,000	86,000	85,000	69,000	53,000	73,000
Total Groundwater Supply	818,000	844,000	841,000	897,000	964,000	879,000
Agricultural	768,000	795,000	790,000	821,000	869,000	812,000
Urban and Industrial	52,000	52,000	52,000	74,000	94,000	68,000
Total Supply (AF/year)[2]	*1,382,000*	*1,406,000*	*1,407,000*	*1,415,000*	*1,423,000*	*1,404,000*
Change in Groundwater Storage (AF/year)[2]	*139,000*	*-55,000*	*-39,000*	*-150,000*	*-233,000*	*-56,000*

Notes:

1 List of projected water budget water years by water year type:
Wet: 1969, 1974, 1975, 1978, 1980, 1982, 1983, 1986, 1993, 1995, 1996, 1997, 1998, 2005, 2006, 2011, 2017, 2019, 2023
Above Normal: 1970, 1973, 1979, 1984, 1999, 2000, 2010
Below Normal: 1971, 2003, 2018
Dry: 1972, 1981, 1985, 2001, 2002, 2004, 2009, 2012, 2016, 2020
Critical: 1976, 1977, 1987, 1988, 1989, 1990, 1991, 1992, 1994, 2007, 2008, 2013, 2014, 2015, 2021, 2022

2 Summations in table may not match the numbers in the table. This is due to the rounding of model results.

2.4.6 Projected Water Budget with Demand Reduction Estimates (ESJWRM PCBL-DR Version 3.0)

Sustainable yield is defined for SGMA purposes as "the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result." (CWC §10721(w)). Groundwater pumping under sustainable conditions for the Eastern San Joaquin Subbasin was calculated through development of an ESJWRM sustainable conditions scenario in which the goal was to generate a long-term (55-year) change in Subbasin groundwater storage of zero, a conservative approach, as a change in storage of greater than zero could occur without causing undesirable results. From 2040, the 55 years of long-term hydrology was applied and various scenarios were run to see what level of groundwater production resulted in a long-term change in storage of, or very close to, zero.

The sustainable conditions scenario is based on the projected conditions scenario (see Section 2.4.4.3 and Figure 2-117) modified by lowering groundwater production across the model domain.

In practice, Subbasin overdraft could be addressed through reduced groundwater production, increased recharge, or a combination of the two; focusing on groundwater production is just for simulation purposes to calculate the Subbasin production under sustainable conditions. The sustainable conditions scenario estimates future conditions of supply, demand, and the resulting aquifer response to implementation of sustainable conditions in the Subbasin. Under sustainable conditions, groundwater pumping activities in the Subbasin are not anticipated to create changes in groundwater inflow that could impact GSP implementation in neighboring subbasins.

There are uncertainties associated with projections in the ESJWRM scenarios due to the sequence of the hydrologic period, population projections, future cropping patterns, and irrigation practices and technologies, as well as uncertainties inherent in the representation of the physical groundwater and surface water system by the model. Therefore, to account for these uncertainties, a range of assumptions (from high-end estimates to low-end estimates) are used in running model scenarios to estimate the production under sustainable conditions and an initial estimate of the adjustment that would be required to achieve the production under sustainable conditions over the 55-year planning period. These assumptions will be honed over time in updates to this Plan and refinements to the ESJWRM as described in Section 7.4.1.

The results of the Subbasin ESJWRM Projected Condition BaseLine with Demand Reduction (PCBL-DR) are summarized below. Detailed assumptions and results for the PCBL-DR are included in Appendix 2-C of this updated GSP. As with the PCBL, the projected conditions with demand reduction scenario of the ESJWRM assumes a 2040 level of development and hydrology from water years 1969-2023.

2.4.6.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
  - Groundwater pumping
  - Surface water deliveries
  - Shortage (if applicable)
- Outflows:
  - Demand (either agricultural or urban)
  - Surplus (if applicable)

The average annual PCBL-DR Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,199 thousand acre-feet per year (TAFY), consisting of approximately 1,059 TAFY of agricultural demand and 140 TAFY of urban demand. This demand is met by an annual average of 526 TAFY of surface water deliveries (452 TAFY of agricultural and 73 TAFY of urban deliveries) and is supplemented by 693 TAFY of groundwater production (628 TAFY of agricultural and 65 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 21 TAFY of surplus in the Subbasin-scale agricultural water supply, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 2-20. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 2-121 and Figure 2-122 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 2-20 also includes the PCBL Version 3.0 results and a demand reduction benefit calculated as the PCBL-DR Version 3.0 results minus the PCBL Version 3.0 results. For urban areas, the 15% reduction in urban demand that was applied to the PCBL-DR Version 3.0 across all major agencies in the Subbasin is reflected in the reduction in urban demand of 16 TAFY compared to the PCBL Version 3.0. For agricultural areas, the PCBL-DR Version 3.0 has 26 thousand acres less of agricultural area, which results in 95 TAFY reduction in agricultural demand compared the PCBL Version 3.0. This represents a comparable reduction in agricultural groundwater pumping of 93 TAFY.

Table 2-20: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-DR Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-DR Version 3.0	DR Benefit (PCBL-DR Version 3.0 minus PCBL Version 3.0)
Agricultural Area (thousand acres)	365	340	-26
Agricultural Demand (TAFY)	1,153	1,059	-95
Agricultural Groundwater Pumping (TAFY)	721	628	-93
Agricultural Surface Water Deliveries (TAFY)	452	452	0
Agricultural Surplus (TAFY)[1]	19	21	2
Urban Area (thousand acres)	129	129	0
Urban Demand (TAFY)	156	140	-16
Urban Groundwater Pumping (TAFY)	67	64	-3
Urban Surface Water Deliveries (TAFY)	73	73	0
Urban Shortage (TAFY)[1]	16	2	-14

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 2-121: ESJ Subbasin Projected Agricultural Demand in the PCBL-DR Version 3.0

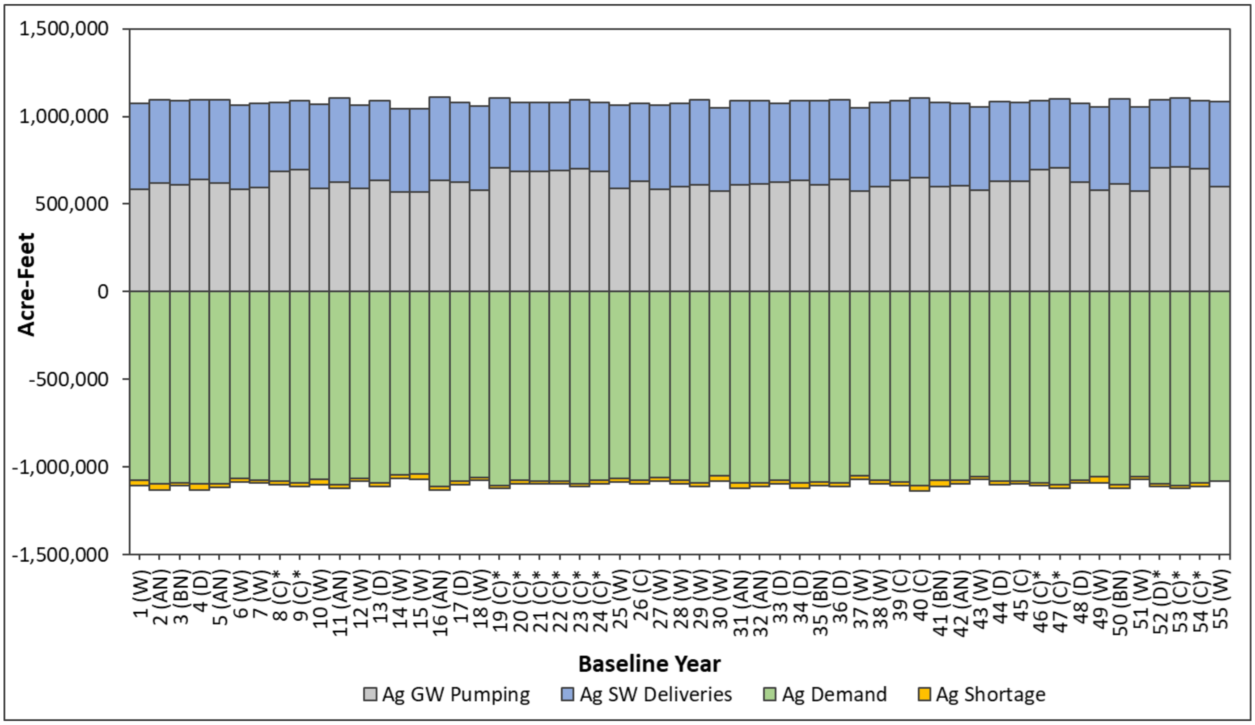
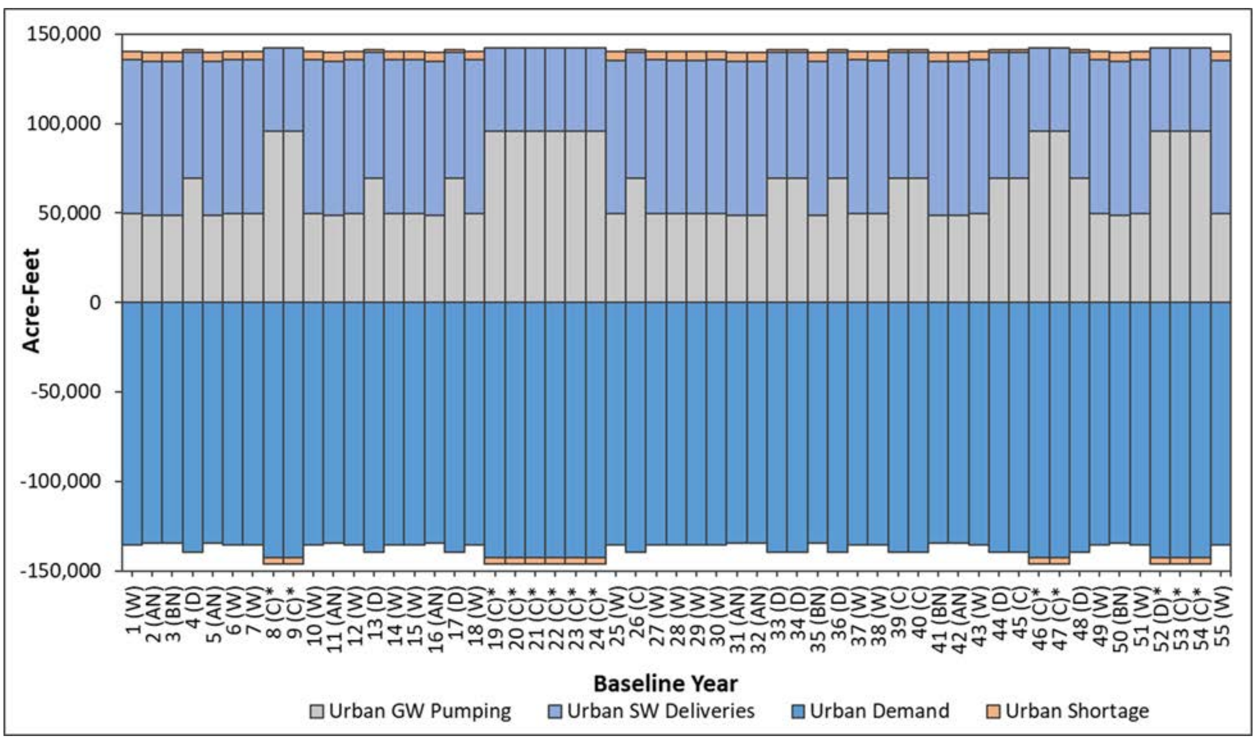


Figure 2-122: ESJ Subbasin Projected Urban Demand in the PCBL-DR Version 3.0



2.4.6.2 Hydrologic Groundwater Water Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
  - Deep percolation (from rainfall and irrigation applied water)
  - Gain from stream (or recharge due to stream seepage)
  - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
  - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
  - Groundwater pumping
  - Loss to stream (or outflow to streams and rivers)
  - Boundary outflow (to surrounding groundwater subbasins)
  - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL-DR Version 3.0 remains the largest component in the groundwater budget with an annual average 704 TAFY. The PCBL-DR Version 3.0 offsets this pumping with 247 TAFY of deep percolation, a net gain from stream of 211 TAFY, 165 TAFY of other recharge, and a total subsurface inflow of 81 TAFY. The cumulative change in groundwater storage can be calculated from the average annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-DR Version 3.0 is -200 AFY, with the negative sign actually indicating an absence of groundwater overdraft and an increase in storage over the 55 years of the PCBL-DR Version 3.0. These annual averages are shown in Table 2-21. The groundwater budget, with cumulative change in storage, is shown for the ESJ Subbasin in Figure 2-123.

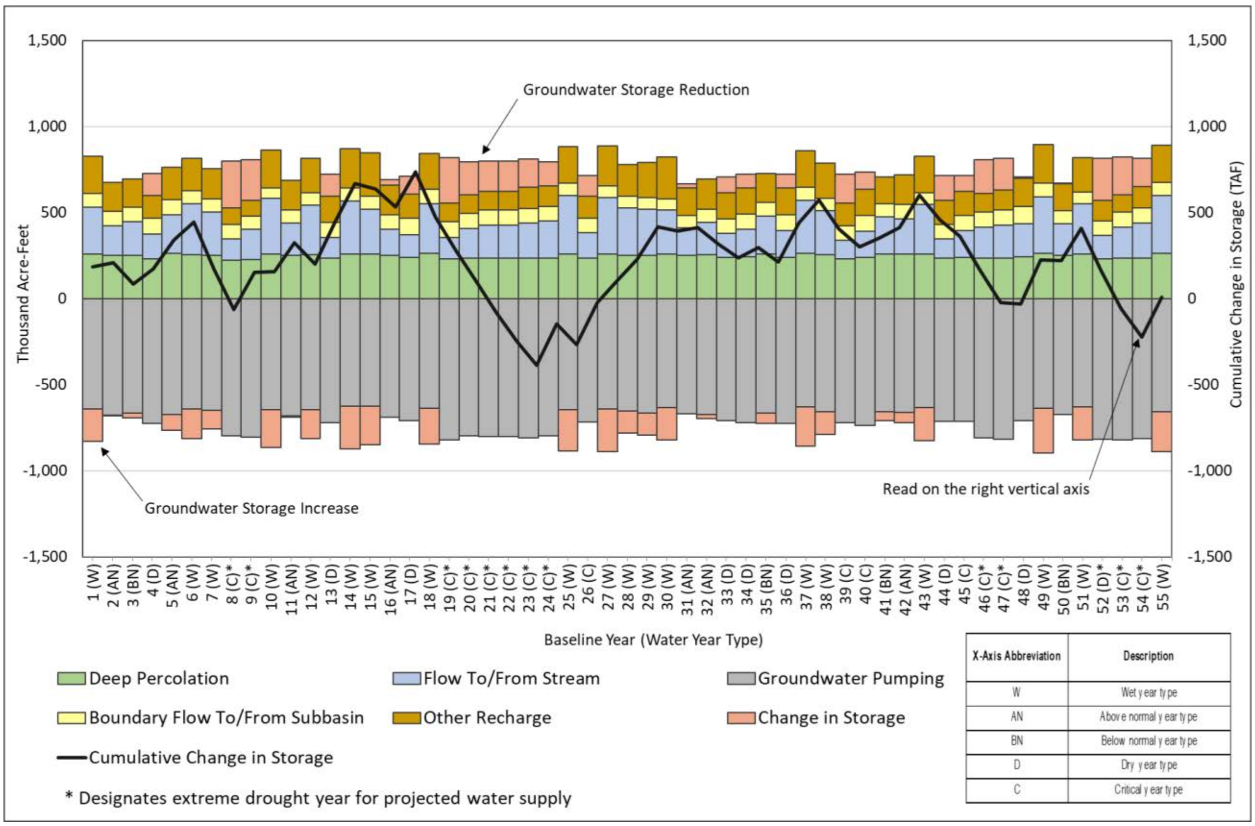
Table 2-21 also includes the PCBL Version 3.0 results and a demand reduction benefit calculated as PCBL-DR Version 3.0 results minus the PCBL Version 3.0 results. The simulated results indicate that the demand reduction may resolve the PCBL Version 3.0 Subbasin overdraft condition when impacts due to climate change are not included. Without the demand reduction, the modeling shows an average overdraft of 30 TAFY over the 55 years of the PCBL Version 3.0 simulation. With the demand reduction in place, the modeling shows approximately 0 TAFY in projected overdraft on average in the PCBL-DR Version 3.0. The PCBL-DR Version 3.0 shows an average increase of 30 TAFY of groundwater in storage when compared to the PCBL.

Compared to PCBL Version 3.0, the PCBL-DR Version 3.0 has 95 TAFY less groundwater pumping due to the percentage reduction in urban per capita water use and agricultural areas, and 29 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL Version 3.0 and PCBL-DR Version 3.0.

Table 2-21: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-DR Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-DR Version 3.0	DR Benefit (PCBL-DR Version 3.0 minus PCBL Version 3.0)
Deep Percolation (TAF)	270	247	-23
Other Recharge (TAF)	165	165	0
Net Stream Seepage (TAF)	240	211	-29
Net Boundary Inflow (TAF)	94	81	-13
Groundwater Pumping (TAF)	799	704	-95
Change in Groundwater Storage (TAF)	-30	0	30

Figure 2-123: ESJ Subbasin Projected Hydrologic Groundwater Budget in PCBL-DR Version 3.0



The sustainable conditions scenario results in groundwater outflows almost equal to groundwater inflows, bringing the long-term (55-year) average change in groundwater storage to close to zero. Based on this analysis, to achieve a simulated long-term average change in storage of 0 AFY, the Subbasin-wide pumping would be approximately is 704,000 AF/year ± 10 percent. This assumes that hydrology and surface water conditions continue as modeled and no projects are implemented.

In order to achieve a net-zero change in groundwater storage over a 55-year planning period, approximately 95,000 AF/year of direct or in lieu groundwater recharge and/or reduction in agricultural and urban groundwater pumping would need to be implemented in the Eastern San Joaquin Subbasin to reduce the projected groundwater pumping to the sustainable conditions level, without consideration to impacts of climate change. This number (95,000 AF/year) is larger than the estimated annual overdraft of the projected conditions scenario (30,000 AF/year) due to the integrated nature of a groundwater subbasin. As efforts are made to reach sustainability in a subbasin, flows to and from neighboring basins and flows to and from streams may vary due to proposed management actions resulting in increased groundwater levels, creating the need for additional recharge or pumping reduction greater than the overdrafted amount.

2.4.7 Projected Water Budget with Climate Change and Demand Reduction Estimates (ESJWRM PCBL-CC-DR Version 3.0)

2.4.7.1 Land and Water Use Water Budget

To assess the impact of climate change on the sustainable conditions run, climate change impacts, described in Section **Error! Reference source not found.**, were incorporated into the PCBL-DR scenario.

The average annual PCBL-CC-DR Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,214 TAFY, consisting of approximately 1,074 TAFY of agricultural demand and 140 TAFY of urban demand. This demand is met by an annual average of 526 TAFY of surface water deliveries (453 TAFY of agricultural and 73 TAFY of urban deliveries) and is supplemented by 702 TAFY of groundwater production (637 TAFY of agricultural and 65 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is about 16 TAFY of surplus in the Subbasin scale agricultural water use budget, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 2-22. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 2-124 and Figure 2-125 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

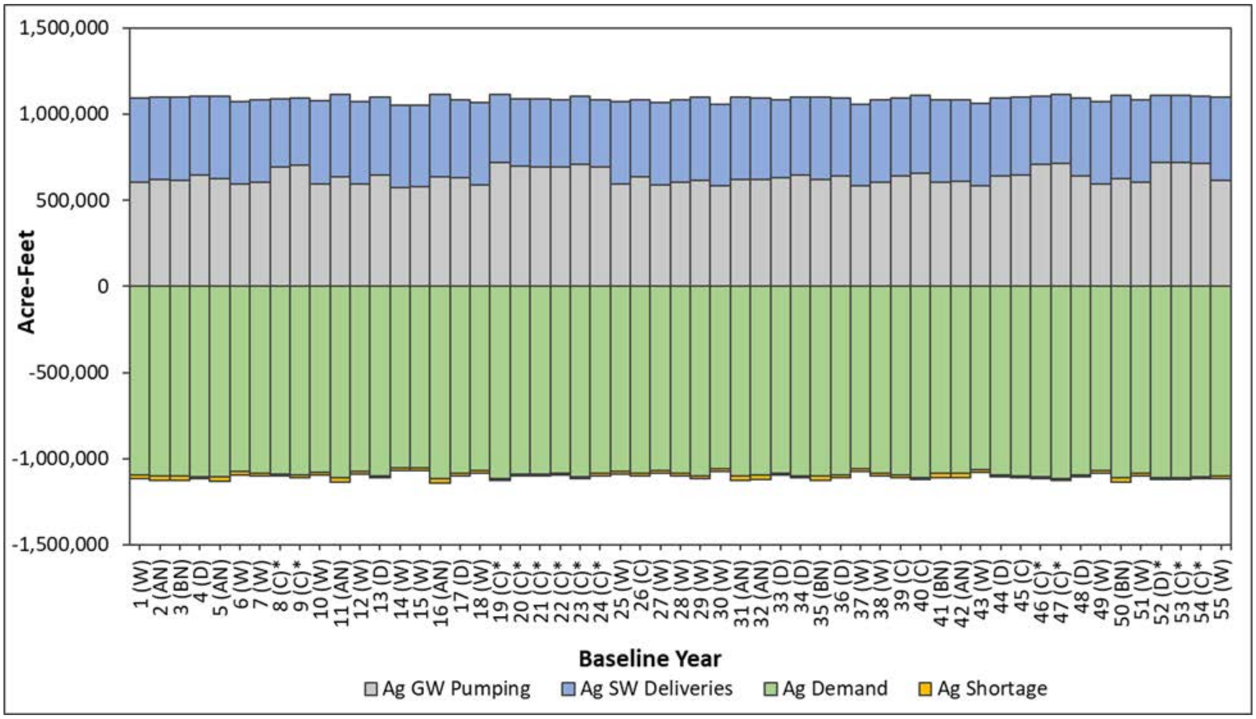
Table 2-22 also includes the PCBL-CC Version 3.0 results and a demand reduction benefit calculated as PCBL-CC-DR Version 3.0 results minus PCBL-CC Version 3.0 results. For urban areas, the 15% reduction in urban demand that applied to the PCBL-CC-DR Version 3.0 across all major agencies in the Subbasin is reflected in the reduction in urban demand of 17 TAFY compared to the PCBL-CC Version 3.0. For agricultural areas, the PCBL-CC-DR Version 3.0 has 44 thousand acres less agricultural area, which results in 166 TAFY less agricultural demand compared the PCBL-CC. This represents a comparable reduction in agricultural groundwater pumping of 164 TAFY.

Table 2-22: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL-CC Version 3.0 and PCBL-CC-DR Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL-CC Version 3.0	PCBL-CC-DR Version 3.0	DR Benefit (PCBL-CC-DR Version 3.0 minus PCBL-CC Version 3.0)
Agricultural Area (thousand acres)	365	321	-44
Agricultural Demand (TAF)	1,240	1,074	-166

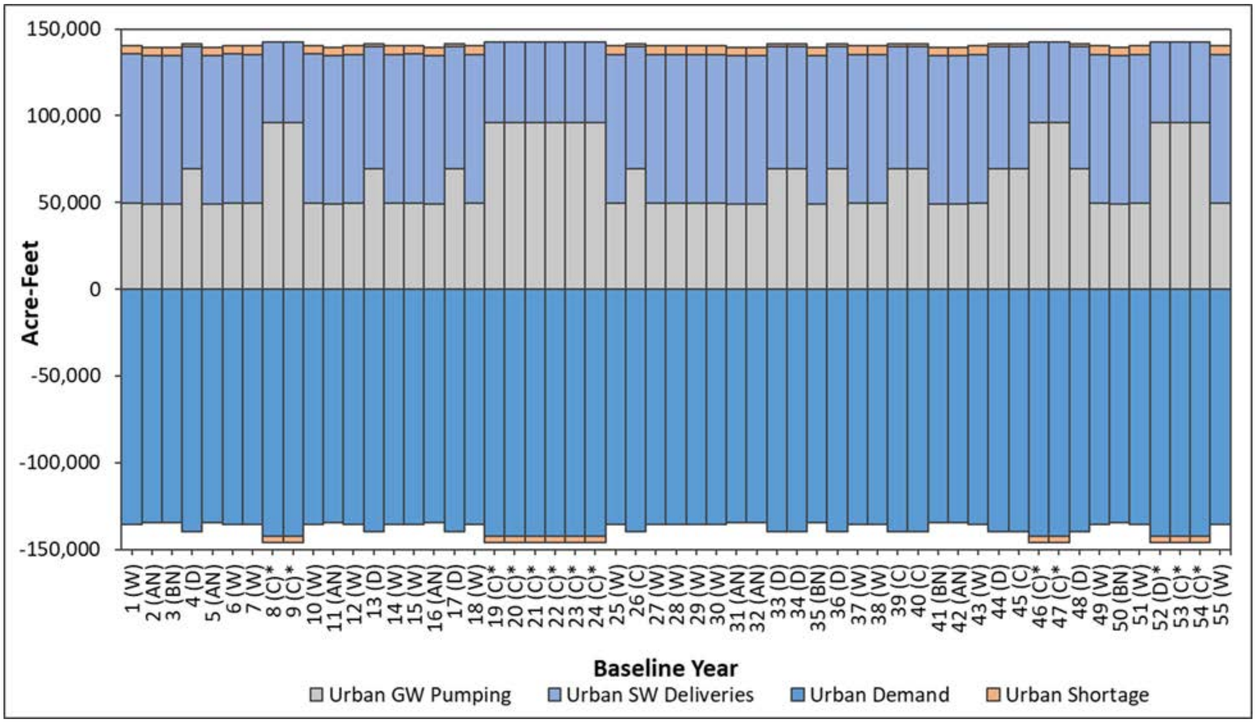
Agricultural Groundwater Pumping (TAF)	801	637	-164
Agricultural Surface Water Deliveries (TAF)	452	453	1
Agricultural Surplus (TAF)[1]	14	16	2
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	140	-16
Urban Groundwater Pumping (TAF)	67	65	-3
Urban Surface Water Deliveries (TAF)	73	73	0
Urban Shortage (TAF)[1]	16	2	-14

Figure 2-124: ESJ Subbasin Projected Agricultural Demand in the PCBL-CC-DR Version 3.0



[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 2-125: ESJ Subbasin Projected Urban Demand in the PCBL-CC-DR Version 3.0



2.4.7.2 Hydrologic Groundwater Water Budget

Pumping in the PCBL-CC-DR Version 3.0 remains the largest component in the groundwater budget with an annual average 713,200 AFY. The PCBL-CC-DR Version 3.0 offsets this pumping with 233,600 AFY of deep percolation, a net gain from stream of 223,200, 167,700 AFY of other recharge, and a total subsurface inflow of 88,600 AFY annually. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Even with this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-CC-DR Version 3.0 is 0 AFY. These annual averages are shown in Table 2-23. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 2-126.

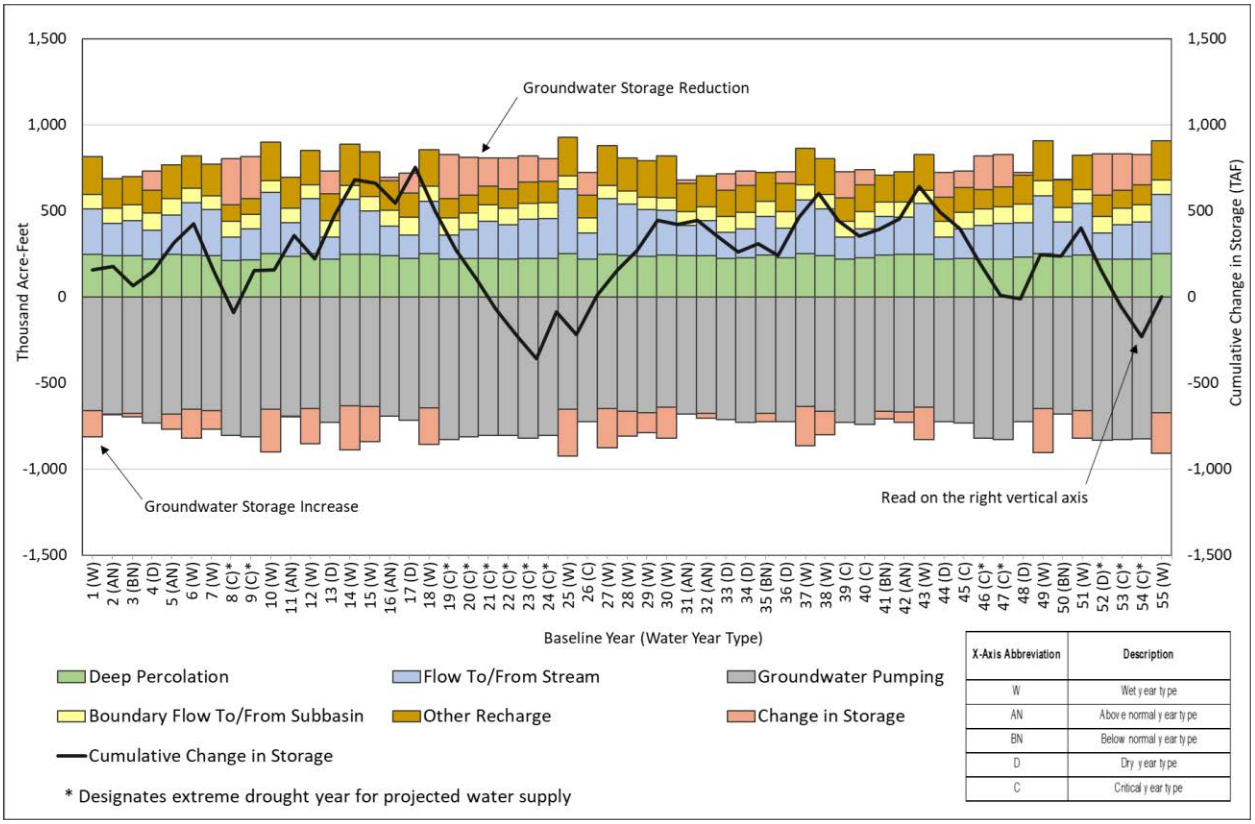
Table 2-23 also includes the PCBL-CC results and a demand reduction benefit calculated as the PCBL-CC-DR Version 3.0 results minus the PCBL-CC results. The results indicate that the demand reduction will resolve the PCBL-CC Subbasin overdraft condition when impacts due to climate change are included. Without the demand reduction, the modeling shows an average overdraft of 56,200 AFY over the 55 years of the PCBL-CC simulation. With the demand reduction in place, the modelling shows a projected overdraft of 0 AFY on average in the PCBL-CC-DR Version 3.0. The PCBL-CC-DR Version 3.0 shows an average increase of 56,200 AFY of groundwater in storage when compared to the PCBL-CC.

Compared to the PCBL-CC, with the demand reduction modeled, the PCBL-CC-DR Version 3.0 has 166,200 AFY less groundwater pumping due to the percentage reduction in urban per capita water use and agricultural areas, and 53,000 AFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL-CC and PCBL-CC-DR Version 3.0 simulations.

Table 2-23: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL-CC and the PCBL-CC-DR Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL-CC	PCBL-CC-DR Version 3.0	DR Benefit (PCBL-CC-DR Version 3.0 minus PCBL-CC)
Deep Percolation (AF)	268,000	233,600	-34,400
Other Recharge (AF)	168,100	167,700	-400
Net Stream Seepage (AF)	276,200	223,200	-53,000
Net Boundary Inflow (AF)	110,900	88,600	-22,300
Groundwater Pumping (AF)	879,400	713,200	-166,200
Change in Groundwater Storage (AF)	-56,200	0	56,200

Figure 2-126: ESJ Subbasin Projected Hydrologic Groundwater Budget in the PCBL-CC-DR Version 3.0



The sustainable conditions scenario with climate change results in groundwater outflows almost equal to groundwater inflows, bringing the long-term (55-year) average change in groundwater storage to close to zero. Based on this analysis, to achieve a simulated long-term average change in storage of 0 AFY, the Subbasin-wide pumping would be approximately is 713,000 AF/year ± 10 percent. This assumes that hydrology and surface water conditions continue as modeled and no projects are implemented.

In order to achieve a net-zero change in groundwater storage over a 55-year planning period, approximately 166,000 AF/year of direct or in lieu groundwater recharge and/or reduction in agricultural and urban groundwater pumping would need to be implemented in the Eastern San Joaquin Subbasin to reduce the projected groundwater pumping to the sustainable conditions level, considering the of impacts of climate change.

2.4.8 Projected Water Budget with PMAs Estimates (ESJWRM PCBL-PMA Version 3.0)

The results of the Subbasin ESJWRM Projected Condition BaseLine with Category A Projects and Management Actions (PCBL-PMA) are summarized below. Detailed results for the PCBL-PMA are included in Appendix 2-C of this updated GSP. As with the PCBL, the projected conditions with projects and management actions scenario of the ESJWRM assumes a 2040 level of development and hydrology from water years 1969-2023. A summary of the 12 Category A PMAs simulated as additional diversions in the PCBL-PMA model is provided in **Error! Reference source not found.**, along with fractions for recoverable loss (i.e., percolation or canal seepage), non-recoverable loss (i.e., evaporation), and delivery (i.e., amount delivered is equal to the total amount minus the recoverable and non-recoverable losses). One PMA was already included in the PCBL as Diversion 55 and is also included in **Error! Reference source not found.**. The remaining 65 PCBL diversions are summarized in the projected documentation (Appendix 2-C).

City of Stockton's Advanced Metering Infrastructure project was added as a Category A project during the public comment period of the 2024 GSP Amendment. Therefore, it is not included in the PMA simulation results shown in the 2024 GSP Amendment. It will be simulated in future iterations of ESJWRM PCBL-PMA. Appendix 2-C details documentation on only the 12 Category A PMAs that were simulated as part of the 2024 GSP Amendment.

2.4.8.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
  - Groundwater pumping
  - Surface water deliveries
  - Shortage (if applicable)
- Outflows:
  - Demand (either agricultural or urban)
  - Surplus (if applicable)

The average annual PCBL-PMA Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,315 TAFY, consisting of approximately 1,153 TAFY of agricultural demand and 162 TAFY of urban demand. This demand is met by an annual average of 572 TAFY of surface water deliveries (493 TAFY of agricultural and 79 TAFY of urban deliveries) and is supplemented by 755 TAFY of groundwater production (687 TAFY of agricultural and 68 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 28 TAFY of surplus in the Subbasin-scale agricultural water supply, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 2-25**Error! Reference source not found.**.

Table 2-25 also includes the PCBL Version 3.0 results and a Category A projects benefit calculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. The PCBL-PMA Version 3.0 has an average of 41 TAFY more surface water for agricultural purposes and 6 TAFY more surface water for urban areas compared to the PCBL Version 3.0. For urban areas, this represents a reduction in groundwater pumping of 600 AFY. For agricultural areas, the increased surface water results in 34 TAFY less groundwater pumping, a number smaller than the amount of surface water provided due to a mismatch between the Category A water supplied and model-calculated agricultural demand on a monthly basis.

Table 2-24: Summary of ESJWRM Category A Projects Surface Water Deliveries

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Average Annual Diversion*** (acre-feet)
					RL*	NL**	Delivery	
55	OID In-lieu and Direct Recharge Project	Import (outside of ESJWRM)	Landowners outside of OID's eastern boundary	Ag	0%	0%	100%	3,000
67	Stockton East WD Lake Grupe In-Lieu Recharge	Calaveras River	Approximately 1,750 acres of orchards surrounding Lake Grupe in SEWD	Ag	0%	0%	100%	4,300
68	Stockton East WD Surface Water Implementation Expansion	Import (outside of ESJWRM)	Approximately 6,750 acres adjacent to surface water conveyance systems in SEWD	Ag	0%	0%	100%	13,300
69	Stockton East WD West Groundwater Recharge Basin	Import (outside of ESJWRM)	Recharge basin near SEWD water treatment plant	Recharge	100%	0%	0%	10,200
70	Central San Joaquin WCD Capital improvement Program	Import (outside of ESJWRM)	CSJWCD	Ag	15%	2%	83%	20,500
71	Long-term Water Transfer to Stockton East WD for M&I	Import (outside of ESJWRM)	City of Stockton area urban users	Urban	0%	0%	100%	12,200
72	City of Lodi White Slough Water Pollution Control Facility Expansion	Import (outside of ESJWRM)	890 acres of agricultural land surrounding White Slough Pollution Control Facility	Ag	4%	2%	94%	3,700
73	North San Joaquin WCD South System Modernization	Mokelumne River	NSJWCD South System	Ag	0%	0%	100%	6,900

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Average Annual Diversion*** (acre-feet)
					RL*	NL**	Delivery	
74	North San Joaquin WCD Tecklenburg Recharge Project	Mokelumne River	Recharge basin located in NSJWCD South System	Recharge	100%	0%	0%	1,300
75	North San Joaquin WCD South System Groundwater Banking with EBMUD	Mokelumne River	NSJWCD South System	Ag	0%	0%	100%	2,800
76	North San Joaquin WCD North System Modernization/Lasko Recharge	Mokelumne River	NSJWCD North System	Ag	50%	0%	50%	4,000
77	City of Stockton Delta Water Treatment Plant Groundwater Recharge Improvements Project Geotechnical Investigation	Import (outside of ESJWRM)	Recharge basin adjacent to Delta Water Treatment Plant	Recharge	100%	0%	0%	5,000
82	North San Joaquin WCD Private Pump Partnerships	Mokelumne River	Riparian areas along Mokelumne River within NSJWCD	Recharge	50%	0%	50%	3,000

*RL = Recoverable Loss (canal seepage or recharge)

**NL = Non-Recoverable Loss (evaporation)

*** Averages calculated only for years with diversions occurring (i.e., non-zero average)

Table 2-25: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-PMA Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-PMA Version 3.0	PMA Benefit (PCBL-PMA Version 3.0 minus PCBL Version 3.0)
Agricultural Area (thousand acres)	365	365	0
Agricultural Demand (TAFY)	1,153	1,153	0
Agricultural Groundwater Pumping (TAFY)	721	687	-34
Agricultural Surface Water Deliveries (TAFY)	452	493	41
Agricultural Surplus (TAFY)[1]	19	28	8
Urban Area (thousand acres)	129	129	0
Urban Demand (TAFY)	156	162	6
Urban Groundwater Pumping (TAFY)	67	68	1
Urban Surface Water Deliveries (TAFY)	73	79	6
Urban Shortage (TAFY)[1]	16	16	0

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 2-127: ESJ Subbasin Projected Agricultural Demand in the PCBL-PMA

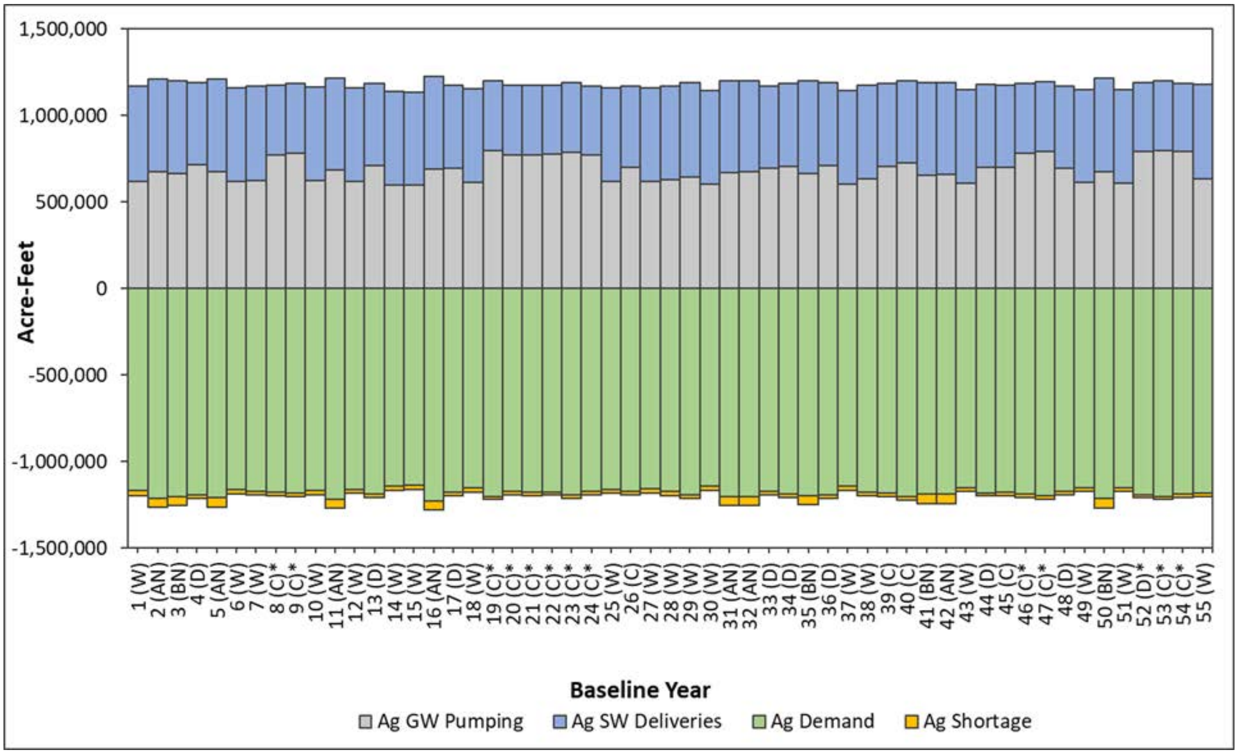
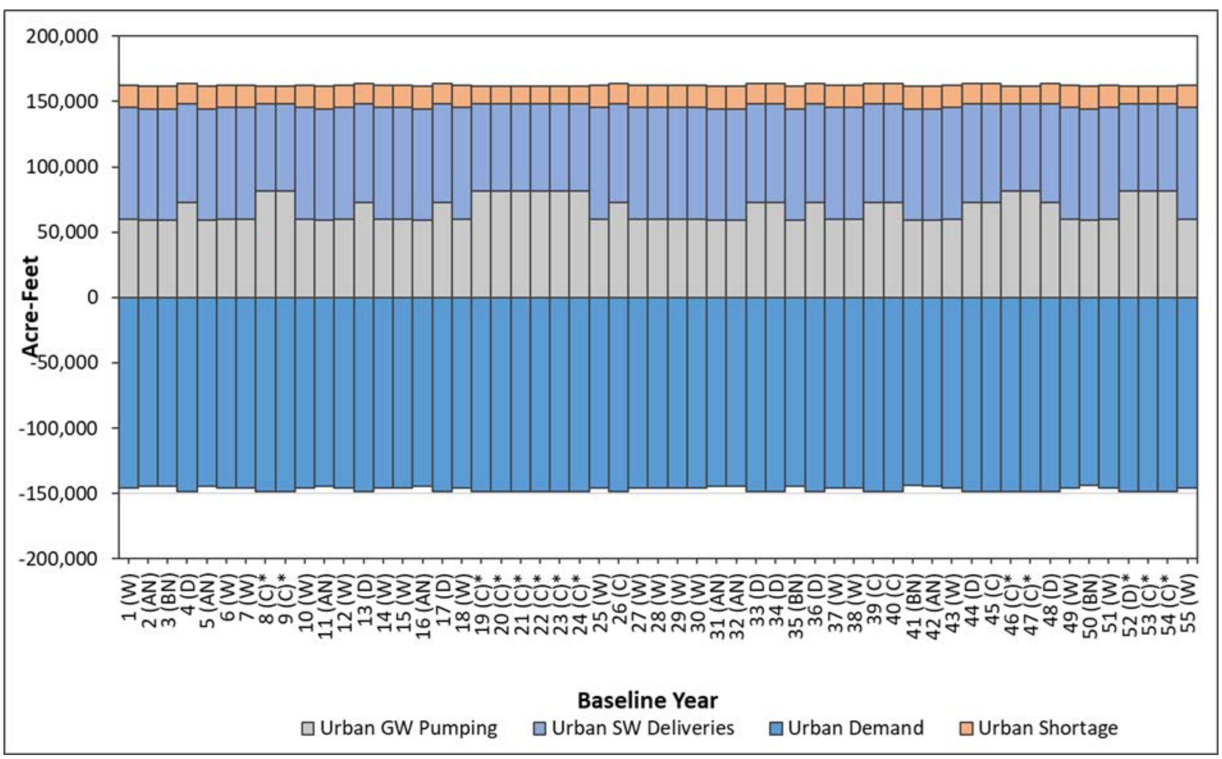


Figure 2-128: ESJ Subbasin Projected Urban Demand in the PCBL-PMA



2.4.8.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
    - Deep percolation (from rainfall and irrigation applied water)
    - Gain from stream (or recharge due to stream seepage)
    - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
    - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
    - Groundwater pumping
    - Loss to stream (or outflow to streams and rivers)
    - Boundary outflow (to surrounding groundwater subbasins)
    - Change in groundwater storage (can be either an inflow or outflow)

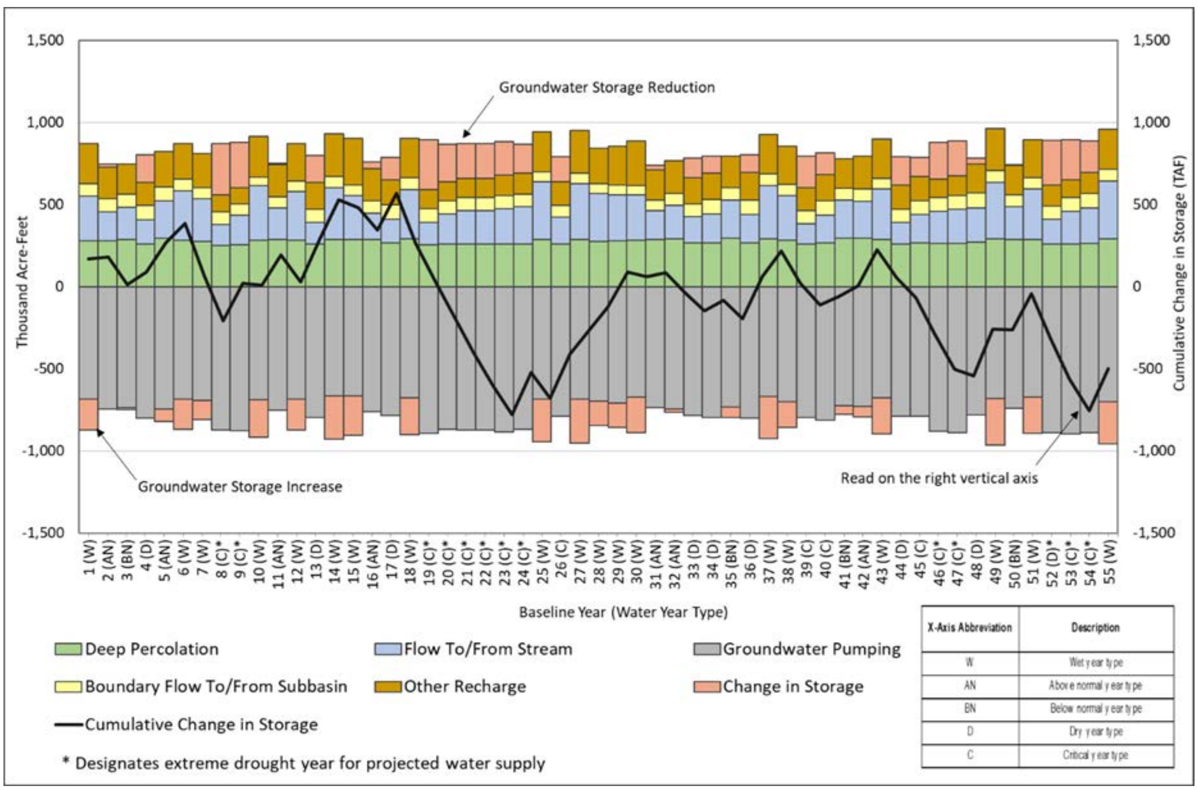
Pumping in the PCBL-PMA Version 3.0 remains the largest component in the groundwater budget with an annual average 766 TAFY. The PCBL-PMA Version 3.0 offsets this pumping with 275 TAFY of deep percolation, a net gain from stream of 223 TAFY, 184 TAFY of other recharge, and a total subsurface inflow of 75 TAFY. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-PMA Version 3.0 is 9 TAFY, indicating that some groundwater overdraft is still occurring even with the Category A projects. These annual averages are shown in Error! Reference source not found.. The groundwater budgets, with a verage cumulative change in storage, are shown for the ESJ Subbasin in Figure 2-129.

Error! Reference source not found. also includes the PCBL Version 3.0 results and a Category A projects benefit c alculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. The results indicate that the Category A projects will resolve the PCBL Version 3.0 Subbasin overdraft condition when impacts due to climate change are not included. Without projects, the modeling shows an average overdraft of 30 TAFY over the 55 years of the PCBL Version 3.0 simulation. With Category A projects in place, the modelling shows a projected overdraft of -9 TAFY on average in the PCBL-PMA Version 3.0. The PCBL-PMA Version 3.0 shows an average increase of 21 TAFY of groundwater in storage when compared to the PCBL Version 3.0. Compared to the PCBL Version 3.0, with Category A projects modeled, the PCBL-PMA Version 3.0 has 33 TAFY less groundwater pumping due to the new in-lieu recharge projects, 19 TAFY more recharge (both direct recharge projects and canal seepage losses for the in-lieu recharge projects), and 17 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL Version 3.0 and PCBL-PMA Version 3.0 simulations.

Table 2-26: ESJ Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL (Version 3.0) and the PCBL-PMA (Version 3.0)

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-PMA Version 3.0	PMA Benefit (PCBL-PMA Version 3.0 minus PCBL Version 3.0)
Deep Percolation (TAF)	270	275	6
Other Recharge (TAF)	165	184	19
Net Stream Seepage (TAF)	240	223	-17
Net Boundary Inflow (TAF)	94	75	-19
Groundwater Pumping (TAF)	799	766	-33
Change in Groundwater Storage (AF)	-30	-9	21

Figure 2-129: ESJ Subbasin Projected Hydrologic Groundwater Budget in the PCBL-PMA Version 3.0



2.4.9 Projected Water Budget with Climate Change and PMAs Estimates (ESJWRM PCBL-CC-PMA Version 3.0)

The results of the Subbasin ESJWRM Projected Condition BaseLine with Climate Change and Category A Projects and Management Actions (PCBL-CC-PMA) are summarized below. Detailed results for the PCBL-CC- PMA are included in Appendix 2-C of this revised GSP. As with the PCBL-CC, the projected conditions with climate change and projects and management actions scenario of the ESJWRM assumes a 2040 level of development and hydrology from water years 1969-2023 with the 2070 Central Tendency climate change dataset. A summary of the 13 Category A PMAs simulated as additional diversions in the PCBL-CC- PMA model is provided in Error! Reference source not found., along with fractions for recoverable loss (i.e., percolation or canal seepage), non-recoverable loss (i.e., evaporation), and delivery (i.e., amount delivered is equal to the total amount minus the recoverable and non-recoverable losses).

2.4.9.1 Land and Water Use Water Budget

The average annual PCBL-CC-PMA Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,401 TAFY, consisting of approximately 1,238 TAFY of agricultural demand and 162 TAFY of urban demand. This demand is met by an annual average of 572 TAFY of surface water deliveries (493 TAFY of agricultural and 79 TAFY of urban deliveries) and is supplemented by 835 TAFY of groundwater production (767 TAFY of agricultural and 68 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is about 22 TAFY of surplus in the Subbasin scale agricultural water use budget, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 2-27. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 2-130 and Figure 2-131 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 2-27 also includes the PCBL-CC Version 3.0 results and a Category A projects benefit calculated as the PCBL-CC-PMA Version 3.0 results minus the PCBL-CC Version 3.0 results. The PCBL-CC-PMA Version 3.0 has an average of 41 TAFY more surface water for agricultural purposes and 6 TAFY more surface water for urban areas compared to the PCBL-CC Version 3.0. For urban areas, this represents a reduction in groundwater pumping of 600 AFY. For agricultural areas, the increased surface water results in 34 TAFY less groundwater pumping, a number smaller than the amount of surface water provided due to a mismatch between the Category A water supplied and model-calculated agricultural demand on a monthly basis.

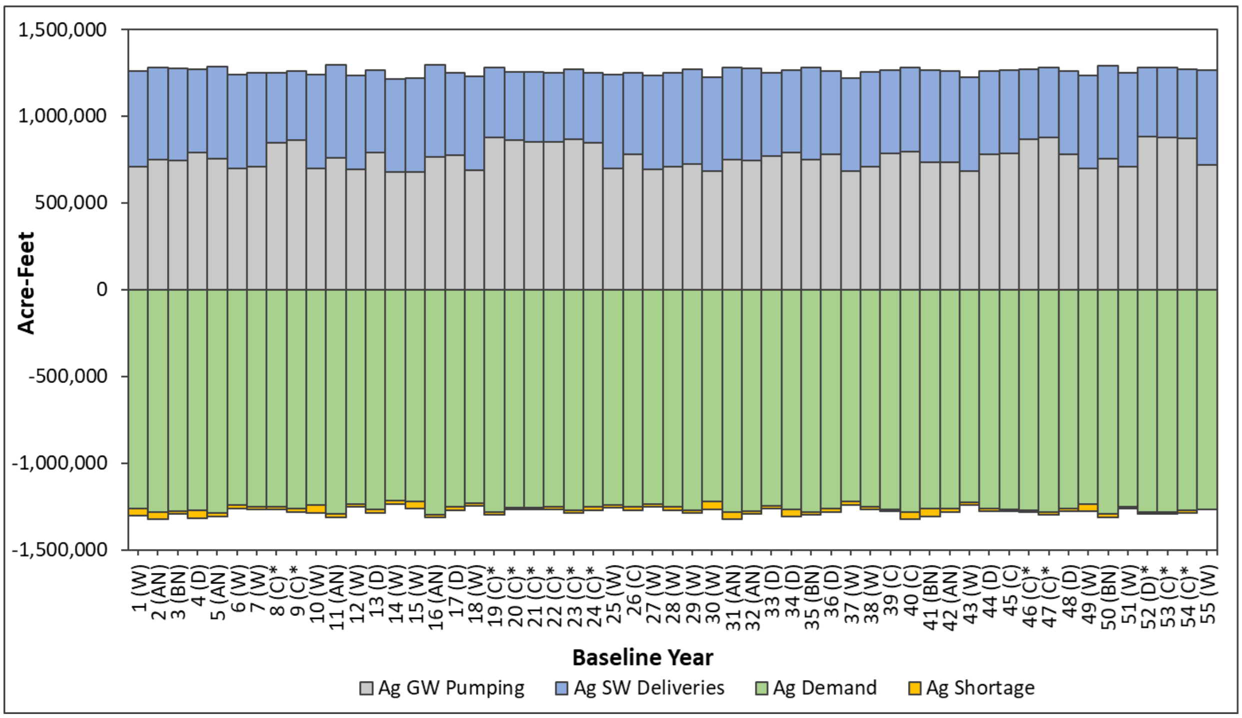
Differences between the amount of surface water supplied for PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0 are due to differences in the amount of surface water available in streams impacted by climate change. These differences are small (less than 200 AFY) between results in Table 2-25 and Table 2-27.

Table 2-27: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL-CC Version 3.0 and PCBL-CC-PMA Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL-CC Version 3.0	PCBL-CC-PMA Version 3.0	PMA Benefit (PCBL-CC-PMA Version 3.0 minus PCBL-CC Version 3.0)
Agricultural Area (thousand acres)	365	365	0
Agricultural Demand (TAF)	1,240	1,238	-1
Agricultural Groundwater Pumping (TAF)	801	767	-34
Agricultural Surface Water Deliveries (TAF)	452	493	41

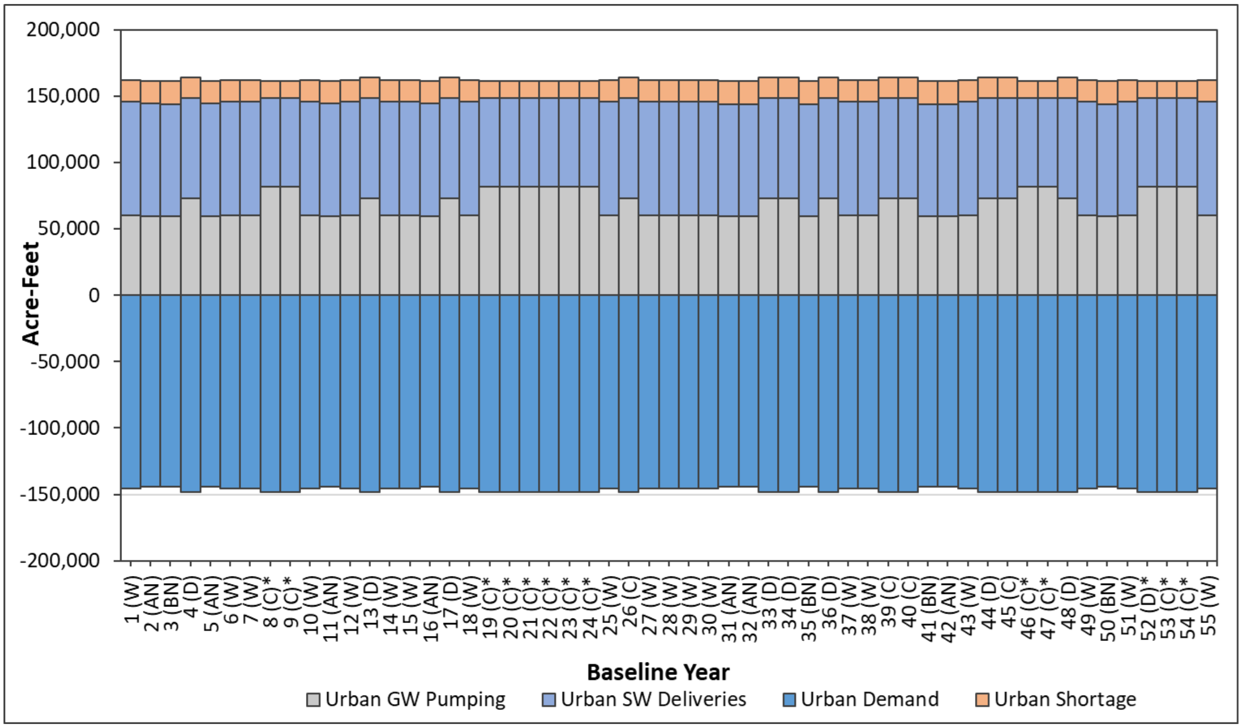
Agricultural Surplus (TAF)[1]	14	22	8
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	162	6
Urban Groundwater Pumping (TAF)	67	68	1
Urban Surface Water Deliveries (TAF)	73	79	6
Urban Shortage (TAF)[1]	16	16	0

Figure 2-130: ESJ Subbasin Projected Agricultural Demand in the PCBL-CC-PMA Version 3.0



[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 2-131: ESJ Subbasin Projected Urban Demand in the PCBL-CC-PMA Version 3.0



2.4.9.2 Hydrologic Groundwater Budget

Pumping in the PCBL-CC-PMA Version 3.0 remains the largest component in the groundwater budget with an annual average 846 TAFY. The PCBL-CC-PMA Version 3.0 offsets this pumping with 274 TAFY of deep percolation, a net gain from stream of 260 TAFY, 187 TAFY of other recharge, and a total subsurface inflow of 91 TAFY annually. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-CC-PMA Version 3.0 is 34 TAFY, indicating that groundwater overdraft is still occurring even with the Category A projects due to the impacts climate change on the Subbasin. These annual averages are shown in **Error! Reference source not found.**. The groundwater budgets, with average cumulative change in storage, are s hown for the ESJ Subbasin in Figure 2-132.

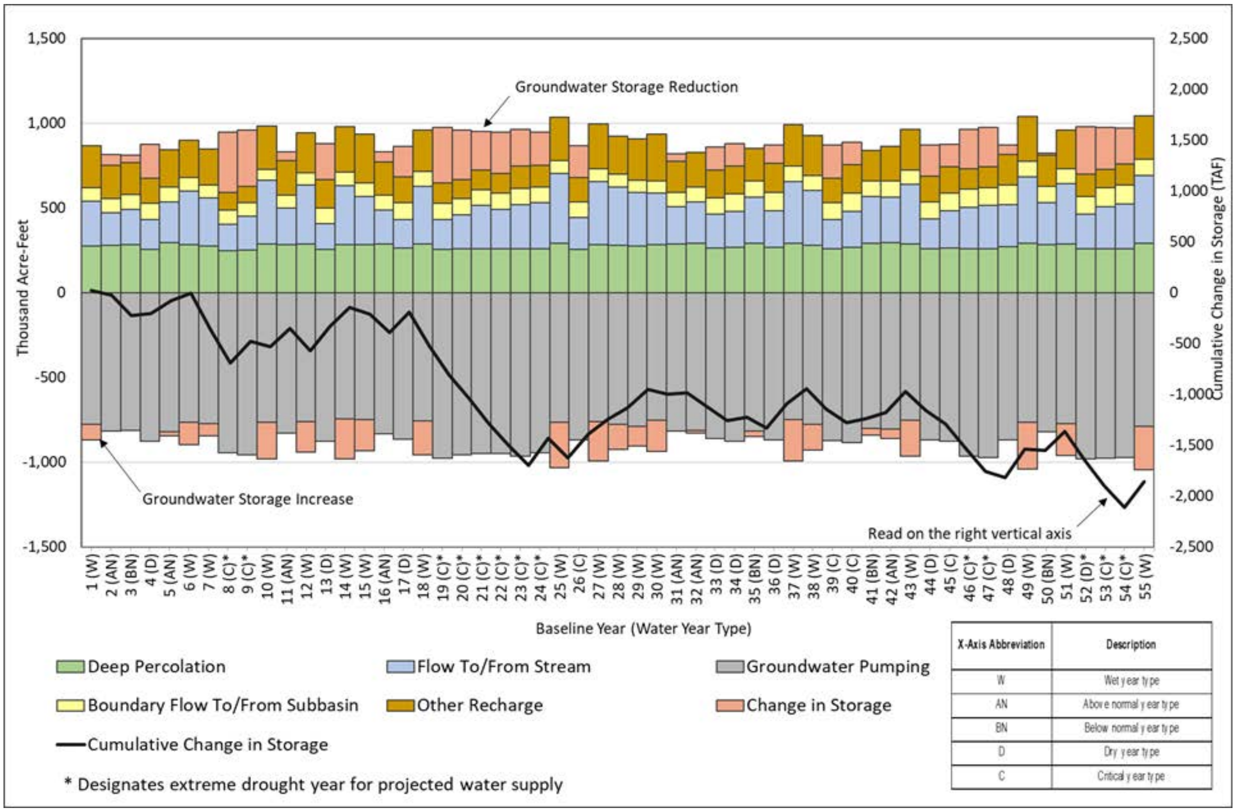
Error! Reference source not found. also includes the PCBL Version 3.0 results and a Category A projects benefit c alculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. While the groundwater storage deficit in the PCBL Version 3.0 is projected to be corrected through the implementation of Category A projects as seen in PCBL-PMA Version 3.0, the modeling shows that when climate change is factored in for the PCBL-CC-PMA Version 3.0, there is still additional work (e.g., projects and/or management actions) that may need to be done to maintain subbasin sustainability. The PCBL-CC Version 3.0 has a projected overdraft of 56 TAFY. When projects are added in, as simulated in PCBL-CC-PMA Version 3.0, this overdraft amount is reduced to 34 TAFY, but still represents continuing groundwater overdraft in the Subbasin that is not sustainable.

Compared to the PCBL-CC Version 3.0, with Category A projects modeled, the PCBL-CC-PMA Version 3.0 has 34 TAFY less groundwater pumping due to the new in-lieu recharge projects, 19 TAFY more recharge (both direct recharge projects and canal seepage losses for the in-lieu recharge projects), and 17 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL-CC Version 3.0 and PCBL-CC-PMA Version 3.0 simulations.

Table 2-28: ESJ Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL-CC and the PCBL-CC-PMA Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL-CC	PCBL-CC-PMA Version 3.0	PMA Benefit (PCBL-CC-PMA Version 3.0 minus PCBL-CC)
Deep Percolation (AF)	268	274	6
Other Recharge (AF)	168	187	19
Net Stream Seepage (AF)	276	260	-17
Net Boundary Inflow (AF)	111	91	-20
Groundwater Pumping (AF)	879	846	-34
Change in Groundwater Storage (AF)	-56	-34	22

Figure 2-132: Eastern San Joaquin Subbasin Projected Hydrologic Groundwater Budget in the PCBL-CC-PMA



For a comparison of the PCBL water budget results with and without PMAs and with and without climate change, please see Appendix 2-C of this updated GSP.

ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Sustainable Management Criteria

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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Appendices

Acronyms

AEM	airborne electromagnetic survey
AF/year	acre-feet per year
AWMPs	Agricultural Water Management Plans
Bay-Delta Plan	Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary
CASGEM	California Statewide Groundwater Elevation Monitoring
CGPS	continuous global positioning system
CSJWCD	Central San Joaquin Water Conservation District
CVRWQCB	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
DDW	Division of Drinking Water
DPC	Delta Protection Commission
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
Eastside GSA	Eastside San Joaquin GSA
EC	electrical conductivity
EPA	Environmental Protection Agency
ESJ	Eastern San Joaquin
ESJGWA Board	Eastern San Joaquin Groundwater Authority Board of Directors
ESJWRM	Eastern San Joaquin Water Resources Model
GAMA	Groundwater Ambient Monitoring and Assessment
GDEs	groundwater-dependent ecosystems
GMP	Groundwater Management Plan
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWL	groundwater level
HCM	Hydrogeologic Conceptual Model
ILRP	Irrigated Lands Regulatory Program
InSAR	interferometric synthetic aperture radar
IRWMP	Integrated Regional Water Management Plan
ISW	interconnected surface water
LCWD	Linden County Water District
LCSD	Lockeford Community Services District
MAF	million acre-feet
MCL	maximum contaminant level
mg/L	milligrams per liter
MO	measurable objective
MokeWISE	Mokelumne Watershed Interregional Sustainability Evaluation
MSL	mean sea level
MT	minimum threshold
NSJWCD	North San Joaquin Water Conservation District
OES	San Joaquin County Office of Emergency Services
OID	Oakdale Irrigation District
OSWCR	Online System for Well Completion Reports
RCA	recommended corrective action
RMN	representative monitoring network
RWQCB	Regional Water Quality Control Board
SEWD	Stockton East Water District
SDWA	South Delta Water Agency
SGMA	the Sustainable Groundwater Management Act

SJCFCWCD	San Joaquin County Flood Control and Water Conservation District
SMC	sustainable management criteria
SMCL	secondary maximum contaminant levels
SSJ GSA	South San Joaquin GSA
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TDS	total dissolved solids
TSS	Technical Support Services
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
Water Code	California Water Code
WDR	Waste Discharge Requirement
WID	Woodbridge Irrigation District

3. SUSTAINABLE MANAGEMENT CRITERIA

Several requirements of Groundwater Sustainability Plans (GSPs) fall under the heading of "Sustainable Management Criteria". These criteria include:

- Sustainability Goal
- Undesirable Results
- Minimum Thresholds
- Measurable Objectives

The Eastern San Joaquin (ESJ) GSP developed these criteria based on information about the Subbasin developed in the hydrogeologic conceptual model (Section 2.1), the descriptions of historical and current groundwater conditions (Section 2.2 and 2.3, respectively), the water budget (Section 2.4), and input from stakeholders during the GSP development process (Section 1.3.4). The sustainable management criteria were developed by working with the Eastern San Joaquin Groundwater Authority Board of Directors (ESJGWA Board), Advisory Committee, and Groundwater Sustainability Workgroup (Workgroup) over several months in 2018 and into 2019 and were revised to address Recommended Corrective Actions (RCAs) presented by the California Department of Water Resources (DWR) in their July 6, 2023 determination letter approving the 2022 Eastern San Joaquin GSP.

This amended GSP considers the six sustainability indicators defined by the Sustainable Groundwater Management Act (SGMA) in the development of sustainable management criteria. SGMA allows several pathways to meet the distinct local needs of each groundwater basin, including development of sustainable management criteria, usage of other sustainability indicators as a proxy, and identification of indicators as not being applicable to the basin. This GSP relies on groundwater levels as a proxy for minimum thresholds and measurable objectives for reduction in groundwater storage and eliminates seawater intrusion as an applicable sustainability criterion.

3.1 SUSTAINABILITY GOAL

The California Water Code (Water Code) defines sustainable groundwater management as "the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results" (CA Water Code §10721). The planning and implementation horizon includes a 20-year implementation period until 2040 where sustainability is achieved and a 50-year planning period where pumping is maintained within the sustainable yield. The sustainability goal reflects this requirement and succinctly states the Groundwater Sustainability Agencies' (GSAs') objectives and desired conditions of the Subbasin.

The sustainability goal description for the Eastern San Joaquin Subbasin is *to maintain an economically-viable groundwater resource for the beneficial use of the people of the Eastern San Joaquin Subbasin by operating the Subbasin within its sustainable yield or by modification of existing management to address future conditions. This goal will be achieved through the implementation of a mix of supply and demand type projects consistent with the GSP implementation plan* (see Chapter 6: Projects and Management Actions and Chapter 7: Plan Implementation).

Groundwater levels in the Subbasin may continue to decline during the implementation period. However, as projects are implemented and basin operations are modified, sustainable groundwater management will be achieved, and levels will stabilize on a long-term average basis. The Subbasin will be managed to prevent undesirable results throughout the implementation period, despite the possible decline of groundwater elevations. This sustainability goal is supported by locally-defined minimum thresholds that will avoid undesirable results. Demonstration of stable groundwater levels on a long-term average basis combined with the absence of undesirable results will ensure the Subbasin is operating within its sustainable yield (see Section 2.4.6) and the sustainability goal will be achieved.

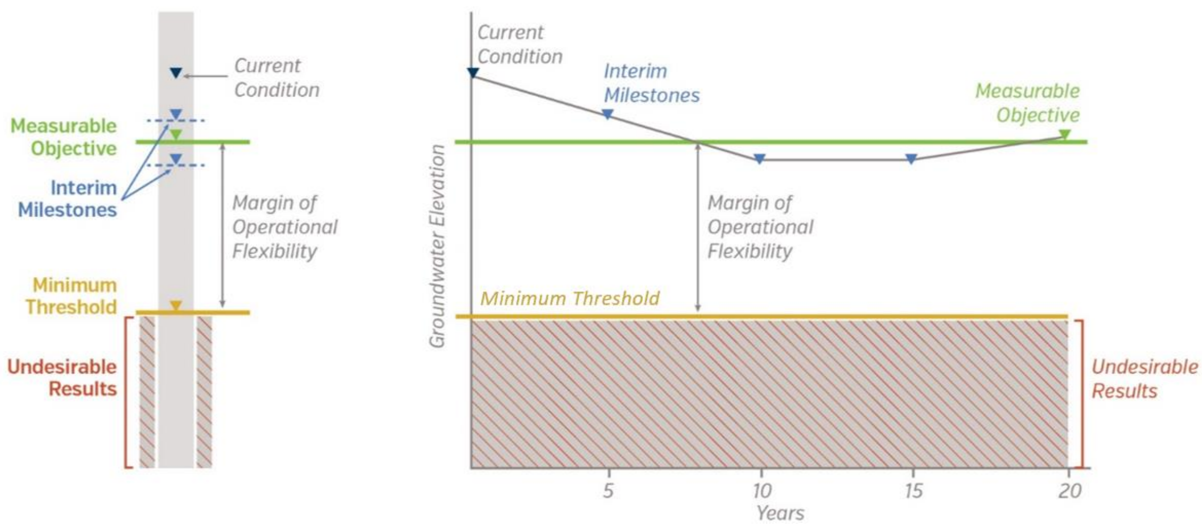
An explanation of how the goal will be achieved is included in Chapter 6: Projects and Management Actions.

Sustainable Management Criteria Definitions

- Undesirable Results – Significant and unreasonable negative impacts associated with each sustainability indicator, avoidance of which is used to guide development of GSP components
- Minimum Threshold – Quantitative threshold for each sustainability indicator used to define the point at which undesirable results may begin to occur
- Measurable Objective – Quantitative target that establishes a point above the minimum threshold that allows for a range of active management in order to prevent undesirable results
- Interim Milestones – Targets set in increments of 5 years over the implementation period of the GSP to put the basin on a path to sustainability
- Margin of Operational Flexibility – The range of active management between the measurable objective and the minimum threshold

See Figure 3-1 for a graphic that demonstrates the relationship between the Sustainable Management Criteria terms.

Figure 3-1: Sustainable Management Criteria Definitions Graphic (Groundwater Levels Example)



3.2 UPDATES TO SUSTAINABILITY INDICATORS

The Eastern San Joaquin Groundwater Authority (ESJGWA) received a Consultation Initiation Letter (Letter) on November 18, 2021 (Appendix 3-A) from DWR. The Letter identified two potential deficiencies with the Eastern San Joaquin Groundwater Subbasin (Subbasin) GSP which precluded DWR's approval, as well as potential corrective actions to address each potential deficiency. The Letter thus initiated consultation between DWR, the Plan Manager, and the Subbasin's GSAs regarding the amount of time needed to address the potential deficiencies and corrective actions. A subsequent meeting with DWR was held on April 4, 2022 to discuss the Subbasin's proposed approach to addressing the identified deficiencies. Revisions to the sustainability indicators and sustainable management criteria were subsequently incorporated into the 2020 Eastern San Joaquin GSP and a revised GSP submitted to DWR on July 27, 2022. In a July 6, 2023 letter, DWR staff concluded that the GSAs had taken sufficient actions to correct deficiencies identified by DWR and approved the 2022 Plan (see Appendix 3-B).

In their July 2023 letter, DWR identified the eight RCAs for the GSAs to consider during preparation of its 5-year Periodic Evaluation. Per DWR's October 2023 guidance entitled *Groundwater Sustainability Plan Implementation: A Guide to Annual Reports, Periodic Evaluations, & Plan Amendments*, "Plan Amendments are completed at the discretion of the GSAs. SGMA and the GSP Regulations do not establish when an amendment is required, nor do they describe what components of the Plan should be amended. In general, however, the more significant or material a change to a GSP or its implementation, the more likely a Plan Amendment is warranted." As the 2024 ESJ Subbasin Periodic Evaluation and associated consideration of DWR's RCAs as contained in their July 2023 determination letter resulted in substantive changes to both sustainable management criteria (SMC) and representative monitoring networks (RMNs), the ESJ GSAs have opted to amend their 2022 GSP. This amended GSP chapter incorporates the responses and associated work to address DWR's eight RCAs, reflecting changes made to the Subbasin sustainability indicators and SMC. Documentation of modifications made to Subbasin sustainability indicators and SMC and additional explanation as to how the Subbasin sustainability indicators and SMC were determined can be found in the appendices as follows:

- RCA No. 1(a) through 1(d) addressed in Appendix 3-C
- RCA No. 2 addressed in Appendix 3-D
- RCA No. 3 addressed in Appendix 3-E
- RCA No. 4 addressed in Appendix 3-E
- RCA No. 5 addressed in Appendix 3-F
- RCA No. 6 addressed in Appendix 3-G
- RCA No. 7 addressed in Appendix 3-F
- RCA No. 8 addressed in Appendix 3-F

3.3 REVISED SUSTAINABILITY INDICATORS

3.3.1 Chronic Lowering of Groundwater Levels

3.3.1.1 Undesirable Results

3.3.1.1.1 Description of Undesirable Results

SGMA defines undesirable results related to chronic lowering of groundwater as:

Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

An undesirable result for chronic lowering of groundwater levels in the Eastern San Joaquin Subbasin is experienced if sustained groundwater levels are too low to satisfy beneficial uses within the Subbasin over the planning and implementation horizon of this GSP (see Section 1.3.1 for a discussion of beneficial uses and users). Potential impacts and the extent to which they are considered significant and unreasonable were determined by the ESJGWA Board with input by the Advisory Committee, Workgroup, Project Management Committee, and members of the public. During development of and revisions to the GSP, potential undesirable results identified by stakeholders included a significant and unreasonable:

- Number of wells going dry
- Reduction in the pumping capacity of existing wells
- Increase in pumping costs due to greater lift
- Need for deeper well installations or lowering of pumps
- Adverse impacts to environmental uses and users, including interconnected surface waters and groundwater dependent ecosystems (GDEs)

3.3.1.1.2 Identification of Undesirable Results

An undesirable result is considered to occur during GSP implementation when at least 25 percent of representative monitoring wells used to monitor groundwater levels (5 of 21[1] wells in the Subbasin) fall below their minimum level thresholds for two consecutive years.

Two consecutive years of minimum threshold exceedances are used to determine if an undesirable result has occurred and to establish a pattern rather than indicate an isolated event. The lowering of groundwater levels during dry or critically-dry years is not considered to be unreasonable unless the levels do not rebound to above the thresholds following wet conditions or are otherwise mitigated through adaptive management or implementation of projects and management actions. While statistically, three data points are required to establish a trend, three years of exceedances was felt to be too extreme, whereas a single exceedance was not sufficient to establish a trend. Therefore, the two consecutive years was selected as part of this definition.

At least 25 percent of representative monitoring wells used to monitor groundwater levels falling below their minimum thresholds for two consecutive years was presented to the Eastern San Joaquin Technical Advisory Committee (ESJ TAC) during the April 10, 2019 meeting and was approved by the Eastern San Joaquin Groundwater Authority (ESJGWA) Board during the May 8, 2019 meeting. The 2020 GSP used the Eastern San Joaquin Water Resources Model (ESJWRM) results under the projected conditions baseline scenario to evaluate impacts associated minimum threshold exceedances. The model results considered in determining that a 25 percent exceedance threshold were sufficient to determine that undesirable results would occur subbasin-wide (e.g., were not a localized event). The 25% exceedance threshold was further evaluated in response to DWR's comments in their 2022 Determination letter, specifically as it relates to both domestic and municipal supply wells and GDEs in the Subbasin. See Appendix 1-G for

[1] Three wells have been added to the representative monitoring network for groundwater levels since the 2020 GSP. One well has historical data (01S10E04C001M) and SMC have been established for that well. The other two were newly constructed under the TSS program and do not have established SMC as of this Amended GSP due to a lack of data.

analyses around potential domestic and public supply well impacts and GDE impacts associated with the 25 percent exceedance portion of the definition of undesirable results.

3.3.1.1.3 Potential Causes of Undesirable Results

The Eastern San Joaquin Subbasin is currently designated as a critically overdrafted subbasin by DWR, a designation originally placed on the Subbasin in 1980 (CA DWR, 1980). The Subbasin has experienced undesirable results related to chronic lowering of groundwater levels in the past, which resulted in the deepening of wells. These historical undesirable results, as well as the widespread deepening of Subbasin wells, were identified through anecdotal data provided by GSAs and through review of prior planning documents, including the 2014 Eastern San Joaquin Integrated Regional Water Management Plan (ESJ IRWMP), which indicates that water levels fell to "unprecedented levels" in the fall of 1992, and that "many private groundwater users were forced to modify or deepen wells during the prolonged 1986-1992 drought period" (Eastern San Joaquin County GBA, 2014). Due to these prior efforts to mitigate low groundwater levels, undesirable results in the Subbasin were remedied. Each ESJGWA member GSA indicated, through multiple meetings, that no current undesirable results exist in their GSA, largely citing these prior large-scale well-deepening efforts and significant undertakings to augment surface water supplies.

Future undesirable results could result from insufficient groundwater recharge and/or offset or delays in implementation of GSP programs or projects due to increased demand or regulatory, permitting, or funding obstacles.

3.3.1.1.4 Potential Effects of Undesirable Results

If groundwater levels were to cause undesirable results, effects could include de-watering of a subset of the existing groundwater infrastructure, starting with the shallowest wells, which are generally domestic wells, and adverse effects on GDEs, to the extent connected with the production aquifer. Lowering levels to this degree could necessitate changes in irrigation practices and crops grown and could cause adverse effects to property values and the regional economy. Additionally, undesirable results due to declining groundwater levels could adversely affect current and projected municipal uses translating into increased costs for potable water supplies.

Potential effects of undesirable results related to GDEs is an area that has been identified as a data gap requiring further study, including through future shallow groundwater monitoring efforts discussed in Section 4.7. However, current databases were used in updated mapping of GDEs and the associated analysis of potential impacts as a result of the undesirable results definition for this sustainability parameter. See Appendix 1-G for more information.

3.3.1.2 Minimum Thresholds

The minimum thresholds for chronic lowering of groundwater levels are the shallower at each representative monitoring well site of the following:

- 2015 groundwater level low with a buffer of 100 percent of historical range applied, *or*
- The 10th percentile domestic well total depth of wells within a 3-mile radius of the monitoring well.[2,3]

As a starting point, a potential minimum threshold was considered for each representative monitoring well based on groundwater level data collected in 2015, if available. A buffer was subtracted from the minimum 2015 groundwater elevation. The buffer was calculated by finding the difference between the minimum and maximum groundwater level over the historical record for each representative monitoring well. The addition of the buffer provides a range of

2 A radius of 2 miles was used for well 03N07E21L003 to reflect domestic well depths in close proximity to the Mokelumne River.

3 In municipalities with ordinances requiring the use of City water (water provided by the City's municipal wells), the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.

operational flexibility in which groundwater levels may continue to decline during implementation of projects and management actions until sustainable yield is reached. The buffer allows for flexibility to account for natural fluctuations in groundwater levels but avoids significant and unreasonable impacts to groundwater levels.

The ESJGWA Board determined that dewatering of domestic wells and impacts to small community drinking water systems may be a potential undesirable result that could be used to confirm the adequacy of the minimum threshold methodology. Domestic wells and those associated with small community water systems are generally shallower than agricultural and municipal wells and thus more sensitive to undesirable effects such as dry wells. Additionally, the loss of a domestic well usually results in a loss of water for consumption, cooking, and sanitary purposes, which can often have substantial impacts on the users of the water and can be financially difficult for the well owner to replace. The 10th percentile domestic well depth (i.e., the depth of the top 10th percent most shallow well) was examined within a radius around the monitoring well representative of local conditions. A radius of 3 miles around each representative monitoring well was used to identify the 10th percentile domestic well construction depth. For representative monitoring well 03N07E21L003, a 2-mile radius was used due to variations in groundwater levels due to its proximity to the Mokelumne River. The 3-mile radius around each representative monitoring well (including the 2-mile radius of monitoring well 03N07E21L003 and the two additional radii that do not contain representative monitoring wells), includes over 4,000 domestic wells, 165 public supply wells and 58 community water systems in the Subbasin. In cases where the 10th percentile domestic well depth was shallower than the historical drought low with the buffer, that value was developed as the minimum threshold to prevent undesirable results associated with dewatering wells in the Subbasin.

Domestic and public water system well data were retrieved from the Online System for Well Completion Reports (OSWCR) database, which is sparsely populated with information on total casing depth, screening intervals, and the age of the well. The 10th percentile well depth was chosen due to the uncertainty in the database and to account for the fact that domestic wells (predominantly) may have been drilled to a very shallow depth prior to the current well drilling standards enforced by local jurisdictions and/or have reached the end of their lifecycle. The 10th percentile domestic well depth for groundwater levels is protective of approximately 90 percent of the domestic wells in the OSWCR dataset and is used as a criterion for determining if a decline in groundwater levels is significant and unreasonable under SGMA. In municipalities with ordinances requiring the use of City water (water provided by the City's municipal wells), the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.

Figure 3-2 shows the location of groundwater level representative monitoring wells throughout the Eastern San Joaquin Subbasin. This updated representative monitoring network includes two new multi-completion wells constructed in 2021 by DWR under the Technical Support Services (TSS) program. Table 3-1 lists the corresponding numeric minimum thresholds at each representative monitoring well and the basis. Additional data on the monitoring wells and minimum thresholds, including hydrographs of historical observed data and domestic well analysis, are provided in Appendix 3-H and 3-I.

The basis for design and selection of the SMCs is the lowest drought-related groundwater conditions observed. The ESJGWA and GSAs focused the GSP goals on the long-term sustainability of the Subbasin and implementation of projects that would help all beneficial users to have a reliable and resilient water supply, even in time of drought, and provide the ability to respond to climate change. The ESJGWA and GSAs are supportive of ongoing agricultural, urban, and industrial water conservation efforts and of achieving the highest levels of water use efficiency technically achievable. It should be noted that water conservation programs have been successful in reducing urban and agricultural water demands such that those demands have become "hardened" and are less able to be reduced in time of drought without real impacts to the quality of life or economy. GSP projects and management actions are designed to reduce overdraft, and to provide sustainable supplies through a drought without severe impacts to quality of life or the economy.

For the two new multi-completion wells have been added to the representative monitoring network for groundwater levels, and for any new monitoring wells that may be added to the representative monitoring network in the future, SMCs for these new wells will be established after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs.

Minimum thresholds for these and other new wells that may be constructed in the future will be established based on adjusted recent groundwater levels from a dry/critical year. The adjustment of groundwater levels is the difference in simulated groundwater levels in ESJWRM between Water Year 2015 (a dry year) and the recent dry/critical year when groundwater level observations are measured. The calculation for the minimum threshold is:

$$Minimum\ Threshold = Observed\ Recent\ Dry/Critical\ GWL - \ (Simulated\ Recent\ Dry\ Year\ GWLs - Simulated\ 2015\ GWLs)$$

As a hypothetical example, suppose Water Year 2027 is a critical year and the observed groundwater elevation for Well A is 75 feet mean sea level (msl) in 2027. Assuming that the simulated groundwater elevations in ESJWRM at Well A increase by 8 feet between 2015 and 2027. The minimum threshold would be 75 feet minus 8 feet, or 67 feet msl. In the absence of historical data, this methodology is meant to estimate historical conditions as closely as possible.

The GSP was not targeted toward emergency responses to drought or the short-term impacts associated with drought since this is the focus of the County Office of Emergency Services (OES) and a requirement for the water purveyors. In addition, the prevailing urban water management plans (UWMPs) and agricultural water management plans (AWMPs) identify water conservation goals and demand reduction targets, including water shortage contingency plans, and the ESJGWA and GSAs are supportive of those plans (and the drought contingency responses) and will encourage the lead agencies for those plans to implement actions and programs consistent with local and state requirements. The ESJGWA will work to better coordinate with the OES and urban purveyors to support emergency drought response efforts. The ESJGWA and GSP development has included representatives from the urban suppliers and will continue to seek opportunities to engage with OES, the urban purveyors and to work to identify mutual goals, objectives and project opportunities.

Additionally, the ESJGWA and GSAs will evaluate other programs as part of an adaptive management strategy (including a demand reduction strategy), and along with an annual evaluation of Subbasin conditions, will continue outreach efforts to domestic well owners and small water systems regarding information related to forecasted water levels with and without project implementation to inform subsequent investments decisions for well improvement and replacement; produce and distribute current and forecasted groundwater level information to well permit applicants to inform the permitting process; review well standards to evaluate opportunities to establish standards to better reflect current and forecasted groundwater level conditions; and actively promote small systems interties and/or consolidation of their systems to achieve supply reliability.

If drinking water impacts are observed during GSP implementation as a result of the established minimum thresholds, the ESJGWA will evaluate the need to revise the minimum threshold methodology and/or implement additional projects or management actions, such as the Subbasin's domestic well mitigation program (Appendix 3-J) to mitigate such impacts (as described in Appendix 3-C). The ESJGWA and GSAs will evaluate other programs as part of the adaptive management strategy, and annual program evaluation and reporting.

The future amendments to the Subbasin GSP will more closely evaluate and include information on UWMP water shortage contingency plans, and the ESJGWA will coordinate with the County OES to support emergency drought responses and plans.

Figure 3-2: Location of Representative Monitoring Wells for Groundwater Levels

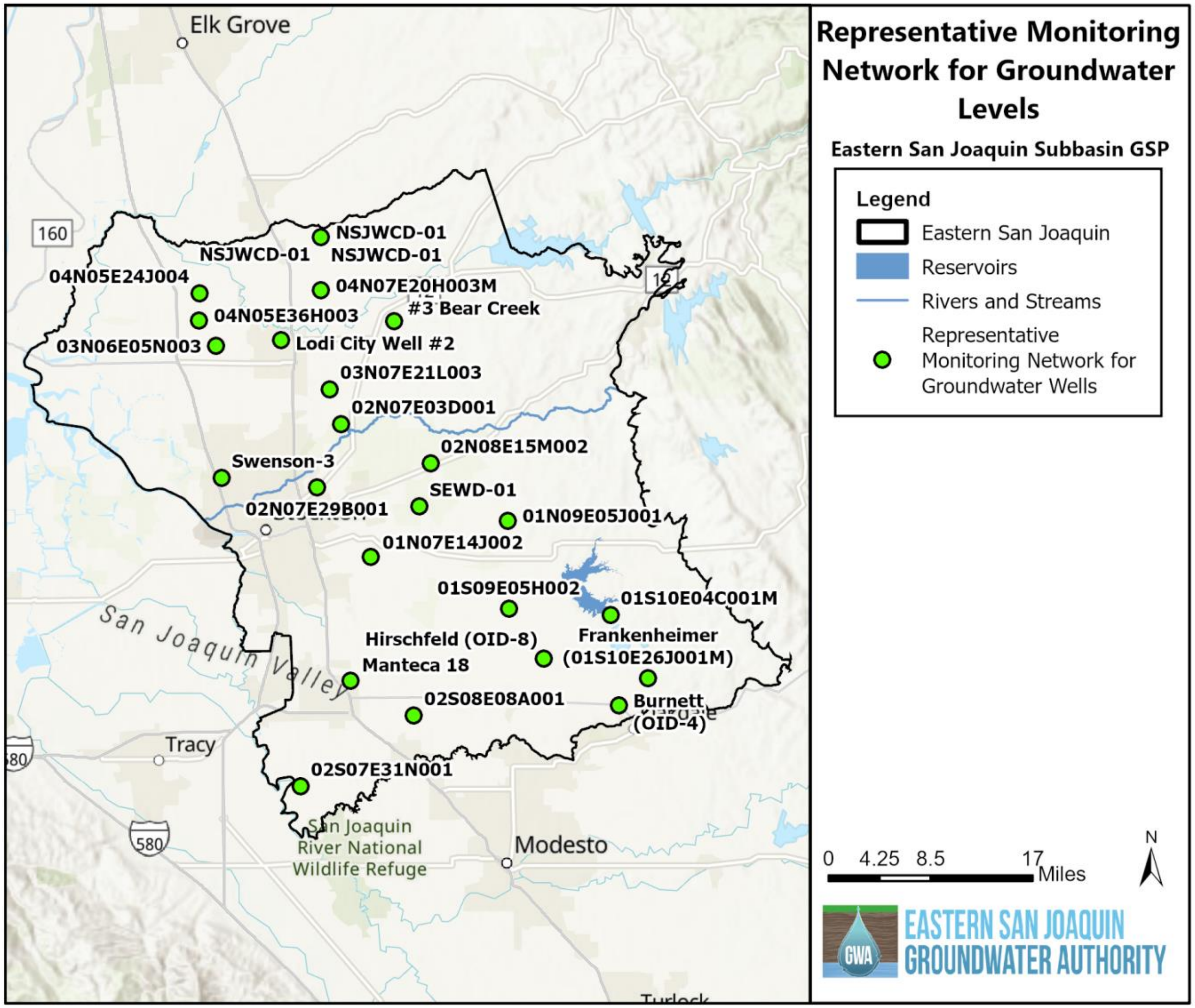


Table 3-1: Minimum Thresholds for Chronic Lowering of Groundwater Levels

Narrative Description			
The minimum threshold is set at the 2015 groundwater level low with a buffer of 100 percent of historical range applied, *or* the 10th percentile domestic well depth, whichever is shallower. In municipalities with ordinances requiring the use of City water, the 10th percentile municipal well depth is used in place of the 10th percentile domestic well depth criteria.			
Numeric Minimum Thresholds			
GSA Well is Located in[1]	Well ID	Minimum Threshold (feet mean sea level [MSL])	Basis for Threshold
CSJWCD	01S09E05H002	-49.8	10th percentile domestic well depth
CSJWCD	01N07E14J002	-93.9	2015 groundwater level with a buffer of 100 percent of historical range
City of Lodi	Lodi City Well #2	-34.4	2015 groundwater level with a buffer of 100 percent of historical range
City of Manteca	Manteca 18	-19.0	2015 groundwater level with a buffer of 100 percent of historical range
City of Stockton	Swenson-3	-26.6	2015 groundwater level with a buffer of 100 percent of historical range
Eastside GSA	01S10E26J001M	43.7	2015 groundwater level with a buffer of 100 percent of historical range
Eastside GSA	01S10E04C001M	54.7	2015 groundwater level with a buffer of 100 percent of historical range
LCWD	02N08E15M002	-124.1	10th percentile domestic well depth
LCSD	#3 Bear Creek	-73.8	2015 groundwater level with a buffer of 100 percent of historical range
NSJWCD	04N07E20H003M	-80.5	2015 groundwater level with a buffer of 100 percent of historical range
NSJWCD	03N07E21L003	-94.0	2015 groundwater level with a buffer of 100 percent of historical range
NSJWCD	NSJWCD-01[2]	TBD	New SMC methodology
OID	Hirschfeld (OID-8)	7.9	2015 groundwater level with a buffer of 100 percent of historical range
OID	Burnett (OID-4)	60.8	2015 groundwater level with a buffer of 100 percent of historical range
SDWA	02S07E31N001	0.8	2015 groundwater level with a buffer of 100 percent of historical range
SSJ GSA	02S08E08A001	0.6	2015 groundwater level with a buffer of 100 percent of historical range
SEWD	02N07E03D001	-113.7	10th percentile domestic well depth
SEWD	01N09E05J001	-86.8	10th percentile domestic well depth
SEWD	02N07E29B001	-130.1	10th percentile domestic well depth
SEWD	SEWD-01[2]	TBD	New SMC methodology
WID	04N05E36H003	-31.1	2015 groundwater level with a buffer of 100 percent of historical range
WID	03N06E05N003	-35.1	2015 groundwater level with a buffer of 100 percent of historical range
WID	04N05E24J004	-31.2	2015 groundwater level with a buffer of 100 percent of historical range

1 Acronyms defined: Central San Joaquin Water Conservation District (CSJWCD), Eastside San Joaquin GSA (Eastside GSA), Linden County Water District (LCWD), Lockeford Community Services District (LCSD), North San Joaquin Water Conservation District (NSJWCD), Oakdale Irrigation District (OID), South Delta Water Agency (SDWA), South San Joaquin GSA (SSJ GSA), Stockton East Water District (SEWD), Woodbridge Irrigation District (WID).

2 New multi-completion well constructed in 2021 under the DWR Technical Support Services (TSS) program.

3.3.1.3 Measurable Objectives and Interim Milestones

Measurable objectives are quantitative goals that reflect the desired Subbasin condition and allow the Subbasin to achieve its sustainability goal. The measurable objective is set to allow a reasonable margin of operational flexibility between minimum thresholds to allow for active management of the Subbasin during dry periods without reaching the minimum threshold. The margin of operational flexibility is intended to accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities. The margin of operational flexibility is defined as the difference between the minimum threshold and the measurable objective. The measurable objective for chronic lowering of groundwater levels is defined as the 2015 groundwater level low values.

Table 3-2 lists the measurable objectives for each representative monitoring well. The margin of operational flexibility is defined at each well as the difference between the minimum and maximum groundwater level over the historical record for that well.

Table 3-2: Measurable Objective for Chronic Lowering of Groundwater Levels

Narrative Description		
The measurable objective is set at the 2015 groundwater level low.		
Numeric Measurable Objectives		
GSA Well is Located in	Well ID	Measurable Objective (feet MSL)
CSJWCD	01S09E05H002	-8.6
CSJWCD	01N07E14J002	-49.9
City of Lodi	Lodi City Well #2	0.6
City of Manteca	Manteca 18	2.8
City of Stockton	Swenson-3	-19.3
Eastside GSA	01S10E26J001M	81.7
Eastside GSA	01S10E04C001M	76.4
LCWD	02N08E15M002	-63.2
LCSD	#3 Bear Creek	-51.8
NSJWCD	04N07E20H003M	-35.5
NSJWCD	03N07E21L003	-51.5
NSJWCD	NSJWCD-01[1]	TBD
OID	Hirschfeld (OID-8)	31.5
OID	Burnett (OID-4)	79.7
SDWA	02S07E31N001	12.3
SSJ GSA	02S08E08A001	24.0
SEWD	02N07E03D001	-61.7
SEWD	01N09E05J001	-22.6

GSA Well is Located in	Well ID	Measurable Objective (feet MSL)
SEWD	02N07E29B001	-80.4
SEWD	SEWD-01[1]	TBD
WID	04N05E36H003	-5.1
WID	03N06E05N003	-14.1
WID	04N05E24J004	-6.2

1. New multi-completion well constructed in 2021 under the DWR Technical Support Services (TSS) program.

Similar to minimum thresholds, for the two new multi-completion wells have been added to the representative monitoring network for groundwater levels, and for any new monitoring wells that may be added to the representative monitoring network in the future, measurable objectives for these new wells will be established after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs.

For new wells lacking sufficient historical data, measurable objectives will be established from an adjustment in groundwater levels from a wet year. The adjustment will add the difference in simulated groundwater levels from ESJWRM between Water Year 2011 (a wet year) and a recent wet year when groundwater level observations are collected. The calculation for measurable objectives is:

$$Measurable\ Objectives = Observed\ Recent\ Wet\ GWL + (Simulated\ Recent\ Wet\ Year\ GWL - Simulated\ 2011\ GWLs)$$

As a hypothetical example, suppose Water Year 2026 is a wet year, and the observed groundwater elevation for Well A is 82 feet msl that year. Suppose that the simulated groundwater elevations in ESJWRM at Well A decrease by 15 feet between Water Year 2011 and 2026. The measurable objective would be 82 feet minus negative 15 feet, equaling 97 feet msl.

To assist the Subbasin in reaching the measurable objective for groundwater levels, interim milestones for 2025, 2030, and 2035 were developed to keep implementation on track. Interim milestones are based on achieving the sustainability goal within the 20-year time period provided by SGMA.

Table 3-3 shows the 5-year milestones, which follow a stepwise trend between the current condition and the measurable objective. Fall 2015 groundwater levels were used to define current conditions where data were available, and the average of fall 2013, fall 2014, and fall 2016 were used where fall 2015 data were not available. For new wells lacking sufficient historical data, interim milestones will be established as appropriate at the time minimum thresholds and measurable objectives are established for the wells. Interim milestones will depend on the date when these other SMC were developed.

Table 3-3: Interim Milestones for Chronic Lowering of Groundwater Levels

Narrative Description
5-year milestones are assumed to remain similar to current for the first 10 years and then follow along a linear trend between the current condition and the measurable objective.
Numeric Interim Milestones

GSA Well is Located in	Well ID	Current Condition (feet MSL)	Measurable Objective (feet MSL)	Interim Milestones		
				2025	2030	2035
CSJWCD	01S09E05H002	-8.7	-8.6	-8.7	-8.7	-8.7
CSJWCD	01N07E14J002	-49.9	-49.9	-49.9	-49.9	-49.9
City of Lodi	Lodi City Well #2	0.6[1]	0.6	0.6	0.6	0.6
City of Manteca	Manteca 18	9.1	2.8	9.1	9.1	6.0
City of Stockton	Swenson-3	-19.3	-19.3	-19.3	-19.3	-19.3
Eastside GSA	01S10E26J001M	81.7	81.7	81.7	81.7	81.7
Eastside GSA	01S10E04C001M	78.0	76.4	78.0	78.0	77.2
LCWD	02N08E15M002	-63.2	-63.2	-63.2	-63.2	-63.2
LCSD	#3 Bear Creek	-49.3	-51.8	-49.3	-49.3	-50.6
NSJWCD	04N07E20H003M	-35.5	-35.5	-35.5	-35.5	-35.5
NSJWCD	03N07E21L003	-51.5	-51.5	-51.5	-51.5	-51.5
NSJWCD	NSJWCD-01[2]	TBD	TBD	TBD	TBD	TBD
OID	Hirschfeld (OID-8)	31.5	31.5	31.5	31.5	31.5
OID	Burnett (OID-4)	79.7	79.7	79.7	79.7	79.7
SDWA	02S07E31N001	13.8[1]	12.3	13.8	13.8	13.1
SSJ GSA	02S08E08A001	22.2[1]	24.0	22.2	22.2	23.1
SEWD	02N07E03D001	-61.7	-61.7	-61.7	-61.7	-61.7
SEWD	01N09E05J001	-20.2	-22.6	-20.2	-20.2	-21.4
SEWD	02N07E29B001	-49.8[1]	-80.4	-49.8	-49.8	-65.1
SEWD	SEWD-01[2]	TBD	TBD	TBD	TBD	TBD
WID	04N05E36H003	-5.1	-5.1	-5.1	-5.1	-5.1
WID	03N06E05N003	-14.1	-14.1	-14.1	-14.1	-14.1
WID	04N05E24J004	-6.2	-6.2	-6.2	-6.2	-6.2

1. Current Condition is the average of fall groundwater levels for 2013-2016
2. New multi-completion well, constructed in 2021 under the DWR Technical Support Services (TSS) program.

3.3.2 Reduction in Groundwater Storage

3.3.2.1 Undesirable Results

3.3.2.1.1 Description of Undesirable Results

The ESJGWA has determined that an undesirable result for the reduction of groundwater storage is experienced if sustained groundwater storage volumes are insufficient to satisfy beneficial uses within the Subbasin over the planning and implementation horizon of this GSP (see Section 1.3.1 for a discussion of beneficial uses and users).

Undesirable results related to groundwater storage in the Subbasin have not occurred historically, are not currently occurring, and are not likely to occur in the future. As discussed in the current and historical groundwater conditions section of this GSP (Section 2.2), there is a large volume (approximately 53 million acre-feet [MAF]) of freshwater in storage. An analysis of groundwater storage using the Eastern San Joaquin Water Resources Model (ESJWRM) Version 1.1 was conducted for the 2020 GSP to evaluate groundwater storage conditions between 1996 and 2015. The results of this analysis showed a range of fluctuation from 1996 to 2015 of approximately 0.01 percent per year. The updated ESJWRM Version 3.0 was subsequently used to evaluate the range of fluctuations from 1996 to 2023; the results of this modeling showed a similar result. See Section 2.2.2 for additional quantification of groundwater storage. A discussion of the geology of the Subbasin can be found in Section 2.1. Information on the updated ESJWRM Version 3.0 model can be found in Appendix 2-C.

3.3.2.1.2 Identification of Undesirable Results

An undesirable result occurs when groundwater storage volumes are insufficient to satisfy beneficial uses within the Subbasin. To identify a volume associated with undesirable results, the ESJWRM Version 1.1 was run for the 2020 GSP to estimate the volume of groundwater storage needed to meet beneficial uses. This analysis determined that groundwater demand for beneficial use occurs within the shallowest 23 MAF of the Subbasin, as this is roughly the zone corresponding to the depth at which pumping occurs and is reasonably expected to occur in the future. Based on this analysis, it was estimated that overlying pumpers have limited access equating to approximately the shallowest 23 MAF of groundwater storage in the Subbasin; therefore, the 2020 GSP defined an undesirable result would occur if groundwater storage levels were depleted by 23 MAF. However, if 23 MAF of groundwater were removed from the Subbasin, groundwater levels would have to drop substantially below the MTs set for groundwater levels. As such, impacts would be experienced under the definition of undesirable results for groundwater levels long before the 23 MAF would have been removed from the Subbasin.

Given that the chronic lowering of groundwater levels is directly related to overdraft conditions, if an undesirable result for groundwater levels occurs first, then mitigation will be activated to respond to the undesirable result, effectively making groundwater level SMC already protective of beneficial uses of groundwater noted in the original undesirable result definition. And as groundwater levels are directly measurable and groundwater storage is not, it is reasonable to use groundwater levels as a proxy for reductions in groundwater storage. To evaluate the approximate volume of groundwater that could potentially be removed from storage before impacts associated with groundwater level undesirable results were experienced, additional analyses were conducted using the updated ESJWRM Version 3.0 model. Model scenarios were simulated where various groupings of five representative monitoring network wells dropped to their associated minimum thresholds under the Projected Conditions Baseline with Climate Change (PCBL-CC) Version 3.0 scenario. The various well groups were chosen based on proximity to the Subbasin's groundwater depression area, historical sustainable management criteria performance, and spatial distribution throughout the Subbasin. The resulting reduction in groundwater storage from each of these test scenarios was recorded and found to vary from 10 MAF to 13 MAF. As such, the undesirable result for reductions in groundwater storage was updated to be between 10 to13 MAF. Defining a range in storage for this undesirable result acknowledges the uncertainty associated with the model in terms of storage. As the climate change scenario was used in the analysis, it also allows for consideration of the uncertainty associated with how extreme impacts of climate changes may be and where impacts within the Subbasin. Additional detail on the update to the undesirable result for storage can be found in Appendix 3-E.

3.3.2.1.3 Potential Causes of Undesirable Results

While reduction of 23 MAF within the SGMA planning horizon of 2040 is highly unlikely, an event of a catastrophic nature or prolonged and exaggerated increases in the mining of groundwater due to extreme and severe drought or major changes in groundwater management over time could cause a reduction of groundwater storage to a significant and unreasonable level, and it is highly likely that the minimum thresholds established for groundwater levels would have been exceeded before this reduction in groundwater in storage would occur. Based on the analysis contained in Appendix 3-E, between approximately 10 and 13 MAF of groundwater would need to be removed from Subbasin storage to trigger undesirable results relating to groundwater levels. And as groundwater levels are a proxy for change in groundwater storage, these values also trigger undesirable results for the reduction in groundwater storage.

Section 7.4.4 references factors that could affect the availability of surface water, including State Water Resources Control Board (SWRCB) plans to reduce flows available for use by 40-60 percent as part of the Water Quality Control Plan for the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan).

3.3.2.1.4 Potential Effects of Undesirable Results

If groundwater levels were to reach levels causing undesirable results, significant and unreasonable effects could include degradation of produced water quality from groundwater sources; insufficient fresh groundwater to access in drought years; increased cost of access; and reduction in beneficial uses, such as domestic supply and changes to agriculture.

3.3.2.2 Minimum Thresholds

This GSP uses groundwater level minimum thresholds as a proxy for the reduction in groundwater storage sustainability indicator.

GSP regulations allow GSAs to use groundwater levels as a proxy metric for any sustainability indicator provided the GSP demonstrates that there is a significant correlation between groundwater levels and the other metrics. In order to rely on groundwater levels as a proxy, one approach suggested by DWR is to:

> *Demonstrate that the minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of other sustainability indicators will be prevented. In other words, demonstrate that setting a groundwater level minimum threshold satisfies the minimum threshold requirements for not only chronic lowering of groundwater levels but other sustainability indicators at a given site* (CA DWR, 2017).

Minimum thresholds for groundwater levels will effectively avoid undesirable results for reduction of groundwater storage. The ESJWRM Version 3.0 was run to estimate the reduction in groundwater storage that would occur if the chronic lowering of groundwater levels sustainability indicator undesirable result was triggered. The results of this analysis showed that this scenario would result in a reduction of approximately 10 to 13 MAF of storage.[4] Because undesirable results as a result of lowering groundwater levels are anticipated to occur prior to a reduction of 23 MAF, the minimum thresholds for groundwater levels are protective of beneficial uses. Minimum thresholds and measurable

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[4] Volumes based on ESJWRM Version 3.0 estimates were calculated using multiple scenarios where five representative monitoring wells for groundwater levels reached their minimum thresholds across the Subbasin. Representative monitoring wells considered to exceed their minimum thresholds were selected based on proximity to the Subbasin's groundwater depression, historical sustainable management criteria performance, and spatial distribution throughout the Subbasin.

objectives for groundwater levels can therefore be used as a proxy for reduction in groundwater storage, as groundwater levels are sufficiently protective against occurrences of significant and unreasonable reduction in groundwater storage.

3.3.2.3 Measurable Objectives and Interim Milestones

As chronic lowering of groundwater levels is used as a proxy for reduction in groundwater storage, the measurable objectives and interim milestones for the reduction in groundwater storage sustainability indicator are the same measurable objectives and interim milestones as for the chronic lowering of groundwater levels sustainability indicator as set forth in Section 3.3.1.3.

3.3.3 Degraded Water Quality

3.3.3.1 Undesirable Results: Degraded Water Quality

3.3.3.1.1 Description of Undesirable Results

The undesirable result related to degraded water quality is defined in SGMA as:

> *Significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies.*

An undesirable result for degraded water quality in the Eastern San Joaquin Subbasin is experienced if SGMA-related groundwater management activities cause significant and unreasonable impacts to the long-term viability of domestic, agricultural, municipal, environmental, or other beneficial uses over the planning and implementation horizon of this GSP.

Salinity and chlorides (a component of salinity) are the only water quality constituents for which minimum thresholds are established in the Eastern San Joaquin Subbasin. High salinity in the western portion of the Subbasin has been an area of historical concern, as described in Section 2.2. There is potential for pumping to contribute to the movement of high saline water from the three sources noted by O'Leary et al. (2015): Sacramento-San Joaquin River Delta (Delta) sediments, deep deposits (called connate water), and irrigation return water (see Section 2.2.4.1). Other constituents, including arsenic and nitrate are evaluated in Section 2.2, with monitoring efforts described in Section 4.3. These constituents are managed through existing management and regulatory programs within the Subbasin, such as the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and the Irrigated Lands Regulatory Program (ILRP), which focus on improving water quality by managing septic and agricultural sources of salinity and nutrients. Additionally, point-source contaminants are managed and regulated through a variety of programs by the Regional Water Quality Control Board (RWQCB), Department of Toxic Substances Control (DTSC), and the U.S. Environmental Protection Agency (EPA). Through new monitoring efforts, the GSP will document trends in these constituents and identify opportunities for coordination with existing programs. A description of existing regulations and requirements for these constituents is provided in Section 2.2.4. Through coordination with existing agencies and through additional monitoring, the ESJGWA will know if existing regulations are being met or groundwater pumping activities in the Subbasin are contributing to significant and unreasonable undesirable effects related to degraded water quality.

Total dissolved solids (TDS) was selected for the evaluation of sustainable management criteria for salinity under this sustainability indicator, as historical data for TDS are more widely available in the Eastern San Joaquin Subbasin than other constituents used to measure salinity, such as electrical conductivity (EC) or chloride. This decision was made by the ESJGWA Board based on the greater availability of TDS data in the Subbasin. TDS data are available through existing monitoring programs such as the CV-SALTS program and Groundwater Ambient Monitoring and Assessment (GAMA) Program or through monitoring or regulatory agencies such as United States Geological Survey (USGS), DWR, SWRCB, and the Central Valley Regional Water Quality Control Board (CVRWQCB) Waste Discharge Requirement (WDR) Dairy program. Additionally, GSA members and their affiliates including Cal Water, SJCFCWCD, and the cities of Stockton, Lodi, and Manteca, provided TDS data from existing production wells. Chloride was also selected as a sustainability indicator for this sustainable management criterion. Chloride is a component (anion) of salinity and an indicator constituent of saltwater intrusion. Given the proximity of the Subbasin to the Delta, and the identification of Delta sediments as a potential source of salinity (O'Leary et. al, 2015), the use of chloride as an indicator of concern was deemed appropriate.

3.3.3.1.2 Identification of Undesirable Results

Undesirable results occur during GSP implementation when more than 25 percent of representative monitoring wells (3 of 10 sites) exceed the minimum thresholds for water quality for two consecutive years and where these concentrations are the result of groundwater management activities.

In addition to the monitoring of changes in groundwater elevations and the potential for those changes to result in undesirable results relative to groundwater quality, the ESJGWA and GSAs will collaborate and share data with other programs monitoring water quality data to observe both ambient and regulated conditions. Programs for coordination include, but are not limited to, the Irrigated Lands Regulatory Program (ILRP) and Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS), two existing regulatory programs for the monitoring and regulation of nitrate and salts. The ESJGWA, in coordination with the GSAs, will evaluate changes in groundwater quality on a bi-annual basis, in coordination with groundwater level monitoring, to determine if groundwater management has the potential to be a contributing factor to declines in groundwater quality. If so, the GSA(s) will coordinate with responsible regulatory agency(ies) to establish a plan to alleviate or prevent further degradation. Please see Appendix 3-F for additional information as to how the ESJGWA and Subbasin GSAs will coordinate to identify undesirable results and the potential causes of the decline in groundwater quality, and to develop and implement appropriate management actions to address that degradation.

3.3.3.1.3 Potential Causes of Undesirable Results

Elevated TDS concentrations in the Subbasin are the result of natural processes and overlying land use activities (O'Leary et al., 2015). Pumping in excess of recharge has resulted in declining aquifer water levels and led to an increase of salinity in groundwater wells since the 1950s (O'Leary et al., 2015). Within the Subbasin, there are localized concerns related to salinity along with three primary sources of salinity, as discussed in Section 2.2.4 of this GSP. To this end, potential mechanisms for causes of undesirable results include human-induced degradation and changes in water levels that may influence water quality, including:

- Falling groundwater levels which may cause migration of already-degraded groundwater from natural sources, nonpoint sources (salt, nitrate), or a plume from a point source.
- Rising groundwater levels creating changes in oxidation potential and mobilization of arsenic.
- Rising groundwater levels from recharge operations or reduced pumping that could mobilize nitrates or salts in the vadose zone.

3.3.3.1.4 Potential Effects of Undesirable Results

The potential effects of undesirable results related to degraded groundwater quality include reduction in usable supply of groundwater, increased treatment costs, and required access to alternate supplies, which can be unaffordable for small users. Some water quality issues could potentially cause more impact to agricultural uses than municipal or domestic uses depending on the impact of the constituent of concern to these water use sectors. Water quality degradation may cause potential changes in irrigation practices or crops grown, adverse effects to property values, and other economic effects.

3.3.3.2 Minimum Thresholds

There are two constituents of concern for the Eastern San Joaquin Subbasin – Total Dissolved Solids (TDS) and chloride (representative of salinity). The minimum threshold for degraded water quality at all representative monitoring well locations is 1,000 milligrams per liter (mg/L) TDS, 250 mg/L chloride, or the groundwater concentration of those constituents as measured in 2015 at that representative monitoring location, whichever is greater. Figure 3-3 shows the representative monitoring locations for groundwater quality.

Minimum thresholds for this sustainability indicator are focused on addressing the major groundwater quality issue of salinity by monitoring TDS and chloride as representative constituents and preventing future water quality degradation due to pumping. Additional constituents, including nitrate and arsenic, will be monitored for informational purposes through the water quality monitoring network to identify trends and fill data gaps (see Section 3.3.3.4).

The ESJGWA Board selected a minimum threshold of 1,000 mg/L for TDS and 250 mg/L for chloride, or the constituent concentration as measured in 2015 (whichever is greater), based on stakeholder concerns for drinking water and agricultural beneficial uses. The minimum threshold reflects input from agricultural and municipal stakeholders, including local drinking water purveyors and the local agricultural community. A meeting was held in Fall 2018 with GSA representatives in areas impacted by high salinity. Representatives from San Joaquin County, City of Lodi, City of Manteca, City of Stockton, and Cal Water were in attendance. Additionally, members of the Workgroup who represent agribusiness interests provided input on the salinity levels at which crops begin to become impacted by salinity. Subsequent communications with Subbasin GSPs and outreach efforts conducted during the preparation of this Amended GSP have confirmed the same concerns regarding salinity concerns as in 2018.

During preparation of this Amended GSP, the inclusion of seawater intrusion as an applicable sustainability criterion was revisited. After further discussions, it was decided that seawater intrusion was not an appropriate sustainability criterion, but chloride was still a constituent of concern. As such, chloride was added as a constituent of concern to be addressed and managed through the groundwater quality sustainability indicator.

In the development of minimum thresholds, beneficial uses of groundwater as a drinking water supply and as an agricultural supply were considered. For drinking water, the secondary maximum contaminant levels (SMCLs) for TDS and chloride were considered. As noted in Section 2.2, the SWRCB Division of Drinking Water (DDW) has established SMCLs for both TDS and chloride in drinking water supplies. SMCLs are established for aesthetic reasons such as taste, odor, and color, and are not based on public health concerns. For TDS, the Recommended SMCL is 500 mg/L, an Upper Limit SMCL is 1,000 mg/L, a Short-Term limit is 1,500 mg/L (SWRCB, 2017). For chloride, the SMCL is 250 mg/L. For agricultural uses, salinity tolerances of major Subbasin crops were considered. As previously stated in Section 1.2.1, dominant Subbasin crops are fruit and nut trees (primarily almonds, cherries, and walnuts), grapes, and alfalfa (USDA, 2015). Salinity tolerances for Subbasin crops range from 900 mg/L TDS (for almonds) to 4,000 mg/L TDS (for wheat) (Texas A&M AgriLife Extension, 2003, adapted from Ayers and Westcott, 1976; Hoffman, 2010). Salinity tolerances of major Subbasin crops are shown in

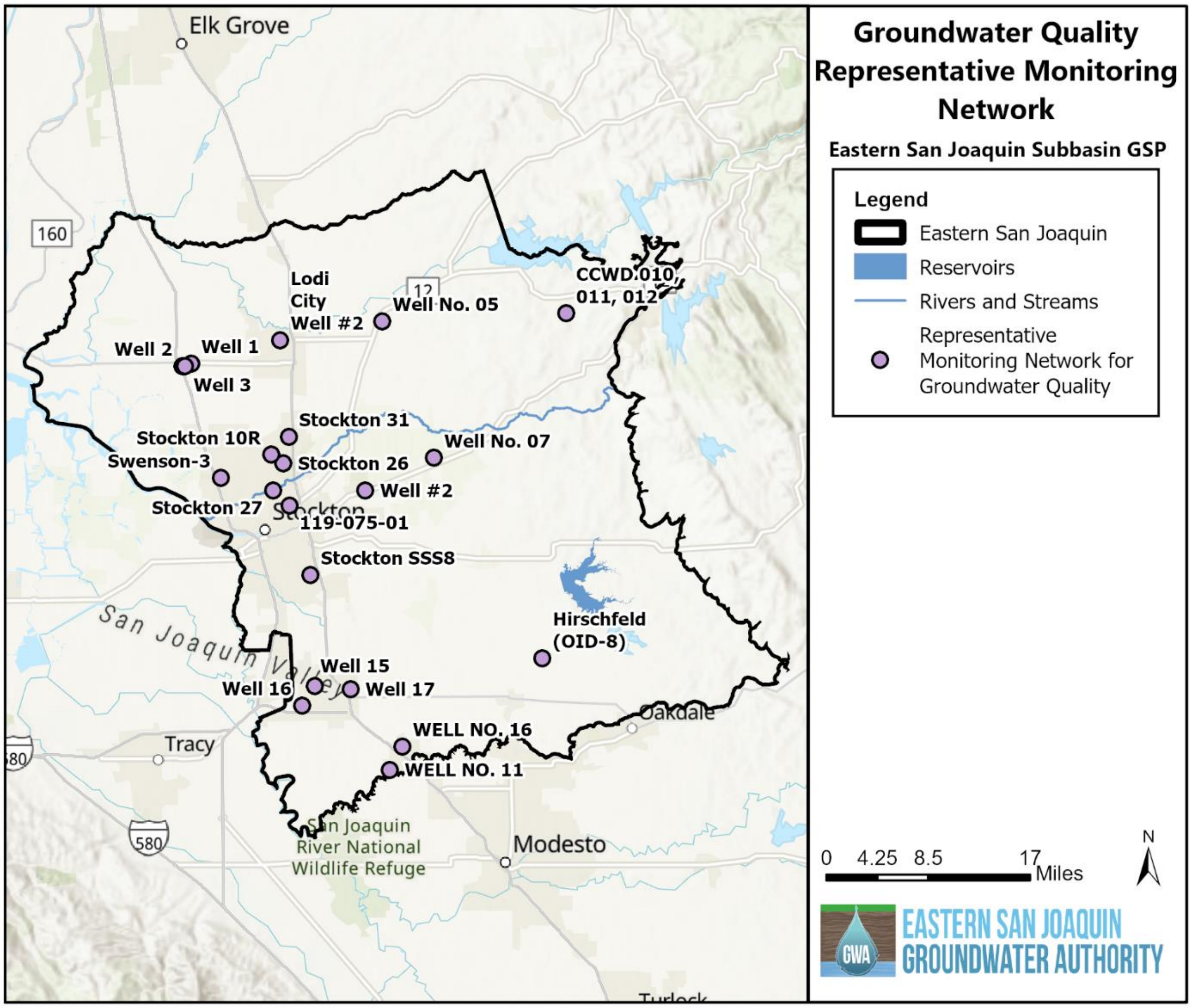
Table 3-4. Because fruit and nut trees and vineyards collectively cover more than half of the acreage of the Subbasin, the minimum threshold was centered on the salinity impact of these crop types. These crop types have lower salinity tolerances, in the range of 900 to 1,000 mg/L TDS. Standards in this range are considered protective of these crop types and therefore the majority of Subbasin crops. TDS values are estimated based on applied irrigation water electrical conductivity values for a 90 percent crop yield potential (Texas A&M AgriLife Extension, 2003, adapted from Ayers and Westcott, 1976).

Table 3-4: Salinity Tolerances of Major Subbasin Crops

Crop Type	Salinity Tolerance (mg/L TDS)
Fruit & Nut Trees - Almonds	900
Fruit & Nut Trees - Apples	1,000
Vineyards - Grapes	1,100
Alfalfa	1,400
Grain - Wheat	4,000
Field Crops - Corn	1,100
Truck Crops - Tomatoes	1,500
Rice	1,700

As the overall goal of the groundwater quality sustainable management criteria is to avoid worsening groundwater quality from 2015 conditions through basin management activities, the minimum thresholds for both TDS and chloride were set at the respective constituent's SMCL (the Upper Limit for TDS) or 2015 groundwater quality concentration, whichever is greater, thereby acknowledging those portions of the Subbasin where degraded groundwater quality existed prior to 2015.

Figure 3-3: Location of Representative Monitoring Wells for Water Quality



Should an existing groundwater quality impairment or new groundwater quality impact be identified as having a direct impact on groundwater users, the ESJGWA and/or GSAs will coordinate with the appropriate regulatory agency(ies) to communicate the situation to those impacted, and will adaptively work with the regulatory agency(ies) to manage the situation. Additionally, the ESJGWA proposes the following program management actions for the Subbasin GSAs to be coordinated through the ESJGWA:

1. Regular Process for coordination
    a. The ESJGWA will hold an annual "groundwater water quality state of the basin" meeting or workshop in January and invite the members of the San Joaquin County & Delta Water Quality Coalition (Coalition) to present the results of the monitoring program.
    b. The ESJ Technical Advisory Committee (TAC) and Subbasin GSAs will invite participation and ex officio representation from the CVRWQCB staff to receive regular information regarding ILRP, CV-SALTS and any planned updates or amendments to the Central Valley *Water Quality Control Plan* (Basin Plan).

2. Monitoring
    a. The ESJGWA will seek to develop monitoring and data sharing agreements with the Coalition.

   b. ESJGWA staff will work with the local Environmental Health Division and SWRCB Division of Drinking to identify drinking water wells which are nearing or have exceeded MCLs or SMCLs, noting the location, number of wells and the constituents of concern.

3. Data Management. Where possible, the ESJGWA will include the assessment of water quality data collected via other monitoring networks in their annual assessments and will use this information to further evaluate trends and any correlations between groundwater levels, the groundwater level MTs, and observed water quality conditions.

4. Annual Report. Beyond the reporting of data from the GSP groundwater level and water quality monitoring network, the ESJ Annual Report will include an expanded groundwater quality discussion to document:
   a. The annual results of the Coalition's monitoring program
   b. Known impairments identified by the CVRWQCB pursuant to the Basin Plan
   c. Wells and locations where MCLs have been exceeded as identified by the SWRCB Division of Drinking Water, consumer confidence reports, or the local Environmental Health Department

3.3.3.3 Measurable Objectives and Interim Milestones

At all representative monitoring well locations, the measurable objective (MO) for degraded water quality for TDS is 600 mg/L TDS. For chloride, the MO is the maximum recent historical measurement (as measured between 2015 and 2023). The TDS MO of 600 mg/L was developed based on the TDS recommended SMCL for drinking water of 500 mg/L with an added 100 mg/L buffer. A MO of 600 mg/L TDS is close to the recommended SMCL of 500 mg/L and significantly below the upper limit SMCL of 1,000 mg/L, and is considered adequate for drinking water and agricultural uses. The chloride MO was set equal to the maximum measured chloride concentration as measured during recent historical conditions (between 2015 and 2023), accounting for fluctuations in constituent concentrations with hydrologic conditions.

Interim milestones for 2025, 2030, and 2035 were developed to keep implementation on track to allow the Subbasin to meet the measurable objective for groundwater quality. Table 3-5 shows the 5-year milestones for TDS, which follow along a linear trend between the current condition (defined as the average TDS concentration between 2015 and 2023) and the measurable objective. Similarly,

Table 3-6 shows the 5-year milestones for chloride, which follow along a linear trend between the current condition (defined as the average chloride concentration between 2015 and 2023) and the measurable objective. Interim milestones are based on the measurable objective and will be coordinated with projects and management actions. In two cases (for Well 16 and Well 17), current conditions were calculated by averaging TDS values collected from 2012-2018. Additional detail on the RMN and SMC is included in Appendix 3-F.

Table 3-5: Measurable Objective and Interim Milestones for Degraded Water Quality for Total Dissolved Solids (mg/L TDS)

Narrative Description
5-year milestones follow along a linear trend between the current condition (average TDS concentration between 2015 and 2023) and the measurable objective.
Numeric Interim Milestones

Well ID	Average TDS (2015 - 2023)*	Measurable Objective (mg/L TDS)	Interim Milestones		
			2025	2030	2035
Well 1	445	600	484	523	562
Well 2 (San Joaquin County)	568	600	576	584	592
Well 3	520	600	540	560	580
119-075-01	360	600	420	480	540
Well 15	310	600	383	456	529
Well 16 (City of Manteca)	250	600	338	426	514
Well 17	305	600	379	453	527
Stockton 27	65	600	199	333	467
Stockton SSS8	330	600	398	466	534
Stockton 31	301	600	376	451	526
Stockton 10R	390	600	443	496	549
Well No. 05	227	600	320	413	506
Well No. 07	173	600	280	387	494
Well #2 (Shady Rest Trailer Court)	323	600	392	461	530
WELL NO. 11[1]	610	600	608	605	602
WELL NO. 16[1] (City of Ripon)	580	600	585	590	595
Swenson-3[2]	NA	600	TBD	TBD	TBD
Lodi City Well #2	190	600	293	396	499
Hirschfeld (OID-8)	200	600	300	400	500
CCWD 010, 011, 012[3]	NA	600	TBD	TBD	TBD

NA – Not Available

* Current Condition is the average TDS value for 2015-2023.

[1] No recent groundwater quality observations. Reported concentration from nearby WELL NO. 3. (CA3910007_003_003) from January 2015, January 2018, and January 2021.

[2] Swenson-3 is currently not accessible, but since it is originally a GWL RMN, it is expected to be accessible going forward. If not, then another well will be selected to replace it. There are no recent groundwater quality observations from this well and the data reported in this table is from nearby well ID CA3910012_030_030 in October 1991.

[3] No recent or nearby groundwater quality observations.

Table 3-6: Measurable Objective and Interim Milestones for Degraded Water Quality for Chloride (mg/L chloride)

Narrative Description
5-year milestones follow along a linear trend between the current condition (average chloride concentration between 2015 and 2023) and the measurable objective.
Numeric Interim Milestones

Well ID	Average Chloride (2015 - 2023)*	Measurable Objective (mg/L chloride)	Interim Milestones		
			2025	2030	2035
Well 1	34.6	36	35	35	35
Well 2 (San Joaquin County)	73	73	73	73	73
Well 3	34.6	36	35	35	35
119-075-01	26.6	30	27	28	29
Well 15	15.8	17	16	16	16
Well 16 (City of Manteca)	12.83	16	14	15	16
Well 17	15.2	17	16	16	16
Stockton 27	10.34	26	14	18	22
Stockton SSS8	38.5	41	39	40	41
Stockton 31	27.4	51	33	39	45
Stockton 10R	18	20	19	20	21
Well No. 05	14.7	17	15	16	17
Well No. 07	3.5	3.8	4	4	4
Well #2 (Shady Rest Trailer Court)	16.3	33	20	24	28
WELL NO. 11[1]	75.5	83	77	79	81
WELL NO. 16[1] (City of Ripon)	75.5	83	77	79	81
Swenson-3[2]	100	100	100	100	100
Lodi City Well #2	6.2	6.2	6	6	6
Hirschfeld (OID-8)	12	12	12	12	12
CCWD 010, 011, 012[3]	NA	TBD	TBD	TBD	TBD

NA – Not Available

* Current Condition is the average chloride value for 2015-2023.

[1] No recent groundwater quality observations. Reported concentration from nearby WELL NO. 3. (CA3910007_003_003) from January 2015, January 2018, and January 2021.

[2] Swenson-3 is currently not accessible, but since it is originally a GWL RMN, it is expected to be accessible going forward. If not, then another well will be selected to replace it. There are no recent groundwater quality observations and the reported data is from nearby well ID CA3910012_030_030 in October 1991.

[3] No recent or nearby groundwater quality observations.

3.3.3.4 Monitoring for Additional Constituents

Increased monitoring is needed to identify water quality trends related to additional constituents, including arsenic and nitrate. Arsenic, as well as cations and anions (which include nitrate), will be monitored for informational purposes through the water quality monitoring network (see Section 4.3.2) to identify trends and fill data gaps. Additionally, these constituents are currently regulated in the Subbasin through existing water resources monitoring and management programs, as described in Section 1.2.2. If water quality conditions violate those regulations, or if monitoring efforts indicate concerning trends, the ESJGWA will take steps to coordinate with regulatory agencies and will evaluate establishing minimum thresholds and measurable objectives for these constituents.

Many of the GSAs are drinking water suppliers and are required to provide a consumer confidence report each year. The ESJGWA will consider requiring GSAs that are drinking water suppliers to notify the ESJGWA if constituents of concern exceed their maximum contaminant level (MCL) to assist in identifying potential trends of concern. While these reports do not reflect the water quality of private well owners, it would provide a basin-wide screen to inform basin groundwater quality conditions.

3.3.4 Seawater Intrusion

Seawater intrusion is not considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin as the Subbasin is not in a coastal area and seawater intrusion is not currently present and is not reasonably expected to occur due to the active management of the ‘X2’ salinity barrier by the State (see Section 2.3.3). The ‘X2’ barrier, where the salinity is approximately 2 parts per thousand (ppt), is located well outside of the Subbasin boundary further downstream in the Delta (Cloern, 2012). (For reference purposes, the salinity of the ocean is about 35 ppt.) Various agencies and regulations, such as the Delta Protection Commission (DPC), Delta Stewardship Council, San Joaquin County & Delta Water Quality Coalition, and State Water Board Resolution No. 2009-011, contribute to managing and maintaining salinity conditions in the Delta region.

3.3.5 Land Subsidence

3.3.5.1 Undesirable Results

3.3.5.1.1 Description of Undesirable Results

The undesirable result related to land subsidence is defined in SGMA as:

> *Significant and unreasonable land subsidence that substantially interferes with surface land uses.*

An undesirable result for land subsidence in the Eastern San Joaquin Subbasin is experienced if the occurrence of land subsidence substantially interferes with beneficial uses of groundwater and infrastructure within the Subbasin over the planning and implementation horizon of this GSP. Critical infrastructure in the Eastern San Joaquin Subbasin has been defined in coordination with the San Joaquin County Department of Public Works and the San Joaquin County Office of Emergency Services as the following infrastructure potentially at risk for interference from land subsidence:

- Major highways, roadways, and bridges
- Canals, pipelines, and levees
- Electrical transmission lines
- Schools
- Fire stations
- Hospitals and other medical facilities
- Law enforcement facilities (police stations, jails, correctional facilities)
- Water and wastewater treatment, distribution, and storage facilities
- Communication facilities

The Subbasin is served by an extensive road network, including major interstate highways. The San Joaquin County Department of Public Works maintains the County's 120-mile network of underground facilities, over 1,600 miles of roadway, 265 bridges, and 364 minor structures. In addition, San Joaquin County supports air service, a deep-water port, transcontinental rail, and commuter trains. Major roadways located within the Subbasin boundary include Interstate 5 (I-5) and multiple State Routes (4, 12, 26, 88, 99, 120). Major bridges in the Subbasin serve both automobile and railroad transport and include the San Joaquin River Bridge, Littlejohns Creek Bridge, Mormon Slough Bridge, and the Union Pacific Mossdale Bridge East.

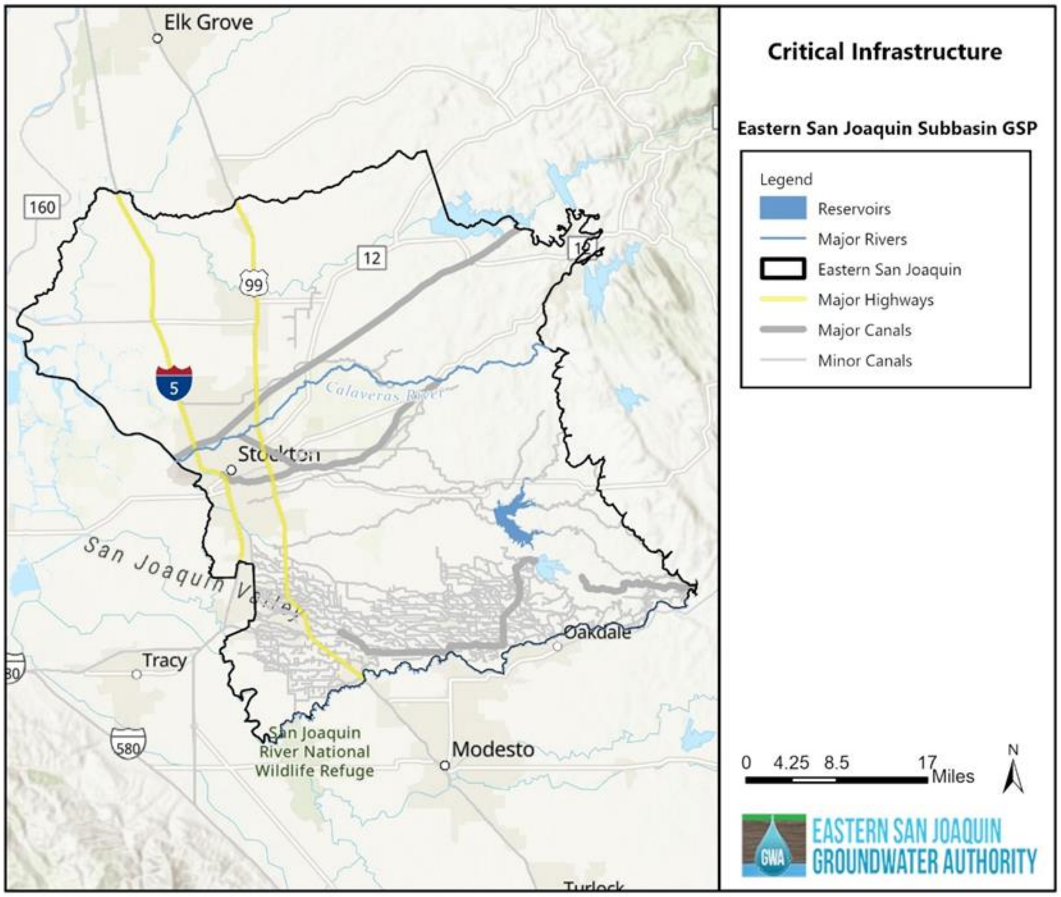
Service buildings within the Subbasin include fire stations, hospitals, jails and correction facilities, police stations, and wastewater plants. The County also maintains 30 water systems with 52 wells, 3 sewage treatment plants, 9 sewage pumping stations, 68 storm drain pumping stations, and over 300 miles of levees and flood channels. In general, major pipelines that run through the County are in areas south of Lodi and southwest of Tracy along the foothills (outside of the Subbasin boundary).

In addition to identifying critical infrastructure at risk for subsidence impacts, the ESJGWA has worked with OES and the Subbasin GSAs to identify the total subsidence load that critical infrastructure in the Subbasin can tolerate during GSP implementation, and what would be considered an undesirable result. Through input from OES, the critical infrastructure in the Subbasin can generally tolerate a significant amount of uniform settlement due to subsidence across the Subbasin, though the total amount of settlement that can be tolerated is dependent on the design of the specific infrastructure. Differential settlement across facilities in a locale, on the other hand, will result in more damage. However, it is worth noting that it is less common for subsidence to cause significant local differential sediment. In addition, the San Joaquin County *2017 Local Hazard Mitigation Plan* identifies land subsidence as a potential cause for levee breakage; however, the hazard of subsidence is ranked "not likely" to occur. Through input from the Subbasin GSAs, local infrastructure can typically withstand subsidence ranging between 24 and 36 inches (San Joaquin County, 2017).

For the purposes of this Amended GSP, the major canals selected as critical infrastructure are the East Bay Municipal Utility District's Mokelumne Aqueduct, stretching from the northeast to the western region of the Subbasin; Stockton East's Mormon Slough and Stockton Diverting Canal in the central region; South San Joaquin Irrigation District's Main District Canal in the southcentral region, and Oakdale Irrigation District's North Main Canal in the southeastern corner of the Subbasin. The major roadways considered critical infrastructure include Highway 5 and Highway 99. Figure 3-4 illustrates all the critical infrastructure, including conveyance systems and major roads, across the Subbasin. Most of the minor canals are concentrated in the southern region of the Subbasin and are displayed for reference purposes only.

There are no historical records of significant and unreasonable impacts from subsidence in the Eastern San Joaquin Subbasin (see Figure 2-78). Per InSAR data currently available, 2015-2016 maximum subsidence rates in the Eastern San Joaquin Subbasin ranged from -1.2 inches per year (in/yr) to -2.4 in/yr, and there has been a maximum average subsidence rate of 0.93 in/yr over the last approximately 8 years (2015-2023). Given that approximately 10 years have lapsed since the implementation of SGMA commenced in 2015, and assuming an additional 10 years for achieving significant progress towards the Subbasin's sustainability goal, it has been assumed that an additional 24 inches of subsidence (-1.2 in/yr times 20 years) can occur until 2040 without experiencing undesirable results relating to inelastic land subsidence. However, if land subsidence becomes an area of concern, the ESJGWA will take actions to understand the causes of the subsidence (including localized hydrogeology and groundwater pumping), consider improved monitoring protocols, and identify the next steps for addressing the potential for undesirable results.

Figure 3-4: Defined Critical Infrastructure in the Eastern San Joaquin Subbasin



3.3.5.1.2 Identification of Undesirable Results

An undesirable result occurs when subsidence substantially interferes with the beneficial uses of groundwater and surface land uses. Subsidence, as it relates to groundwater use and management, occurs as a result of the compaction of subsurface materials due to the dewatering of fine-grained geologic materials, such as clay, leading to structural collapse and loss of void spaces. Undesirable results would occur when substantial interference with land use and critical infrastructure occurs (including significant damage to canals, pipes, or other water conveyance facilities) as a result of groundwater basin activities (such as pumping) and management.

Undesirable results related to inelastic land subsidence will be identified through data collected from the Subbasin's representative monitoring network for inelastic land subsidence (using land subsidence data collection efforts conducted by individual GSAs, continuous global positioning system (CGPS) data collected and posted by the United States Geological Survey (USGS), and UNAVCO monitoring data collected and posted by UNAVCO's Plate Boundary Observatory Program) supplemented with InSAR datasets collected and posted by DWR, and other publicly available datasets.

3.3.5.1.3 Potential Causes of Undesirable Results

Potential causes of future undesirable results for land subsidence would include significant increases in groundwater production beyond what is currently projected resulting in dewatering of compressible clays in the subsurface, which are not known to be common in the Eastern San Joaquin Subbasin, as indicated by historical absence of subsidence.

Corcoran Clay is one type of subsurface material that is potentially predisposed to compression. See Section 2.1.5 for a description of Corcoran Clay extent in the Subbasin.

3.3.5.1.4 Potential Effects of Undesirable Results

If land subsidence conditions were to reach undesirable results, the adverse effects could potentially cause an irrecoverable loss of groundwater storage and damage to infrastructure, including water conveyance facilities and flood control facilities. This could impact the ability to deliver surface water, resulting in increased groundwater use, or could impact the ability to store and convey flood water. These could have adverse effects to property values or public safety.

3.3.5.2 Minimum Thresholds

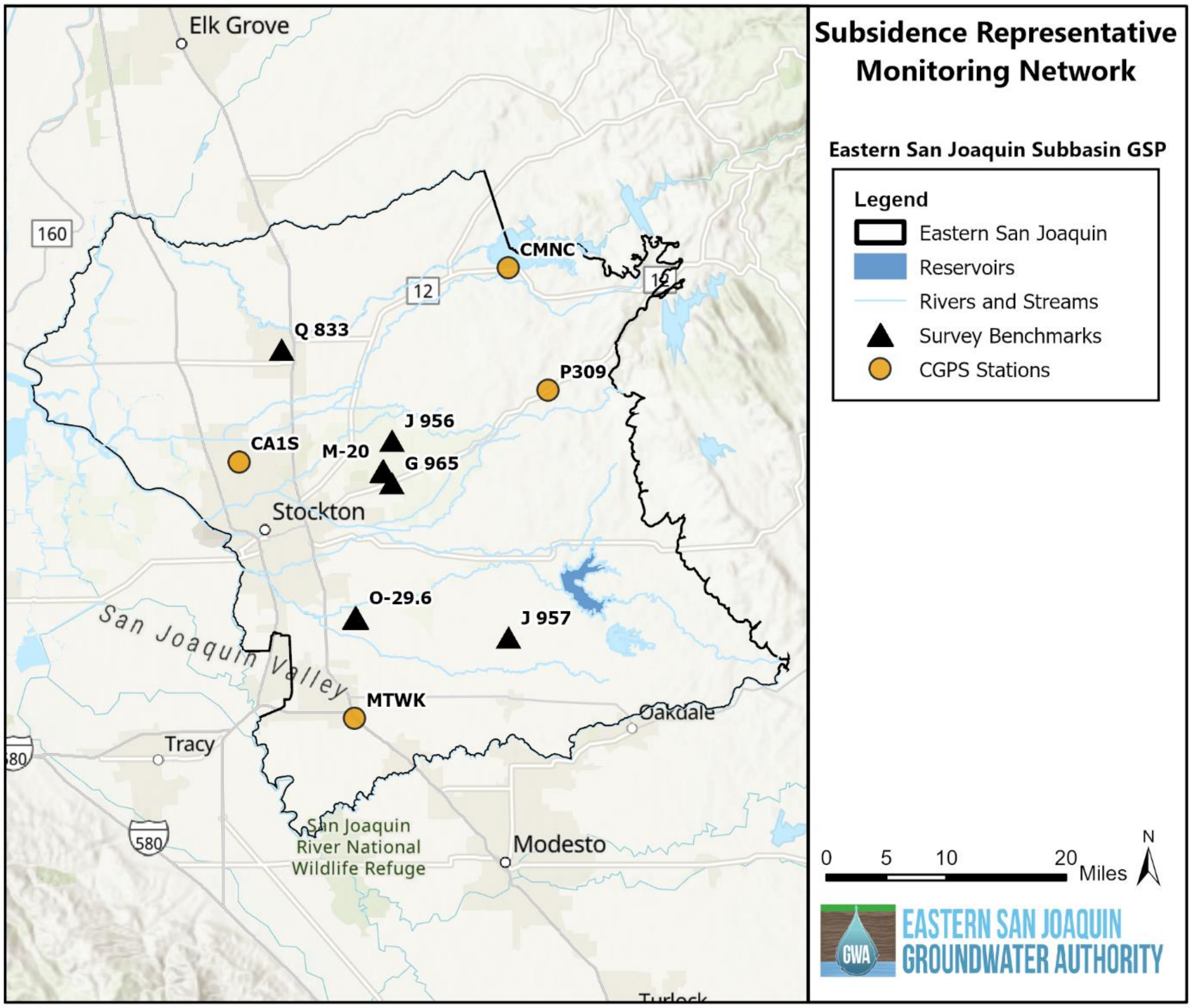
The minimum threshold for land subsidence in the Subbasin is set at no more than 0.2 foot/year [2.4 inches/year] in any five-year period between 2020 and 2040, resulting in no more than a total additional 2 feet (24 inches) of land subsidence by 2040. This is set within the same magnitude of estimated error of the InSAR data (+/- 0.1 foot [0.03 m]), which is currently the most comprehensive tool available for measuring subbasin-wide land subsidence consistently each year, based on historical subsidence rates. The minimum threshold of 24 inches of additional subsidence by 2040 reflects the historical subsidence level with an added buffer, and is in line (both by method and magnitude) with the minimum thresholds established by other nearby basins overlying the Corcoran Clay.

The minimum thresholds selected for land subsidence for the Subbasin have been selected as a preventative measure to ensure the maintenance of current ground surface elevations and as an added safety measure for potential future impacts not presently occurring in the Subbasin and nearby basins. This avoids significant and unreasonable rates of land subsidence in the Subbasin, which are those that lead to a permanent subsidence of land surface elevations that impact infrastructure and agricultural production in the Subbasin and neighboring groundwater subbasins.

Given that the Subbasin is currently at the measurable objective (within the bounds of measurement error) and not expected to experience significant or unreasonable subsidence, it is not anticipated that the land subsidence minimum threshold will significantly affect any beneficial users of groundwater, land uses, or property interests. It is possible, should the current subsidence rates steepen, that there might be an impact to groundwater pumping (e.g., wells could be physically damaged, or conservation measures enacted). However, given the specific nature of the variable aquifer geology across the Subbasin, it would likely be confined to the southwestern portion of the Subbasin where a combination of groundwater overdraft and localized clay layers would operate together to display an inelastic subsidence signal. Nevertheless, neither of these cases are currently anticipated to coexist in the Subbasin at significant and unreasonable levels, especially with the development of projects and management actions that will achieve and maintain the Subbasin's SMC for groundwater levels.

There are currently no other state, federal, or local standards that relate to this sustainability indicator in the Subbasin. Additionally, in coordination with updates as described below for the 5-year interim milestones and as previously stated, as part of the Subbasin's annual reporting process and to further supplement the land subsidence data collection efforts put forward in the GSP, CGPS data, InSAR data, and other subsidence data have been, and will continue to be, evaluated annually by the ESJGWA. These data will be compiled and evaluated each year as part of the data assessment and production of the Annual Report, submitted to DWR each year by April 1st. The current representative monitoring network for inelastic land subsidence is shown in Figure 3-5.

Figure 3-5: Location of Representative Monitoring Sites for Subsidence



3.3.5.3 Measurable Objectives and Interim Milestones

The measurable objective for subsidence is based on the long-term avoidance of land subsidence: 0 ft/year, on a long-term average. This measurable objective is set recognizing the interconnectedness of the Subbasin with surrounding subbasins, and the ability to meet this objective is dependent on the successful management of all nearby subbasins.

Interim milestones are set in 5-year increments to provide time for the GSAs to adequately monitor for and, if necessary, address an issue that is technically complex, not well understood, and that has the potential to result in negative socioeconomic impacts depending on the ultimate solution. The interim milestones are defined as:

- 2025: -0.1 ft/year (1.2 in/yr)
- 2030: -0.05 ft/year (0.6 in/yr)
- 2035: -0.05 ft/year (0.6 in/yr)
- After 2040: 0 ft/yr (0 in/yr)

The land subsidence interim milestone for 2025 was at a rate of -0.2 ft/year (2.4 in/year). This rate is higher than actual subsidence rates experienced throughout the Subbasin between 2015 and 2023 based on InSAR data available from DWR's SGMA Data Viewer. The subsequent interim milestones have reduced subsidence values as projects and management actions are implemented to address groundwater levels and subsidence. These interim milestones are set recognizing that little active subsidence is currently occurring in the Eastern San Joaquin Subbasin, the interconnectedness of the Subbasin with surrounding subbasins (where subsidence may be occurring), and the ability to meet this objective is dependent on the successful management of all nearby subbasins.

3.3.6 Depletions of Interconnected Surface Water

Depletions of interconnected surface waters (ISWs) are defined as "conditions where groundwater pumping results in reductions in flow or water levels of ISW." However, DWR's guidance entitled *Depletions of ISW: An Introduction* (CA DWR, 2024) notes that "the definition above differs from how depletions may be defined in other hydrologic contexts, where they can refer to any surface water losses without considering the cause." In acknowledging this, analyses were conducted using the ESJWRM model to evaluate stream losses to the aquifer system regardless of the cause, and to determine, based on the best available data and tools currently available, the timing, locations and magnitude of depletions that have occurred in the Subbasin or could occur in the future. These analyses are summarized in Appendix 3-G of this Amended GSP.

3.3.6.1 Undesirable Results

3.3.6.1.1 Description of Undesirable Results

The undesirable result related to *depletions of interconnected surface water* is defined in SGMA as:

> *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.*

Major rivers and streams that potentially have a hydraulic connection to the groundwater system in certain reaches are the Calaveras River, Dry Creek, the Mokelumne River, the San Joaquin River, and the Stanislaus River. Many of the smaller creeks and streams in the Subbasin are substantially used for the conveyance of irrigation water, and these systems have not been considered in the analysis of depletions.

3.3.6.1.2 Identification of Undesirable Results

The undesirable result for depletions of interconnected surface water in the Eastern San Joaquin Subbasin is depletions that result in reductions in flow or levels of major rivers and streams that are hydrologically connected to the basin such that the reduced surface water flow or levels have a significant and unreasonable adverse impact on beneficial uses and users of the surface water within the Subbasin over the planning and implementation horizon of this GSP. Beneficial uses and users were identified previously in Section 1.3.1.

3.3.6.1.3 Potential Causes of Undesirable Results

Potential causes of undesirable results would include increased regional groundwater extractions, reduced recharge due to drought, reduced availability of surface water supplies, and increased groundwater extraction along interconnected stream reaches.

3.3.6.1.4 Potential Effects of Undesirable Results

If depletions of interconnected surface water were to reach levels causing undesirable results, effects could include reduced flow and stage within rivers and streams in the Subbasin to the extent that insufficient surface water would be available to support diversions for agricultural or urban uses or to support regulatory environmental requirements. These effects could result in decreased surface water diversions and/or changes in irrigation practices and crops grown, and could cause adverse effects on property values and the regional economy. Reduced flows and stage, along with potential associated changes in water temperature and quality, could also negatively impact aquatic species and habitats in the rivers and streams and along the riparian environments. Such impacts are tied to the inability to meet minimum flow requirements, which are defined for the Mokelumne, Stanislaus, and San Joaquin Rivers, which, in turn, are managed through operations at Camanche Reservoir, Woodbridge Dam, New Melones Reservoir, and other reservoirs. It is important to note that the operations of upstream reservoirs are conducted by other entities, such as the U.S. Bureau of Reclamation, U.S. Army Corps of Engineers and East Bay Municipal Utilities District, and are outside the control of the Subbasin GSAs.

3.3.6.2 Minimum Thresholds

Minimum thresholds were established for ISW representative monitoring wells using groundwater levels as a metric. Groundwater level data are used to calculate water table gradients and, therefore, the volume of water gained and lost. Without additional DWR guidance at the time of this Amended GSP or more certainty around stream depletions due to pumping with the existing modeling toolset, the SMCs rely on the best available information at the time of analysis. The ISW SMCs using groundwater levels as a metric aim to be "sufficiently protective to ensure significant and unreasonable occurrences of [stream depletions] will be prevented," as prescribed in the DWR's *Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria* (DWR, 2017).

The ESJ 2020 GSP and 2022 Revised GSP used groundwater level minimum thresholds as a proxy for the depletions of interconnected surface water sustainability indicator. This Amended GSP developed a representative monitoring network (RMN) specific for the interconnected surface water sustainability indicator consisting of a subset of wells from the chronic lowering of groundwater levels RMN combined with new wells constructed specifically to fill data gaps relating to an understanding of ISW. As such, some wells have a data set that allows for the setting of SMC, while others lack data because they are new.

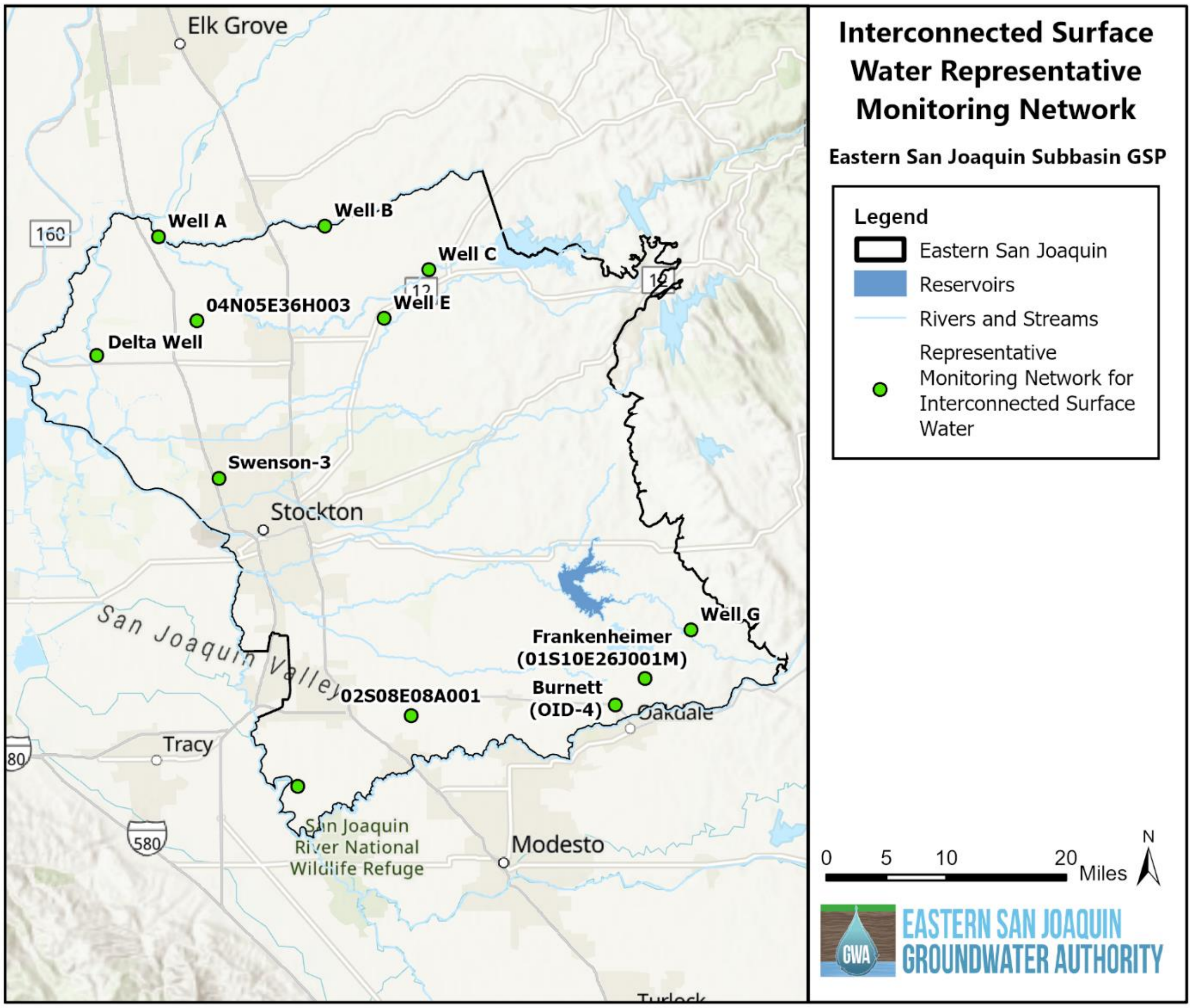
The ISW minimum thresholds for wells with historical groundwater level observations are the same as for the chronic lowering of groundwater levels minimum thresholds. Analyses were conducted to demonstrate that the groundwater level minimum thresholds are protective of stream depletions and stream-aquifer interactions (stream connectivity, stream gains and losses, and stream gains and losses as a percentage of streamflow), and therefore the use of these minimum thresholds is justified. Descriptions of the analyses conducted and the associated results can be found in Appendix 3-G. Minimum thresholds will be established for new representative monitoring sites after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs. Table 3-7 summarizes the minimum thresholds for the revised ISW representative monitoring network wells. Figure 3-6 shows the revised representative monitoring network for interconnected surface water.

Table 3-7: Minimum Thresholds for Interconnected Surface Water

Well ID	Minimum Threshold (ft msl)
Well A	New well – need to collect data
Well B	New well – need to collect data
Well C	New well – need to collect data
Well E	New well – need to collect data
Well G	New well – need to collect data
Delta Well	New well – need to collect data
04N05E36H003	-31.1
Swenson-3	-26.6

Well ID	Minimum Threshold (ft msl)
Frankenheimer (01S10E26J001M)	43.7
Burnett (OID-4)	60.8
02S07E31N001	0.8
02S08E08A001	0.6

Figure 3-6: Location of Representative Monitoring Sites for Interconnected Surface Water



Establishing minimum thresholds for new monitoring wells requires data; as such, the minimum thresholds for recently constructed new monitoring wells and other new wells that may be constructed in the future will be established based on adjusted recent groundwater levels from a dry/critical year. The adjustment of groundwater levels is the difference in *simulated* groundwater levels in ESJWRM flow model between Water Year 2015 (a dry year) and the recent dry/critical year when groundwater level observations are measured. The calculation for the Minimum Threshold is:

$$Minimum\ Threshold = Observed\ Recent\ Dry/Critical\ GWL - (Simulated\ Recent\ Dry\ Year\ GWLs - Simulated\ 2015\ GWLs)$$

As a hypothetical example, suppose Water Year 2027 is a critical year and the observed groundwater elevation for Well C is 75 feet mean sea level (msl) in 2027. Assuming that the *simulated* groundwater elevations in ESJWRM at Well C increase by 8 feet between 2015 and 2027. The Minimum Threshold would be 75 feet minus 8 feet, or 67 feet msl.

3.3.6.3 Measurable Objectives and Interim Milestones

Similar to minimum thresholds, measurable objectives and interim milestones were established for ISW representative monitoring wells using groundwater levels as a metric, and as with the minimum thresholds for wells with historical groundwater level observations, the measurable objectives and interim milestones are the same as for the chronic lowering of groundwater levels measurable objectives and interim milestones. For new monitoring wells without historical groundwater level data, measurable objectives and interim milestones will be established for new representative monitoring sites after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs. Table 3-8 summarizes the measurable objectives and interim milestones for the revised ISW representative monitoring network wells.

Table 3-8: Measurable Objectives and Interim Milestones for Interconnected Surface Water

Well ID	Measurable Objective (ft msl)	Interim Milestone (ft msl)		
		2025	2030	2035
Well A	New well – need to collect data			
Well B	New well – need to collect data			
Well C	New well – need to collect data			
Well E	New well – need to collect data			
Well G	New well – need to collect data			
Delta Well	New well – need to collect data			
04N05E36H003	-5.1	-5.1	-5.1	-5.1
Swenson-3	-19.3	-19.3	-19.3	-19.3
Frankenheimer (01S10E26J001M)	81.7	81.7	81.7	81.7
Burnett (OID-4)	79.7	79.7	79.7	79.7
02S07E31N001	12.3	13.8	13.8	13.1
02S08E08A001	24	22.2	22.2	23.1

Establishing measurable objectives and interim milestones for new monitoring wells requires data; as such, the measurable objectives and interim milestones for recently constructed new monitoring wells and other new wells that may be constructed in the future will be established based after sufficient data have been collected. Measurable objectives will be established from an adjustment in groundwater levels from a wet year. The adjustment will add the difference in *simulated* groundwater levels from ESJWRM between Water Year 2011 (a wet year) and a recent wet year when groundwater level observations are collected. The calculation for Measurable Objectives is:

$$\begin{aligned}&Measurable\ Objectives \\ &\quad = Observed\ Recent\ Wet\ GWL + \ (Simulated\ Recent\ Wet\ Year\ GWL \\ &\quad - Simulated\ 2011\ GWLs)\end{aligned}$$

As a hypothetical example, suppose Water Year 2026 is a wet year, and the observed groundwater elevation for Well C is 82 feet msl that year. Suppose that the *simulated* groundwater elevations in ESJWRM at Well C decrease by 15 feet between Water Year 2015 and 2026. The Measurable Objective would be 82 feet minus negative 15 feet, equaling 97 feet msl.

Interim milestones for recently constructed new monitoring wells and other new wells that may be constructed in the future will be calculated as 5-year milestones following a linear trend between the current condition (set as the period in time sufficient data have been collected) and the measurable objective for the time period remaining from the establishment of minimum thresholds and measurable objectives to 2040.

ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Monitoring Networks

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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Tables

Figures

Acronyms

BMP	best management practice
CGPS	continuous global positioning system
CASGEM	California Statewide Groundwater Elevation Monitoring
CGPS	continuous global positioning system
DWR	Department of Water Resources
EC	electrical conductivity
ESJGWA	Eastern San Joaquin Groundwater Authority
ft. bgs	feet below ground surface
GDEs	Groundwater-Dependent Ecosystems
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
GWL	groundwater level
InSAR	Interferometric Synthetic Aperture Radar
ISW	interconnected surface water
LCSD	Lockeford Community Services District
NAVD 88	North American Vertical Datum of 1988
NCCAG	Natural Communities Commonly Associated with Groundwater
NGS	National Geodetic Survey
RMN	representative monitoring network
RMW	representative monitoring well
SGMA	Sustainable Groundwater Management Act
SJC	San Joaquin County
SOPAC	Scripps Orbit and Permanent Array Center
TDS	total dissolved solids
TSS	Technical Support Services
UNAVCO	University Navstar Consortium
UNGL	University of Nevada Geodetic Laboratory
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

4. MONITORING NETWORKS

Monitoring networks in the Eastern San Joaquin Subbasin are dedicated to monitoring short-term, seasonal, and long-term trends in sustainability indicators. There are four networks: two representative networks for water levels (one for the chronic lowering of groundwater levels sustainability indicator and one for the interconnected surface waters sustainability indicator), a representative network for groundwater quality, and a representative network for inelastic subsidence. These monitoring networks are tools for the Eastern San Joaquin Groundwater Authority (ESJGWA) and will allow the ESJGWA to compile data on key sustainability indicators and monitor groundwater trends on a variety of temporal and spatial scales. The objective of these monitoring networks is to detect undesirable results in the Subbasin as described in Chapter 3: Sustainable Management Criteria of this Groundwater Sustainability Plan (GSP). The data and trends will allow the ESJGWA to detect changes in Subbasin conditions, meet the Subbasin's sustainability goal, avoid minimum thresholds, and evaluate the effectiveness of projects and management actions implemented. Ultimately, the monitoring network and associated data will guide decisions to prevent undesirable results occurring within the GSP implementation timeframe. Other objectives of the monitoring networks, as defined by the Department of Water Resources (DWR), include:

- Demonstrate progress toward achieving measurable objectives described in the Plan
- Monitor impacts to the beneficial uses or users of groundwater
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds
- Quantify annual changes in water budget components

The monitoring networks are intended to monitor for the chronic lowering of groundwater levels, degradation in groundwater quality, interconnected surface waters and inelastic subsidence. As discussed in Chapter 3: Sustainable Management Criteria, the reduction in groundwater storage sustainability indicator will be evaluated using groundwater levels as a proxy.

The schedule and costs associated with monitoring and implementation will be discussed in Chapter 7: Plan Implementation of the GSP.

4.1 MONITORING NETWORK FOR CHRONIC LOWERING OF GROUNDWATER LEVELS

This section provides information on how the groundwater level monitoring network was developed, criteria for selecting dedicated monitoring wells, monitoring frequency, spatial density, and summary protocols. The monitoring network that collects data for groundwater levels is the Representative Monitoring Network (RMN). These wells will be used to monitor sustainability in the Subbasin. These wells are used to determine compliance with minimum thresholds and measurable objectives for the groundwater level sustainability indicator.

4.1.1 Representative Monitoring Network for Groundwater Levels

Representative monitoring wells represent overall conditions in the production zone in the Subbasin and are reflective of regional groundwater conditions in the vicinity. Table 4-1 identifies and summarizes the 23 representative monitoring wells for groundwater levels. Well locations were shown previously in Figure 3-2 in Chapter 3: Sustainable Management Criteria.

Table 4-1: Representative Monitoring Wells for Groundwater Levels

Local Well ID	CASGEM Site Code	Well Location	Well Depth (ft.)	Screen Interval in ft. bgs (ft. MSL)	Measurement Period (years)	Measurement Count
Swenson-3	380067N1213458W003	San Joaquin County (SJC)	204	194–204 (-190 to -200)	2014–2018	20
01S09E05H002	378824N1210000W001	SJC	256	148–256 (-41 to -149)	1991–2018	7
Burnett (OID4)	377909N1208675W001	Stanislaus County	501	168–249 (21 to -60)	2005–2019	3
02N07E03D001	380578N1212017W001	SJC	484	130–484 (-74 to -428)	1990–2018	1
04N07E20H003M	381843N1212261W001	SJC	180	164–180 (-87to -103)	1972–2019	111
02S07E31N001	377136N1212508W001	SJC	Unknown	Unknown	1991–2018	14
02S08E08A001	377810N1211142W001	SJC	180	50–180 (22 to -108)	1991–2018	8
01N07E14J002	379316N1211665W001	SJC	556	168–556 (-116 to -504)	1991–2018	12
01N09E05J001	379661N1210011W001	SJC	750	100–750 (56 to -594)	2011–2018	13
02N07E29B001	379976N1212308W001	SJC	202	130–202 (-88 to -160)	1989–2018	2
02N08E15M002	380206N1210943W001	SJC	Unknown	Unknown	2011–2013	2
03N07E21L003	380909N1212153W001	SJC	Unknown	Unknown	1991–2013	15
03N06E05N003	381317N1213524W001	SJC	292	252–292 (-225 to -265)	1991–2018	16
04N05E36H003	381559N1213727W001	SJC	112	50–112 (-27 to -89)	1971–2018	4
04N05E24J004	381816N1213723W001	SJC	190	150–190 (-128 to -168)	1991–2018	9
#3 Bear Creek	Not Part of CASGEM Program	Lockeford Community Services District (LCSD)	780	0–780 (96 to -684)	2011–2018	18

Local Well ID	CASGEM Site Code	Well Location	Well Depth (ft.)	Screen Interval in ft. bgs (ft. MSL)	Measurement Period (years)	Measurement Count
Lodi City Well #2	Not Part of CASGEM Program	City of Lodi	315	109–310 (-57 to -258)	1927–2015	17
Hirschfeld (OID8)	Not Part of CASGEM Program	Stanislaus County	408	88–179 (44 to -47)	2005–2016	19
Well 18	Not Part of CASGEM Program	City of Manteca	350	109–349 (-65 to -305)	1997–2018	5
Frankenheimer (01S10E26J001M)	378163N1208321W001	Stanislaus County	Unknown			10
01S10E04C001M	378846N1208816W001	Stanislaus County				
NSJWCD-01	382345N1212261W001 - 06	NSJWCD	1.215	Multiple 165-1,200	NA	0
SEWD-01	379794N1211083W001 - 05	SEWD	1,650	Multiple 190-1,635	NA	0

Representative groundwater level sites were selected by several different criteria. These include:

1. **Adequate Spatial Distribution –** Representative monitoring does not require the use of all wells that are spatially “clumped” together within a portion of the Subbasin. Adequately spaced wells will provide sufficient coverage with fewer monitoring sites.

2. **Robust and Extensive Historical Data –** Representative monitoring sites with a longer period of record and a greater number of historical measurements will provide insight into long-term trends that can provide information about groundwater conditions through varying climatic periods such as droughts and wet periods. Historical data may also show changes in groundwater conditions through anthropogenic effects as well. While some sites chosen may not have extensive historical data, they may still be selected because there are no wells nearby with longer records.

3. **Increased Density in Heavily Pumped Areas –** Selection of additional wells in heavily pumped areas such as in the central portion of the Subbasin and other agriculturally intensive areas will provide additional data where the most groundwater change may occur.

4. **Increased Density near Areas of Geologic or Hydrologic Uncertainty –** Having a greater density of representative wells in areas of uncertainty, such as around faults or large elevation gradients, may provide insight into groundwater dynamics to improve management practices and strategies.

5. **Wells with Multiple Depths –** The utilization of wells with different screen intervals is important to collect data on the groundwater conditions at different elevations within the aquifer. This can be achieved by using wells with different screen depths that are close to one another, or by using multi-completion wells.

6. **Consistency with BMPs –** Using published Best Management Practices (BMPs) provided by DWR will promote consistency across subbasins and promote compliance with established regulations.

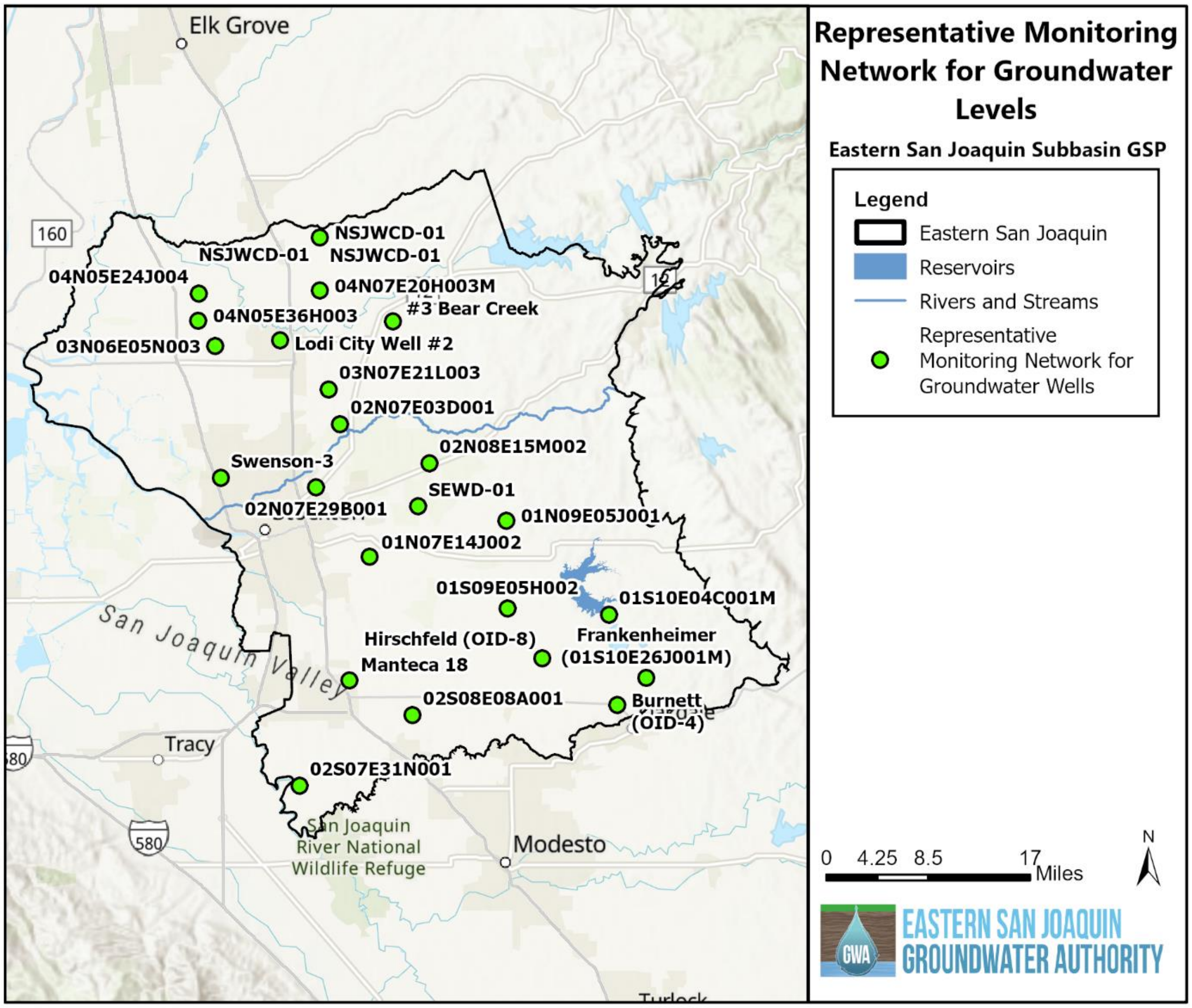
7. **Adequate Well Construction Information –** Well information such as perforation depths, construction date, and well depth was considered and encouraged when considering wells to be included.

8. **Professional Judgement –** Professional judgement is used to make the final decision about each well, particularly when more than one suitable well exists in an area of interest.

9. **Maximum Coverage –** Monitoring network wells were selected to prioritize spatial and vertical density of monitoring.

Figure 4-1 shows the revised representative monitoring network for groundwater levels.

Figure 4-1: Representative Monitoring Network for Groundwater Levels



4.1.2 Monitoring Protocols for Groundwater Level Data Collection and Monitoring

Groundwater monitoring protocols are essential to producing quality data measurements and protecting the water quality of monitoring wells. Existing protocol resources include DWR's *Groundwater Elevation Monitoring Guidelines* (CA DWR, 2010) and USGS's *National Field Manual for the Collection of Water Quality Data* (USGS, var.). Protocols are established to improve consistency in data and ensure comparable methodologies.

Typical groundwater level measurement equipment used by agencies includes electric sounders, data loggers, steel tapes, and air gauges. Regardless of the instrumentation used in the field, each groundwater level data measurement must include: well identification number, measurement date, reference point and land surface elevation, depth to water, method of measuring water depth, measurement quality codes, any observations on well conditions (i.e., condition of surface seal, accessibility issues, obstructions within the wells, etc.), and measurement to the base of the well (total well depth).

DWR released a BMP for monitoring protocols, in the *Best Management Practices for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites* (CA DWR, 2016a). The monitoring protocols described in DWR's BMP recommend that groundwater level measurements are taken in a manner to ensure data are:

- Taken from the correct location, well ID, and screen interval depth
- Accurate and reproducible
- Representative of conditions that inform appropriate basin management data quality objectives
- Recorded with all salient information to correct, if necessary, and compare data
- Handled in a way that ensures data integrity.
- Taken using a CASGEM-approved water-level measurement method to ensure consistency across measurements. Methods include:
  - Establishing a reference point
  - Using one of four approved methods (steel tape, electric sounding tape, sonic water-level meter, or pressure transducer) to measure groundwater levels

Existing wells, monitored under the CASGEM program, already use these procedures in the collection of groundwater level data. The protocols used for CASGEM groundwater level monitoring will be used when possible in data monitoring and collection in support of this GSP.

4.1.3 Frequency and Timing of Groundwater Level Monitoring

Representative monitoring network wells for groundwater levels will be monitored semi-annually in March and October to capture the seasonal high and low groundwater levels and to avoid interference from pumping wells during irrigation season.

Frequency of groundwater level monitoring is cited in the *Draft Monitoring Networks and Identification of Data Gaps Best Management Practice* (CA DWR, 2016b) which presents guidance on monitoring frequency based on the type of monitoring, aquifer type, confinement, recharge rate, hydraulic conductivity, and withdrawal rate. While semi-annual monitoring is required for groundwater levels, DWR guidance recommends monthly sampling of groundwater levels for the Eastern San Joaquin Subbasin based on aquifer type, volume of long-term aquifer withdrawals, and recharge potential. Sampling frequencies were developed based on this guidance in combination with a consideration of sampling costs.

A semi-annual monitoring frequency will generate data that is useful for monitoring for the long term, regional trends in groundwater level conditions. These measurements are also valuable for local groundwater management and for investigating local pumping’s effects on nearby wells. This frequency meets the goal of a successful monitoring schedule which provides enough data to adequately interpret changes in groundwater levels and fluctuations over short- and long-term periods, as these fluctuations could be the result of storm events, droughts, or other climatic variations, seasons, and anthropogenic activities.

4.1.4 Spatial Density of Groundwater Level Monitoring Network

The goal of the groundwater level monitoring network is to provide adequate spatial coverage within the Subbasin. This includes the ability to monitor and identify groundwater changes across the Subbasin through time. The spatial location of monitoring wells in the networks was based on proximity to other monitoring wells and ensuring adequate coverage near other prominent features such as faults or production wells. Monitoring wells in close proximity to active pumping wells could be influenced by groundwater withdrawals, thus skewing static level monitoring.

To achieve a suitable monitoring network density, DWR recommends selecting existing, dedicated groundwater monitoring wells with known construction information over production wells to incorporate into the network. When deciding on the number of groundwater wells to be monitored in a basin to adequately represent static water levels (and corresponding elevations), the following factors should be considered:

- Known hydrogeology of the basin
- Slope of the groundwater table or potentiometric surface
- Existence of high-volume production wells and the frequency of their use
- Availability of easily accessible monitoring wells

In 2010, DWR released *Groundwater Elevation Monitoring Guidelines*, which discusses the selection and requirements for new wells to be incorporated into groundwater level monitoring networks (CA DWR, 2010). The recommended network density ranges from 0.2 to 10 groundwater monitoring wells per 100 square miles depending on local pumping rates. The Subbasin is approximately 1,195 square miles. Based on the recommendations by DWR, the number of monitoring wells for the Eastern San Joaquin Subbasin should range from 2.4 to 119.5 wells per 100 square miles, as summarized in Table 4-2.

Table 4-2: DWR Monitoring Well Density Recommendations

Reference	Monitoring Well Density (wells per 100 sq. miles)	Recommended No. of Monitoring Wells in the Subbasin
Heath (1976)	0.2 – 10	2.4 – 119.5
Sophocleous (1983)	6.3	75.9
Hopkins (1994)		
Basins pumping more than 10,000 AF/year per 100 miles	4.0	47.8

The spatial density of the groundwater level monitoring network was calculated for the representative monitoring network, as summarized in Table 4-3. The density of the representative monitoring network is 1.7 wells per 100 square miles, a total of 23 monitoring wells, which falls into the lower to middle range of DWR's recommendations. However, the Subbasin is continuing to work to expand its representative monitoring network and to construct additional wells to address identified data gaps.

Table 4-3: Groundwater Level Monitoring Network Density

Monitoring Network	No. of Wells	Well Density (Wells per 100 sq. miles)
Representative Monitoring Network	23	1.7

4.2 MONITORING NETWORK FOR REDUCTION IN GROUNDWATER STORAGE

Groundwater levels will be used as a proxy for the reduction in groundwater storage sustainability indicator as described in Chapter 3: Sustainable Management Criteria. Sustainable management criteria for groundwater storage will be monitored through the groundwater levels monitoring networks, described in Section 4.1. Monitoring data collected by the groundwater level monitoring networks will support future characterization of groundwater in storage.

4.3 MONITORING NETWORKS FOR DEGRADED WATER QUALITY

Groundwater quality monitoring is conducted through a representative groundwater well monitoring network specific for this sustainability indicator. This section provides information on how the monitoring network was developed, criteria for selecting dedicated monitoring wells, monitoring frequency, spatial density, and summary protocols.

The representative monitoring network for groundwater quality is used to determine compliance with minimum thresholds and measurable objectives developed for the degraded water quality sustainability indicator. The network monitoring for water quality tests for total dissolved solids (TDS) and chloride, in addition to field parameters including pH, electrical conductivity (EC), and temperature. Other groundwater quality data are collected from publicly available sources and other ongoing monitoring programs (such as the Irrigated Lands Program) and evaluated for arsenic, nitrate, and other constituents of concern for informational purposes. The GSP does not include sustainability goals, measurable objectives, or minimum thresholds for these other constituents.

4.3.1 Representative Monitoring Network for Groundwater Quality

Twenty-one representative monitoring wells were selected for monitoring groundwater quality. These wells are currently monitored and managed by City of Manteca, Cal Water, City of Stockton, and San Joaquin County. Table 4-4 identifies and summarizes the agencies with the 21 representative monitoring wells selected for the groundwater quality monitoring network, which is shown in Figure 4-2.

Figure 4-2: Representative Monitoring Network for Groundwater Quality

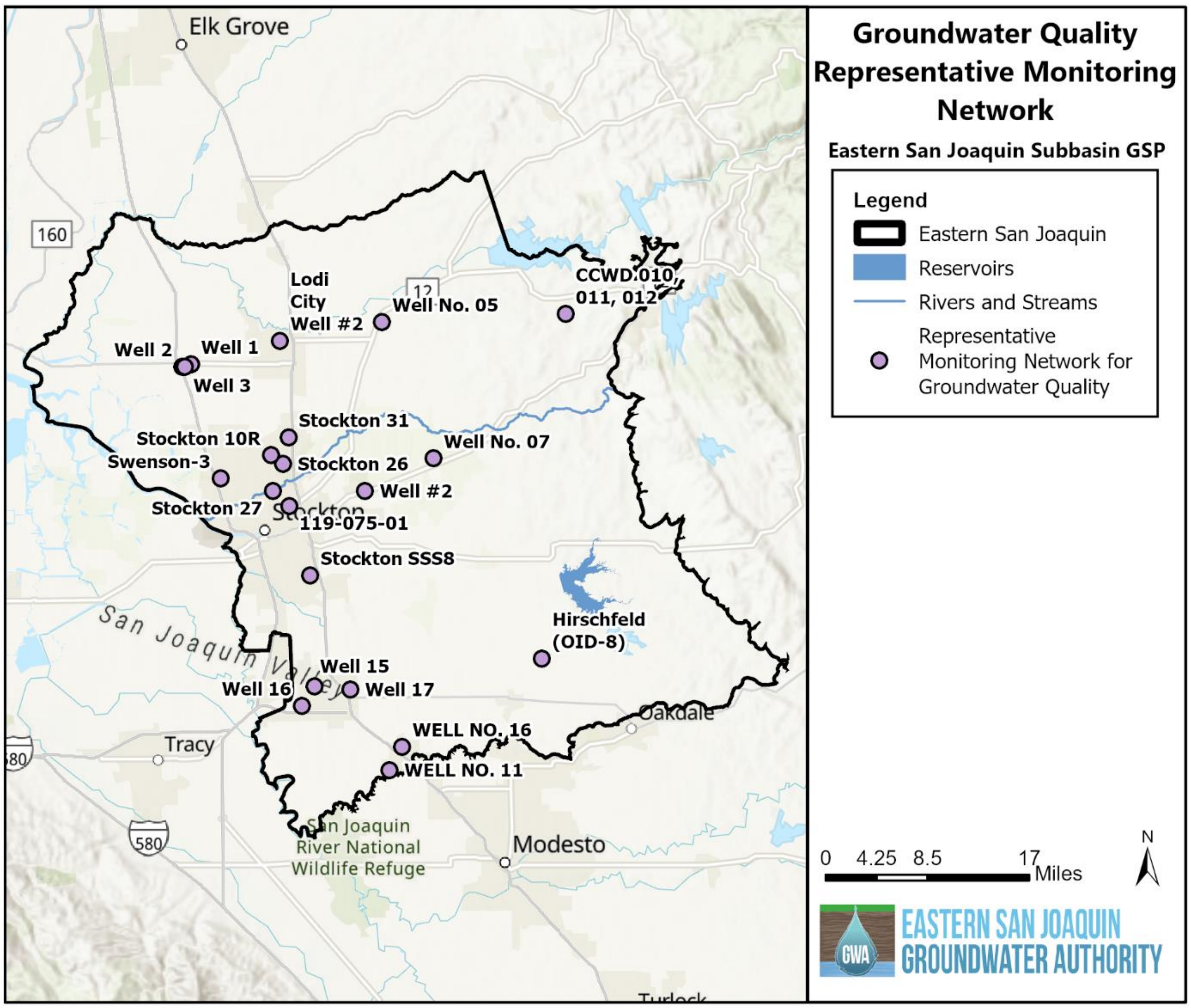


Table 4-4: Representative Monitoring Network Wells for Water Quality

GSP Well ID	CASGEM ID	GM Well ID	Monitoring Agency	Latitude	Longitude	Source	Screen Group	Screen Top (feet bgs)	Screen Bottom (feet bgs)	Well Depth (feet bgs)
Well 1	381154N1213818W001	CA3901248_001_001	San Joaquin County (Flag City)	38.115366	-121.381755	2020 RMW	Shallow (less than 200')	110	170	-
Well 2	381131N1213920W001	CA3901248_002_002	San Joaquin County (Flag City)	38.113064	-121.391997	2020 RMW	Shallow (less than 200')	110	170	-
Well 3	381130N1213887W001		San Joaquin County (Flag City)	38.11299	-121.388682	2020 RMW	Unknown	-	-	-
119-075-01	01N/07E-18D01M	CA3910001_063_063	Cal Water	37.980357	-121.263022	2020 RMW	Deep (greater than 200')	200	560	-
Well 15	378089N1212325W001	CA3910005_015_015	City of Manteca	37.808954	-121.232674	2020 RMW	Both	140	240	-
Well 16	377904N1212476W001	CA3910005_016_016	City of Manteca	37.790339	-121.247724	2020 RMW	Both	137	274	-
Well 17	378059N1211878W001	CA3910005_028_028	City of Manteca	37.805695	-121.18896	2020 RMW	Both	110	230	-
Stockton 27			City of Stockton	37.994542	-121.282878	2023 AR	Shallow (less than 200')	0	200	-
Stockton SSS8	379146N1212401W001	CA3910012_089_089	City of Stockton	37.91465	-121.237343	2020 RMW	Both	158	256	-
Stockton 31		CA3910012_094_094	City of Stockton	38.045846	-121.263778	2023 AR	Both[1]	157	362	380
Stockton 10R	380292N1212843W001	CA3910012_100_100	City of Stockton	38.028706	-121.285004	2020 RMW	Both[2]	164	488	498
Well No. 05		CA3910008_005_005	Lockeford CSD	38.155478	-121.150908	New CA7	Deep (greater than 200')	250	310	-
Well No. 07		CA3910019_007_007	Linden County WD	38.025715	-121.088695	New CA7	Deep (greater than 200')	480	600	-
Well #2		CA3900755_002_002	Shady Rest Trailer Court	37.994757	-121.171349	New CA7	Deep (greater than 200')	200	210	-
WELL NO. 11		CA3910007_012_012	City of Ripon	37.729054	-121.141496	New CA7	Shallow (less than 200')	125	155	163
WELL NO. 16		CA3910007_026_026	City of Ripon	37.7510854	-121.1264178	New CA7	Deep (greater than 200')	232	356	366
Swenson-3	380067N1213458W003			38.0067	-121.3458	GWL RMN	Multiple Wells[3]	194	502	
Lodi City Well #2		CA3910004_003_003	City of Lodi	38.1376	-121.274	GWL RMN	Both	110	309	-
Hirschfeld (OID-8)			Oakdale ID	37.8352	-120.957	GWL RMN	Deep (greater than 200')	-	-	408
CCWD 010, 011, 012			Calaveras County WD	38.16278308	-120.92918	Former Broad Monitoring Network	Multiple Wells[4]	115	390	

[1] Screened: 157-172, 183-207, 308-328, 337-362 feet deep
[2] Screened: 164-172, 180-194, 208-266, 294-306, 358-412, 452-466, 474-488 feet deep
[3] Screened 1: 482-502, 2: 294-314; 3:194-204 feet deep
[4] Screened 010: 370-390; 011: 250-270; 012: 115-135 feet deep

Representative monitoring wells were selected based on their ability to represent conditions in the Subbasin and indicate long-term, regional changes in groundwater quality conditions. Groundwater Sustainability Agencies (GSAs) in areas affected by high TDS and chloride levels identified wells to be used as representative monitoring wells that met the following criteria:

1. Adequate Spatial Distribution – High TDS and/or chloride concentrations historically have occurred in the western portion of the Subbasin, near the San Joaquin River and urban areas; as such, the majority of representative monitoring wells are located in the western half of the Subbasin. Monitoring wells are located both within areas of high TDS and/or chloride concentrations, to observe and monitor TDS and/or chloride trends, and adjacent to high TDS and/or chloride areas, to observe potential TDS and/or chloride movement.

2. Extensive Historical Data – Wells with longer records of TDS and/or chloride monitoring were preferentially selected over wells with short or sporadic records. Monitoring wells with historical TDS and/or chloride records provide insight on long-term trends and the groundwater condition responses to varying climatic periods such as droughts and wet periods and/or anthropogenic effects.

3. A Range of TDS Concentrations – Wells with historically low TDS and/or chloride concentrations near areas with high salinity were looked at to alert a change in groundwater quality conditions and a possible migration of salinity.

4. Known Well Construction Information – Wells with known construction data, including total depth, screen intervals, and construction date, were preferred. Knowledge of the depth at which water quality measurements are taken would better describe the representative conditions of specific portions of the aquifer.

5. Current TDS Monitoring Program – Wells currently monitored for TDS and/or chloride were preferred over wells not currently monitored for water quality constituents. These wells are already equipped for monitoring and have existing protocols to ensure accurate and consistent measurements, and they represent a current asset for the Subbasin that can be further utilized.

6. Consistency with BMPs – DWR's published BMPs were used as guidance documents to ensure consistency across all basins and ensure compliance with established regulations.

7. Professional Judgement – Professional judgement was used to make the final decision about each well, particularly when more than one suitable well exists in an area of interest.

4.3.2 Monitoring Protocols for Groundwater Quality Data Collection and Monitoring

Groundwater quality data sampling protocols are based on DWR's *Best Management Practices for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites* (CA DWR, 2016a), which cites the USGS's 1995 publication *Ground-Water Data-Collection Protocols and Procedures for the National Water-Quality Assessment Program: Collection and Documentation of Water-Quality Samples and Related Data* (USGS, 1995). The BMP recommends groundwater quality monitoring protocols and also recommends using the USGS *National Field Manual for the Collection of Water Quality Data* (USGS, var.) for additional protocols. These publications include protocols for equipment selection, setup, use, field evaluation, sample collection techniques, sample handling, and sample testing.

Groundwater quality sampling protocols recommended in the BMP include ensuring that:

- Groundwater quality data are taken from the correct location
- Groundwater quality data are accurate and reproducible
- Data represents conditions that inform appropriate basin management and are consistent with the data quality objectives

- Data are handled in a way that ensures data integrity
- All salient information is recorded to normalize, if necessary, and compare data

As a quality assurance measure, an operating standard will be developed to ensure data integrity. See Chapter 7: Plan Implementation for additional information on monitoring plan implementation.

4.3.3 Frequency and Timing of Groundwater Quality Monitoring

Groundwater quality measurements will be collected semi-annually from the representative monitoring network wells. Although DWR does not provide specific recommendations on the frequency of monitoring for TDS and/or chloride, concentrations of groundwater quality, especially salinity, do not typically fluctuate significantly throughout a year to require multiple samples per year. No existing monitoring wells were found to be monitored continuously for groundwater quality (such monitoring is typically performed only for EC and temperature), nor were there agencies that reported ongoing, non-regulatory, regularly scheduled groundwater quality monitoring programs. Table 4-5 identifies the historical frequency of groundwater quality monitoring conducted for local water quality wells by each monitoring agency.

Table 4-5: Historical Groundwater Quality Monitoring Frequency at Identified Local Water Quality Wells

Agency	Data Record	Historical Monitoring Frequency (Approx.)
Cal Water	1979 - 2018	Approx. every 3 years
City of Lodi	2008 - 2018	Approx. every 3 years
City of Manteca	1975 - 2017	Monthly
City of Stockton	1989 - 2016	Quarterly
San Joaquin County – Flag City	2009 - 2017	Annually

4.3.4 Spatial Density of Groundwater Quality Monitoring Wells

DWR's *Monitoring Networks and Identification of Data Gaps BMP* states "The spatial distribution must be adequate to map or supplement mapping of known contaminants" (CA DWR, 2016b). The goal of the groundwater quality monitoring network is to adequately cover the Subbasin to accurately characterize salinity concentrations and trends. This includes both spatial coverage and temporal coverage in order to identify changes in groundwater quality over time.

DWR's *Monitoring Networks and Identification of Data Gaps BMP* identifies different sources and calculations for establishing monitoring network densities on a Subbasin-specific case (CA DWR, 2016b). These density calculations and guidance are summarized in Table 4-2. The spatial density of the groundwater quality monitoring network was calculated for the representative monitoring network, as summarized in Table 4-6. The representative monitoring network consists of a total of 21 monitoring wells, a density of 1.2 wells per 100 square miles.

Table 4-6: Groundwater Quality Monitoring Network Density

Monitoring Network	No. of Wells	Well Density (Wells per 100 sq. miles)
Representative Monitoring Network	21	1.2

4.4 MONITORING NETWORK FOR SEAWATER INTRUSION

Seawater intrusion is not considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin.

4.5 MONITORING NETWORK FOR LAND SUBSIDENCE

Monitoring for inelastic land subsidence is conducted through a representative monitoring network specific for this sustainability indicator. This section provides information on how the monitoring network was developed, criteria for selecting dedicated monitoring locations, monitoring frequency, spatial density, and summary protocols.

The representative monitoring locations for inelastic land subsidence monitoring were selected from existing subsidence datasets and monitoring locations, including CGPS vertical displacement data from the DWR Sustainable Groundwater Management Act (SGMA) Data Viewer, InSAR subsidence rates from the SGMA Data Viewer, and survey benchmarks from U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (USACE), California Department of Transportation (CalTrans), the San Joaquin County Department of Public Works, and local agencies. There are no DWR or USGS extensometers in the Eastern San Joaquin Subbasin.

4.5.1 Representative Monitoring Network for Subsidence

Four CGPS stations were selected for the Subbasin's representative monitoring network for inelastic land subsidence based on data availability, location, and monitoring status. The first station, P309 (SOPAC), is located in the eastern region of the Subbasin, north of the Calaveras River, and provides a comprehensive data record from March 4, 2006, to January 19, 2024. This station was chosen due to its extensive data period and its spatial coverage in the eastern portion of the Subbasin. The second station, MTWK (UNAVCO), is situated in the southern region of the Subbasin, south of the city of Manteca, with data available from December 12, 2019, to January 19, 2024. It is the closest station to the Corcoran clay, an important area to monitor due to the potential for inelastic subsidence near clay-rich areas.

Additionally, two stations from the University of Nevada Geodetic Laboratory (UNGL) were included in the RMN to provide further spatial coverage and address data gaps. The CMNC station, located along the southern edge of the Camanche Reservoir, has data in 2020 and between February 2022 and January 2024. The CA1S station, north of the city of Stockton, offers a continuous record from October 2021 to September 2023. These stations were selected to enhance the spatial distribution of monitoring locations and continuity of subsidence data in the Subbasin.

Six survey benchmarks from San Joaquin County and National Geodetic Survey (NGS) were selected to supplement the CGPS data. Survey benchmarks were also selected to expand the spatial coverage of the subsidence monitoring network in the Subbasin and verify to InSAR data. From San Joaquin County, survey benchmarks M-20 and O-29 were selected. Benchmark M-20 was chosen for the RMN due to its location in the Subbasin, situated in the area with the highest subsidence rate. Benchmark O-29 was selected for its position near a localized, unverified point location of increased subsidence according to InSAR data.

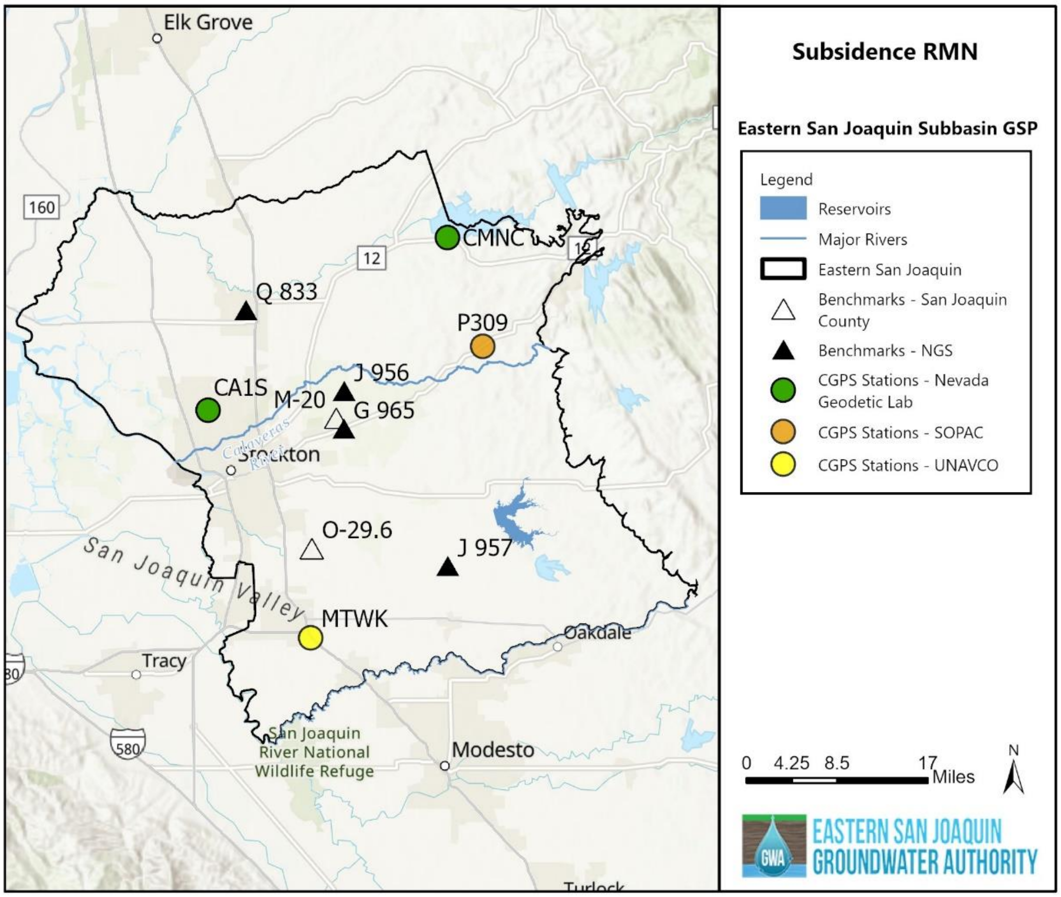
From the NGS, benchmarks Q-833, J-956, G-965, and J-957 were selected. Benchmark Q-833 was chosen due to its proximity to the LODI CGPS Station, its good condition, and elevation observations in 1947 and 1987. Benchmark J-956 is an important survey benchmark because it was recently surveyed in 2024, is in good condition, and is located in the cone of depression area with higher subsidence rates. Benchmark G-965 was selected for the RMN because of its good condition, long period of record dating back to 1962, and its location in the cone of depression area, with the latest survey in 1987. Benchmark J-957 was chosen for its observations in 1962 and 1987, its good condition, and its location in the southeast corner of the Subbasin. InSAR will serve as a supplementary data source for the rest of the Subbasin, and its accuracy will be validated using CGPS and benchmark data.

Table 4-7 describes monitoring site type, location, and data source for the four CGPS Stations and six survey benchmarks that will make up the Subbasin's RMN for the inelastic land subsidence sustainability indicator. Figure 4-3 shows the selected representative monitoring locations across the Subbasin.

Table 4-7: Representative Monitoring Network for Inelastic Land Subsidence

Name	Type	Location (dd)	Source
CA1S	CGPS	Lat: 38.022 N Long: 121.324 W	UNGL
CMNC	CGPS	Lat: 38.206 N Long: 120.999 W	UNGL
MTWK	CGPS	Lat: 37.778 N Long: 121.185 W	UNAVCO
P309	CGPS	Lat: 38.089 N Long: 120.951 W	SOPAC
Q-833	Survey Benchmark	Lat: 38.130 N Long: 121.272 W	NGS
J-956	Survey Benchmark	Lat: 38.043 N Long: 121.139 W	NGS
G-965	Survey Benchmark	Lat: 38.003 N Long: 121.139 W	NGS
M-20	Survey Benchmark	Lat: 38.014 N Long: 121.139 W	San Joaquin County
O-29.6	Survey Benchmark	Lat: 37.875 N Long: 121.183 W	San Joaquin County
J-957	Survey Benchmark	Lat: 37.856 N Long: 120.998 W	NGS

Figure 4-3: Representative Monitoring Network for Inelastic Land Subsidence



4.5.2 Monitoring Protocols for Subsidence Data Collection and Monitoring

Monitoring for inelastic land subsidence will occur semi-annually for survey benchmarks. Standard practices and protocols for land surveying as set forth in the *Caltrans Surveys Manual* (California Department of Transportation, 2021) will be followed to measure land surface elevations at those locations. Measurements will be in the same vertical datum, preferably NAVD88. CGPS data will be downloaded from the online data sources referenced in Section 4.5.1. InSAR data will be sourced annually from DWR's SGMA Data Viewer and compared against the land-based measurements as a quality control check.

4.5.3 Frequency and Timing of Subsidence Monitoring

As noted in Section 4.5.2, land surface elevations will be surveyed semi-annually in the spring and fall at the benchmarks noted in Table 4-7. Data for all other representative monitoring locations will be sourced from online published data in coordination with preparation of the Subbasin's Annual Report.

4.5.4 Spatial Density of Subsidence Monitoring Stations

Per DWR's *Best Management Practices for the Sustainable Management of Groundwater, Monitoring Protocols, Standards, and Sites* (2016a), the representative monitoring locations for inelastic land subsidence in the Subbasin was established to monitor regions where the potential for subsidence exists. As such, the monitoring locations were selected to provide an overall network of sites for data collection that represent the different areas of the Subbasin – areas upland, near the Delta, overlying the Corcoran clay and overlying unconfined alluvial systems. While the representative monitoring network contains discrete data collection locations, the use of InSAR survey data in the annual evaluation for the potential for subsidence provides Subbasin-wide coverage in coordinate with the direct data measurements.

4.6 MONITORING NETWORK FOR DEPLETIONS OF INTERCONNECTED SURFACE WATERS

This section provides information on how the monitoring network was developed for interconnected surface water (ISW), criteria for selecting dedicated monitoring wells, monitoring frequency, spatial density, and summary protocols. Like the wells used to monitor groundwater levels to assess sustainability in the Subbasin, these wells are used to determine compliance with minimum thresholds and measurable objectives for the interconnected surface water sustainability indicator.

4.6.1 Representative Monitoring Network for Interconnected Surface Water

The representative monitoring wells contained in the network for interconnected surface water consists of a subset of the groundwater level (GWL) RMN wells that are within five miles of connected surface waters plus six newly constructed monitoring wells constructed in 2022 and 2024 to address data gaps. Only one well (the shallowest well in a gap area) was selected from the GWL RMN along the Mokelumne River since there are the new ISW wells along other sections of the Mokelumne River. Table 4-8 identifies and summarizes the 12 representative monitoring wells for interconnected surface waters.

Table 4-8: Representative Monitoring Wells for Interconnected Surface Water

Well ID	Latitude, Longitude	Well Perforations (feet below ground surface)	Nearest Adjacent Stream	Well Category
Well A	38.23583, -121.41869	14 – 31.5	Mokelumne River	New ISW Well
Well B	38.245966, -121.217862	25 – 35	Dry Creek	New ISW Well
Well C	38.20457, -121.09278	15 – 30	Mokelumne River	New ISW Well
Well E	38.15838, -121.14675	35 – 50	Mokelumne River	New ISW Well
Well G	37.86248, -120.77601	26 – 41	Little Johns Creek	New ISW Well
Delta Well	38.1229, -121.4932	125 – 150, 275 – 300	Mokelumne River	New ISW Well
04N05E36H003	38.1559, -121.3727	50 – 112	Mokelumne River	GWL RMN
Swenson-3	38.0067, -121.3458	194 – 204	San Joaquin River	GWL RMN
Frankenheimer (01S10E26J001M)	37.8163, -120.8321	323 – 599	Stanislaus River	GWL RMN

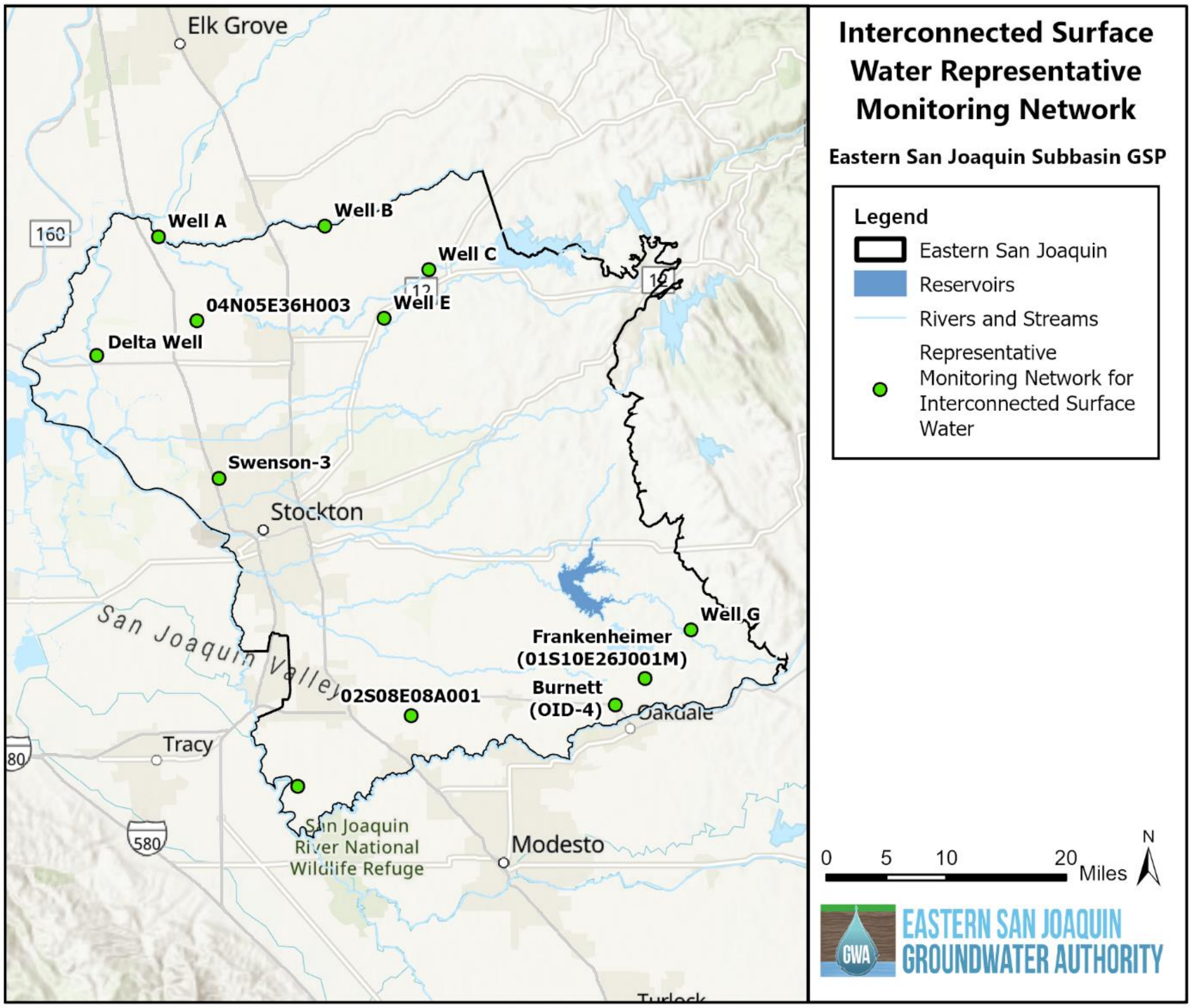
Well ID	Latitude, Longitude	Well Perforations (feet below ground surface)	Nearest Adjacent Stream	Well Category
Burnett (OID-4)	37.7909, -120.86752	168 – 249	Stanislaus River	GWL RMN
02S07E31N001	37.7136, -121.2508	130 – 226	San Joaquin River	GWL RMN
02S08E08A001	37.781, -121.1142	50 – 180	Stanislaus River	GWL RMN

Representative groundwater level monitoring sites were selected from the GWL RMN for their proximity to identified interconnected surface water reaches, thorough and recent groundwater level observations, and known perforations. The six new monitoring wells recently constructed, Well A, Well B, Well C, Well E, Well G and the Delta Well, were sited based on interconnected surface water data gaps described in the 2020 GSP and 2022 Revised GSP identifying a need for additional information on interconnected surface water to inform the SMC and to benefit future model calibration efforts. The specific well locations were further refined based on the additional criteria, including:

- The location of existing monitoring sites, including CASGEM Wells, SJC wells, USGS multi-completion wells, and other multi-completion wells.
- Areas with recharge and service water interaction
- Areas of critical overdraft
- Areas of water quality concern
- Areas in close proximity to subbasin boundaries
- Areas proximate to identified GDEs and interconnected surface water reaches
- Areas to support future model refinement
- Property owned by one of the Subbasin GSAs.

The ISW RMN wells were selected to reflect both shallow, dynamic interactions between streams and the aquifer, as well as deeper regional pumping trends. Figure 4-4 shows the revised representative monitoring network for interconnected surface water.

Figure 4-4: Representative Monitoring Network for Interconnected Surface Water



4.6.2 Monitoring Protocols for Interconnected Surface Water Data Collection and Monitoring

Monitoring protocols for interconnected surface water representative monitoring wells are the same as those used for data collection from groundwater level representative monitoring wells. See Section 4.1.2 for the applicable protocols.

4.6.3 Frequency and Timing of Interconnected Surface Water Monitoring

The frequency and timing of the collection of monitoring data from interconnected surface water representative monitoring wells are the same as those used for the monitoring of groundwater level representative monitoring wells. See Section 4.1.3 for more detail on the frequency and timing of monitoring for the groundwater level RMN. Some wells will have transducers installed using American Rescue Plan Act (ARPA) funding allowing for more frequent groundwater level observation collection.

4.6.4 Spatial Density of Interconnected Surface Water Monitoring Network

As with the representative monitoring network for groundwater level monitoring, the goal of the interconnected surface water monitoring network is to provide adequate spatial coverage within the Subbasin. This includes the ability to monitor and identify changes across the Subbasin boundaries (most of which are comprised of rivers), as well as along interconnected reaches within the Subbasin. The spatial location of monitoring wells in the network was based predominantly on proximity to interconnected reaches of the rivers and streams in the Subbasin.

4.7 DATA GAPS

4.7.1 Groundwater Level Data Gaps

Groundwater level monitoring data gaps exist in areas where data are limited. Specifically, areas of high data needs include monitoring near streams, Subbasin boundaries, and the groundwater depression in the central part of the Subbasin. Additionally, areas without multiple-completion wells present a limitation for depth-specific information collection. Additional sampling taken within these identified areas will provide more information about groundwater levels and trends in the indicated locations.

4.7.2 Groundwater Quality Data Gaps

Groundwater quality monitoring data gaps have four components:

1. Spatial distribution: Monitoring wells are mainly focused in the western portion of the Subbasin, as this area has historically had the highest concentrations of TDS. Additional sampling will provide more information about salinity both to provide more detailed understanding within areas with current monitoring coverage and to expand monitoring to areas without current salinity issues.
2. Well construction data: As described in Section 2.2.4, many wells with salinity measurements lack well depth and construction information. Both deeper and shallower groundwater quality monitoring wells are needed to better understand the spatial and depth distribution of salinity concentrations in the Subbasin.
3. Monitoring frequency: Temporally, groundwater quality monitoring occurs at different frequencies across the Subbasin, dependent on the monitoring agency responsible (summarized in Table 4-4). The groundwater quality monitoring network under the GSP will utilize a standardized, semi-annual monitoring schedule to facilitate the regular sampling of wells.
4. Monitoring for additional constituents: Groundwater quality concerns in the Subbasin are currently focused on salinity, represented by TDS and chloride as constituents of concern. Additional groundwater quality components such as arsenic and cations and anions, including nitrate, are monitored under existing water resources monitoring and management programs. Informational monitoring of these constituents may preempt future groundwater quality issues in the Subbasin.

4.7.3 Interconnected Surface Water System Data Gaps

The ESJGWA recognizes the depletions of interconnected surface water as a data gap area. The ESJGWA has completed some refinements to the representative monitoring network, but a future study and additional refinement of interconnected surface water representative monitoring network will be needed, along with continued coordination efforts with neighboring subbasins to better inform Subbasin conditions and interconnected rivers that serve as boundaries for the Subbasin. As discussed in Section 7.4.1, future model calibration will be improved by more information on interconnected surface water, including the incorporation of additional shallow groundwater levels near interconnected stream reaches.

4.7.4 Groundwater-Dependent Ecosystem Data Gaps

The Natural Communities Commonly Associated with Groundwater (NCCAG) areas not identified as Groundwater-Dependent Ecosystems (GDEs) through the GDE analysis are data gap areas requiring further evaluation and refinement to determine whether they require classification as a GDE. These areas include NCCAGs that either access co-occurring surface water, were identified as located in an area with groundwater levels deeper than 30 feet below the ground surface, or were located adjacent to irrigated agriculture. The purpose of this data gap is to identify potential existing GDEs that may have been incorrectly identified or not identified as GDEs through the GDE screening process discussed in Section 2.2.7 and Section 2.3.7. Potential impacts to fish and wildlife species associated with GDEs that occur as a result of groundwater pumping under and are not captured under the depletions of interconnected surface water sustainability indicator is also considered a data gap area. Additional detail on this data gap is discussed in Appendix 3-C.

4.7.5 Plan to Fill Data Gaps

Data gaps will be largely filled by leveraging existing wells, constructing new wells, additional water quality monitoring, modeling, and studies of interconnected surface water and GDEs, which are discussed in Chapter 7: Plan Implementation. These efforts will be supported through a combination of funding and financing sources, including through DWR Technical Support Services (TSS) funding, future grant funding, and GSA funding. A description of data collection and analysis efforts to fill data gaps, and information on how these efforts will be funded, is provided in Chapter 7: Plan Implementation.

There are up to 12 proposed new monitoring well sites (shown in Figure 4-5 as orange diamonds). Progress has been made toward drilling new wells at 6 sites since the 2020 GSP (shown as circles with orange outlines). New wells will be measured for groundwater levels and/or groundwater quality, depending on the data gap for which the well is intended to fill. The locations of the proposed monitoring wells are subject to change based on the needs of the Subbasin and well siting feasibility. Additional multi-completion groundwater level information will assist with better understanding of groundwater-surface water interaction and GDEs. Future multi-completion wells and/or well pairs may be constructed to support the efforts to understand groundwater levels and quality at varying depths in the Subbasin.

Additional new shallow groundwater level and quality monitoring wells located near streams, Subbasin boundaries, and the groundwater depression area in the center of the Subbasin will also improve the understanding of aquifer-stream dynamics. The proposed locations of these wells will be selected to be co-located with identified and potential GDE areas and near streams to further understanding of groundwater-surface water connectivity and to refine GDE data gaps. Additionally, groundwater level data collected from these wells will improve the understanding of groundwater flows between subbasins and groundwater quality data will assist in tracking quality in different areas of the Subbasin. Relevant data from these and other wells will be shared with GSAs in neighboring subbasins, and parallel efforts will be coordinated.

The USGS *National Field Manual for the Collection of Water Quality Data* (USGS, var.) will be used as a guide for selection of wells, well locations, and collection of reliable data, as recommended by DWR's *Monitoring Protocols, Standards, and Sites* BMP (CA DWR, 2016a). Requirements are summarized in Table 4-9. The DWR's *California Well Standards, Bulletin 74-81 and 74-90* will be used as references for guidance for construction of new monitoring well installation, per DWR's *Best Management Practices for the Sustainable Management of Groundwater Monitoring Protocols, Standards, and Sites* (CA DWR, 2016a). Additionally, procedures will follow applicable San Joaquin County, Calaveras County, or Stanislaus County well standards, including proper permitting and inspection from the applicable county for each well.

Aside from new groundwater monitoring wells, data gaps will also be addressed through additional analyses of interconnected surface water, including additional refinement of GDEs, and through the use of publicly available data collected by others in the Subbasin. The ESJGWA plans to conduct field verification of the potential GDE sites identified in Appendix 3-C. This field exercise will assess both species presence and source of water for each ecosystem. The results of this study, combined with additional shallow groundwater level data collected at new wells, will determine what additional regional or site-specific biological analyses may be needed to effectively assess locations of GDEs and appropriately manage impacts to them. Future projects and management actions may be developed to address these needs once there is sufficient data to evaluate GDEs effectively.

Additional activities related to filling data gaps are discussed in Chapter 6: Projects and Management Actions and Chapter 7: Plan Implementation.

Figure 4-5: Proposed New Monitoring Well Locations (Shown as Orange Diamonds)

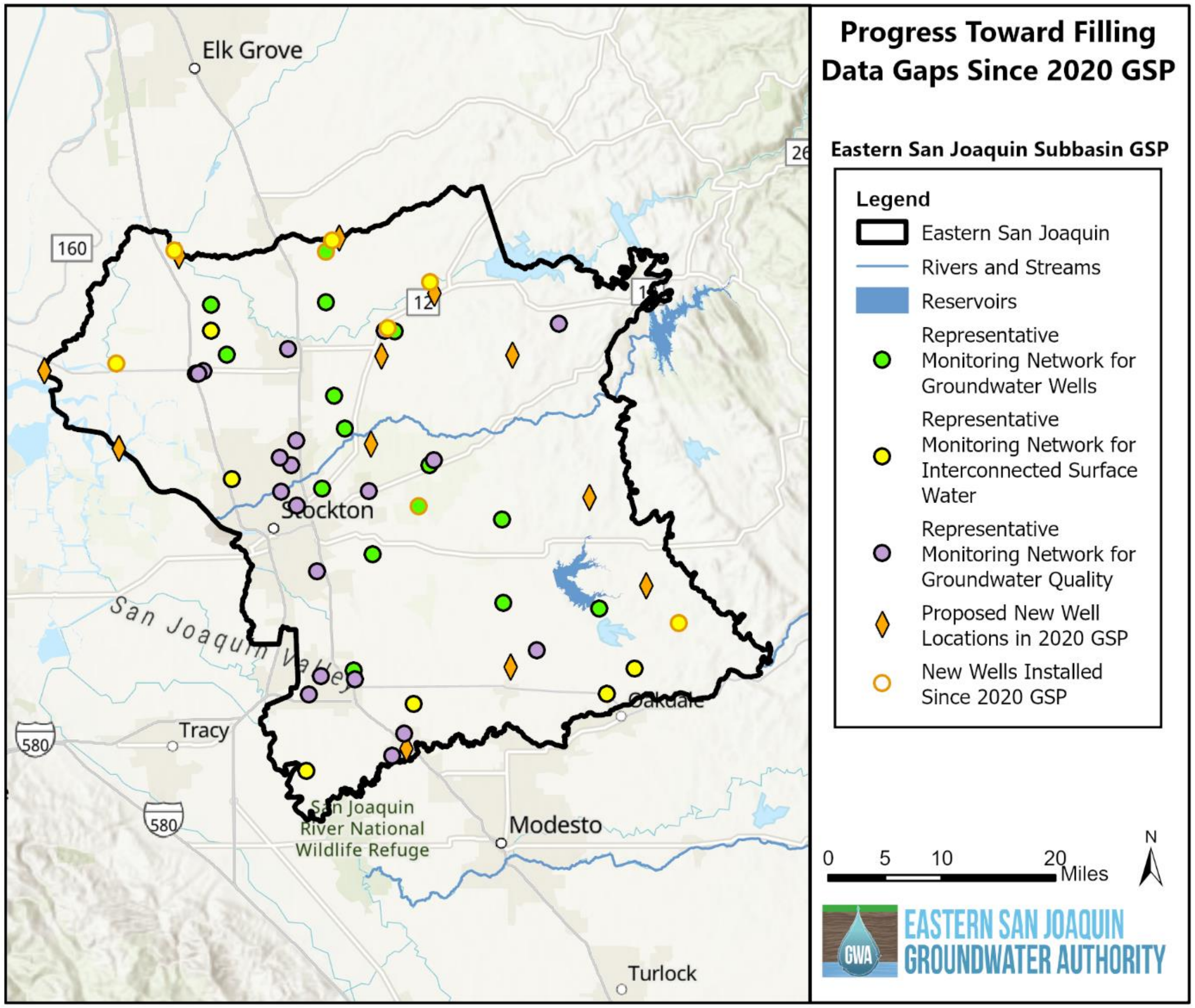


Table 4-9: Considerations for Well Selection and Well Installation

Well Location
• Location conforms to the study's network design for areal and depth distribution. • Land-use/land-cover characteristics, if relevant, are consistent with study objectives. • Site is accessible for equipment needed for well installation and sample collection.
Hydrogeologic Unit(s)
• Hydrogeologic unit(s) that contribute water to the well can be identified. • Depth and thickness of targeted hydrogeologic unit(s) are known or can be determined. • Yield of water is adequate for sampling (typically, a minimum of 1 gallon (3.785 liters) per minute).
Well Records, Description, Design, Materials, and Structure
• Available records (for example, logs of well drilling, completion, and development) have sufficient information to meet the criteria established by the study. • Borehole or casing/screen diameter is adequate for equipment. • Depth to top and bottom of sample-collection (open or screened) interval is known (to determine area contributing water to well). • Length of well screen is proportional to the vertical and areal scale of investigation. • Well has only one screened or open interval in one aquifer, if possible. (Packers can be used to isolate the interval of interest, but packers might not completely isolate zones in unconsolidated or highly fractured aquifers. If packers are used, materials of construction must be compatible with analytes to be studied.) • Top of well screen is several feet below mean annual low-water table to reduce chances of well going dry and to avoid sampling from unsaturated intervals. • Filter pack is of a reasonable length (a long interval compared with length of screened or open interval usually results in uncertainty as to location of the source of water to well). • Well-construction materials do not leach or sorb substances that could alter ambient target-analyte concentrations. • Well-structure integrity and communication with the aquifer are sound. (Checks include annual depth-to-bottom measurements, borehole caliper and downhole-camera video logs, and aquifer tests.)
Pump Type, Materials, Performance, and Location of Sampler Intake
• Supply wells have water-lubricated turbine pumps rather than oil-lubricated turbine pumps. (Avoid suction-lift, jet, or gas-contact pumps, especially for analytes affected by pressure changes, exposure to oxygen, or that partition to a gas phase.) • Pump and riser-pipe materials do not affect target-analyte concentrations. • Effects of pumping rate on measurements and analyses have been or will be evaluated. • Samples intake is ahead of where water enters treatment systems, pressure tanks, or holding tanks.

Source: *National Field Manual for the Collection of Water-Quality Data* (USGS, var.)

ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Data Management System

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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Acronyms

μmhos/cm	micromhos per centimeter
CASGEM	California Statewide Groundwater Elevation Monitoring
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
DMS	data management system
DWR	Department of Water Resources
ESJGWA	Eastern San Joaquin Groundwater Authority
ETo	evapotranspiration
GAMA	groundwater ambient monitoring and assessment
GIS	geographic information systems
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
SGMA	the Sustainable Groundwater Management Act

5. DATA MANAGEMENT SYSTEM

This chapter includes the Data Management System Section that satisfies §352.6 of the Sustainable Groundwater Management Act Regulations. This section contains three main subsections:

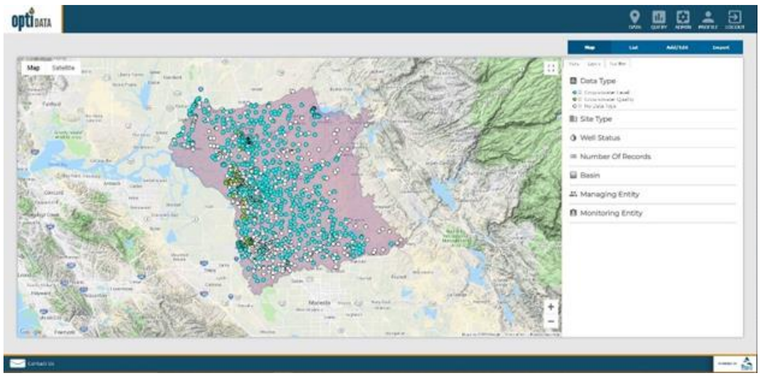
- Overview of the Eastern San Joaquin Subbasin Data Management System
- Functionality of the Data Management System
- Data Included in the Data Management System

5.1 OVERVIEW OF THE EASTERN SAN JOAQUIN SUBBASIN DATA MANAGEMENT SYSTEM

The Eastern San Joaquin Subbasin Data Management System (DMS) is implemented using the Opti platform. The DMS serves as a data sharing portal to enable utilization of the same data and tools for visualization and analysis to support sustainable groundwater management and transparent reporting of data and results.

The DMS is web-based and publicly accessible using common web browsers including Google Chrome, Firefox, and Microsoft Edge. It is a flexible and open software platform that utilizes familiar Google maps and charting tools for analysis and visualization. The site may be accessed here: https://opti.woodardcurran.com/esj

Figure 5-1: Opti DMS Screenshot



5.2 FUNCTIONALITY OF THE DATA MANAGEMENT SYSTEM

The DMS is a modular system that includes numerous tools to support Groundwater Sustainability Plan (GSP) development and ongoing implementation, including:

- User and Data Access Permissions
- Data Entry and Validation
- Visualization and Analysis
- Query and Reporting

The DMS can be configured for additional tools and functionality as the needs of the Eastern San Joaquin Groundwater Authority (ESJGWA) change over time. The following sections briefly describe the currently configured tools. For more detailed instructions on the usage of the DMS, please refer to the Opti Public User Guide (the Opti Public User Guide can be accessed online at https://opti.woodardcurran.com/esj/upload/OptiPublicDMS_Guide.pdf.

5.2.1 User and Data Access Permissions

User access permissions are controlled through several user types that have different roles in the DMS as summarized in Table 5-1 below. These user types are broken into three high-level categories:

- System Administrator users manage information at a system-wide level, with access to all user accounts and entity information. System Administrators can set and modify user access permissions when an entity is unable to do so.
- Managing Entity (Administrator, Power User, User) users are responsible for managing their entity's site/monitoring data and can independently control access to this data. Entity users can view and edit their entity's data and view (not edit) shared or published data of other entities. An entity's site information (wells, gages, etc.) and associated data may only be edited by Administrators and Power Users associated with the entity.
- Public users may view data that are published but may not edit any information. These users may access the DMS using the Guest Login feature on the login screen.

Monitoring sites and their associated datasets are added to the DMS by Managing Entity Administrators or Power Users. In addition to the user permissions, access to the monitoring datasets is controlled through three options:

- Private data are monitoring data that are only available for viewing, depending on user type, by the entity's associated users in the DMS.
- Shared data are monitoring data that are available for viewing by all users in the DMS (excludes Public Users).
- Public data are monitoring data that are available publicly and can be viewed by all user types in the DMS and may be published to other sites or DMSs as needed.

The Managing Entity Administrators have the ability to set and maintain the data access options for each dataset associated with their entity.

Table 5-1: Data Management System User Types

Modules/Submodules	System Administrators	Entity			Public
		Admin	Power User	User	
Data: Map	●	●	●	●	○
Data: List	●	●	●	●	○
Data: Add/Edit	●	●	●		
Data: Import	●	●	●		
Query	●	●	●	●	○
Admin	●				
Profile	●	●	○	○	○

● Indicates access to all functionality, ○ Indicates access to partial functionality (see explanations in following sections)

5.2.2 Data Entry and Validation

To encourage agency and user participation in the DMS, data entry and import tools are easy to use, accessible over the web, and help maintain data consistency and standardization. The DMS allows Entity Administrators and Power Users to enter data either manually via easy-to-use interfaces, or through an import tool utilizing Excel templates, ensuring data may be entered into the DMS as soon as possible after collection. The data are validated by Managing Entity's Administrators or Power Users using a number of quality control checks prior to inclusion in the DMS.

As part of the 2020 GSP and 2022 Revised GSP implementation, a mobile and tablet interface was developed for the DMS to facilitate the real-time upload of data collected in the field. The Eastern San Joaquin (ESJ) Data Management System (DMS) mobile interface is implemented using the Esri ArcGIS Field Maps mobile app (or the Collector app if already installed) and is integrated with the DMS via web services to ArcGIS Online.* The mobile interface is intended to provide all ESJ staff and their consultants with easy-to-use interfaces to collect well and groundwater related data in the field. Data collected using the mobile interfaces are pulled into the DMS on a nightly basis where it is quality controlled prior to insertion into the database.

5.2.2.1 Data Collection Sites

Site information is input for groundwater wells, stream gages, and precipitation meters manually either through the Data Entry tool or when prompted in the Import tool. In the Data Entry tool, new sites may be added by clicking on New Site. Existing sites may be updated using the Edit Site tool. During data import, the sites associated with imported data are checked by the system against the existing site list in the DMS. If the site is not in the existing site list, the user is prompted to enter the information via the New Site tool before the data import can proceed.

The information that is collected for sites is shown in Table 5-2. Required fields are indicated with an asterisk.

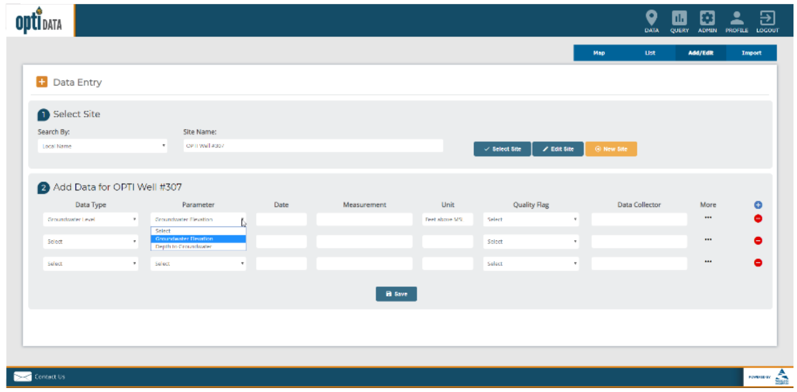
Table 5-2: Data Collection Site Information

Basic Info	Well Info	Construction Info
Site Type*	State Well ID	Total Well Depth
Local Site Name*	CASGEM ID	Borehole Depth
Local Site ID	Ground Surface Elevation	Casing Perforations
Latitude/Longitude*	Reference Point	Casing Diameter
Description	Reference Point Elevation	Casing Modifications
County	Reference Point Location	Well Capacity
Managing Entity*	Reference Point Description	Well Completion Report Number
Monitoring Entity*	Well Use	Comments
Type of Monitoring	Well Status	
Type of Measurement	Well Type	
Monitoring Frequency	Aquifers Monitored	
	Groundwater Subbasin Name/Code	
	Comments	
	Upload File	

* Required fields; all other fields are optional

5.2.2.2 Monitoring Data Entry

Figure 5-2: DMS Data Entry Tool



Monitoring data, including but not limited to groundwater elevation, groundwater quality, streamflow, and precipitation, may be input either manually through the Data Entry tool or using templates in the Import tool. The Data Entry tool allows users to select a site and add data for the site using a web-based tool (see Figure 5-2). The following information is collected:

- Data Type (e.g., groundwater elevation, groundwater quality, streamflow, or precipitation)
- Parameter for selected Data Type, units populate based on selection
- Date of Measurement
- Measurement Value
- Quality Flag (e.g., quality assurance description for the measurement such as “Pumping”, “Can’t get tape in casing”, etc., as documented by the Data Collector)
- Data Collector
- Supplemental Information based on Data Type (e.g., Reference Point Elevation, Ground Surface Elevation, etc.)

Data import templates include the same data entry fields and are available for download from the DMS. The Excel-based templates contain drop-down options and field validation similar to the data entry interface.

5.2.2.3 Data Validation

Quality control helps ensure the integrity of the data added to the DMS. The entities that maintain the monitoring data that were loaded into the DMS may have performed previous validation of that data; no effort was made to check or correct that previous validation and it was assumed that all data provided was valid. While it is nearly impossible to determine complete accuracy of the data added to the DMS since the DMS cannot detect incorrect measurements due to human error or mechanical failure, it is possible to verify that the data input into the DMS meets some data quality standards. This helps promote user confidence in the data stored and published for visualization and analysis.

Upon saving the data in the data entry interface or importing the data using the Excel templates, the following data validation checks are performed by the DMS:

- <u>Duplicate measurements</u>: The database checks for duplicate entries based on the unique combination of site, data type, date, and measurement value.
- <u>Inaccurate measurements</u>: The database compares data measurements against historical data for the site and flags entries that are outside the historical minimum and maximum values.
- <u>Incorrect data entry</u>: Data field entries are checked for correct data type (e.g., number fields do not include text, date fields contain dates, etc.)

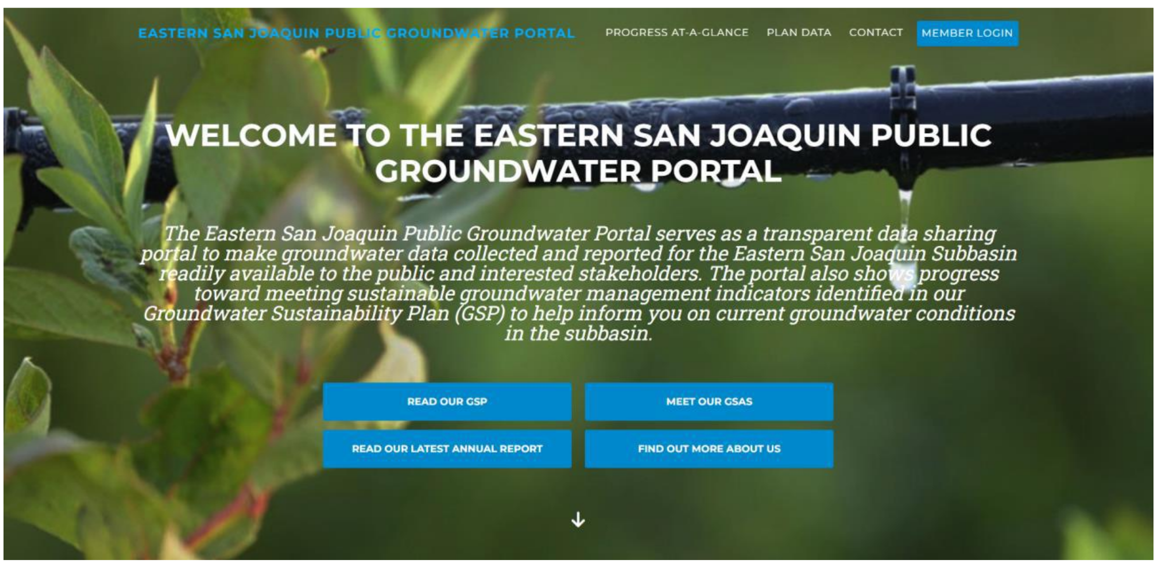
Users are alerted to any validation issues and may either update the data entries or accept the values and continue with the entry/import. Users may access partially completed import validation through the import logs that are saved for each data import. The partially imported data are identified in the Import Log with an incomplete icon under the Status field. This allows a second person to access the imported data and review prior to inclusion in the DMS.

5.2.3 Visualization and Analysis

Transparent visualization and analysis tools enable utilization of the same data and methodologies, allowing stakeholders and neighboring Groundwater Sustainability Agencies (GSAs) to use the same data and methods for tracking and analysis. In the Eastern San Joaquin Subbasin DMS, data visualization and analysis are performed in both Map and List views.

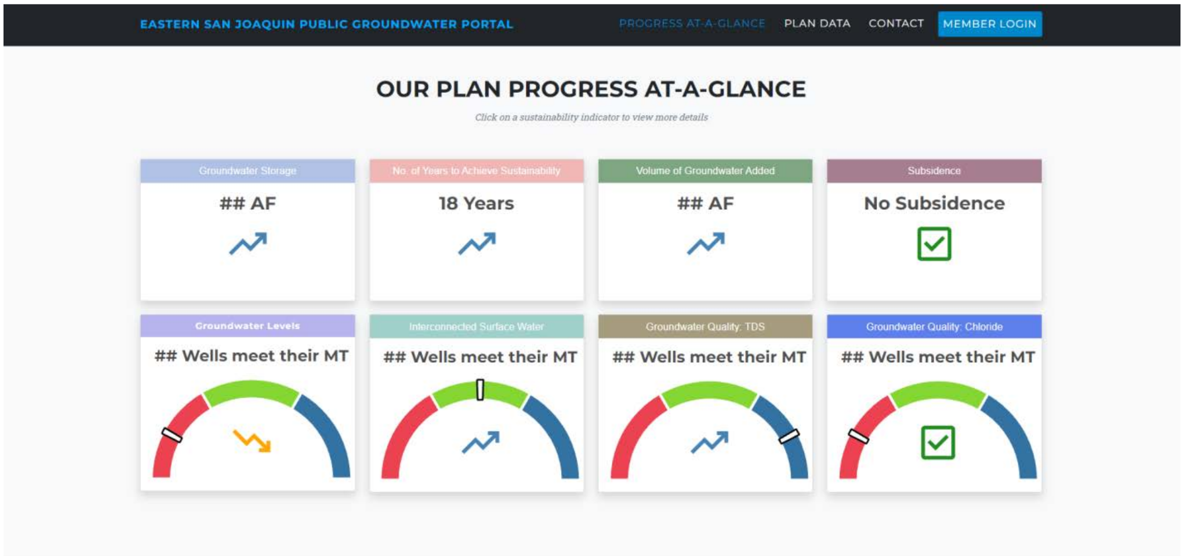
The Eastern San Joaquin Subbasin DMS underwent refinement in 2023 to improve streamlining of communication of subbasin status to the public and improved access to SGMA-related data. The refined DMS portal is conceived as a simple-to-use public portal that pulls data directly from the ESJ SGMA DMS into an easy-to-understand and interactive website. The new Groundwater Portal also provides access to other subbasin information and websites. Upon entering the Groundwater Portal of the DMS (Figure 5-3), users who wish to login may click on the “Member Login” button to access the existing DMS for data updates, analysis, and reporting. Public users may access the GSP, view a list of member GSAs, read the latest annual report, and visit the ESJ Groundwater Authority webpage.

Figure 5-3: Landing Page of Groundwater Portal



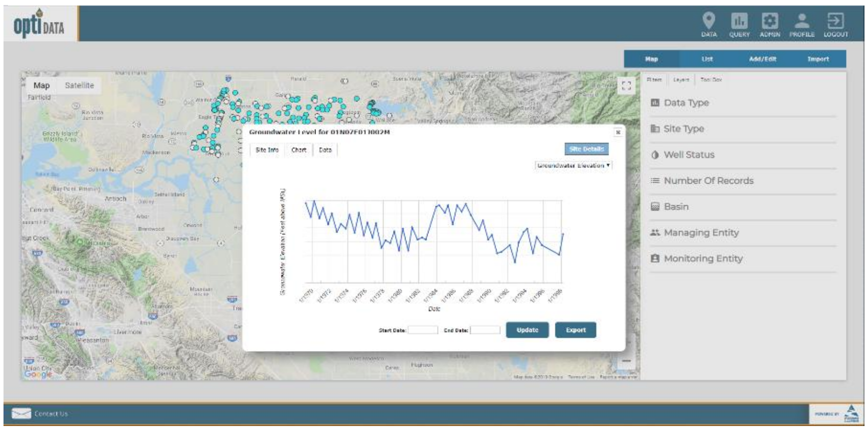
The updated portal also includes a “Progress-At-A-Glance” link or scrolling down displays the ESJ Subbasin dashboard, as shown in Figure 5-4. The dashboard is intended to give a quick and easy-to-understand snapshot of the subbasin conditions. The dashboard framework is ready to be populated when and if the ESJ Groundwater Authority determines what information should be made available to the public.

Figure 5-4: Progress-At-A-Glance Dashboard



5.2.3.1 Map View

Figure 5-5: Typical DMS Data Display



The Map view displays all sites (groundwater wells, stream gages, precipitation meters, etc.) in a map-based interface (see Figure 5-5). The sites are color coded based on associated data type and may be filtered by different criteria such as number of records or monitoring entity. The ESJ Plan Data map is an interactive map interface built utilizing the ArcGIS JavaScript API, ArcGIS Online, and a live link to the ESJ SGMA DMS data. The map interface includes geospatial information, search functions based on address or place, map filters, and data view and download functions. Users may click on a site to view the site detail information and associated data. The monitoring data are displayed in both chart and table formats. In these views, the user may select to view different parameters for the data type. The chart and table may be updated to display selected date ranges, and the data may be exported to Excel.

5.2.3.2 List View

The List view displays all sites (groundwater wells, stream gages, precipitation meters, etc.) in a tabular interface. The sites are listed according to site names and associated entities. The list can be sorted and filtered by different criteria such as number of records or monitoring entity. Similar to the Map view, users may click on a site to view the site detail information and associated data. The monitoring data are displayed in both chart and table formats. In these views, the user may select to view different parameters for the data type. The chart and table may be updated to display selected date ranges, and the data may be exported to Excel.

5.2.3.3 Analysis Tools

The Toolbox is available in the Map view and offers Administrative and Entity users access to the Well Tiering tool to support monitoring plan development. The flexibility of the DMS platform allows for future analysis tools, including contouring, total water budget visualization, and management area tracking.

5.2.4 Query and Reporting

The DMS has the ability to format and export data and analysis at different levels of aggregation, and in different formats, to support local decision making and for submission to various statewide and local programs (i.e., the Sustainable Groundwater Management Act [SGMA], California Statewide Groundwater Elevation Monitoring [CASGEM], groundwater ambient monitoring and assessment [GAMA], etc.). Additionally, data contained in the DMS may be viewed and downloaded. Clicking on the representative monitoring well in the map view will open a modal (pop-out window) to view and download data. The modal displays a hydrograph along with the Measurable Objective and Minimum Threshold for the well. A tabular view of the data is also available. All data can be printed or downloaded to the user's selected location in Excel format.

5.2.4.1 Ad-hoc Query

The data in the DMS can be queried and reported using the Query Tool. The Query Tool includes the ability to build ad-hoc queries using simple options. The data can be queried by:

- Monitoring or Managing Entity
- Site Name
- Data Type

Once the type of option is selected, the specific criteria may be selected (e.g., groundwater elevation greater than 100 ft.). Users may also include time periods as part of the query. The query options can build upon each other to create reports that meet specific needs. Queries may be saved and will display in the saved query drop-down menu of the user who created the query for future use.

The query results are displayed in a map format and a list format. In both the Map and List views, the user may click on a well to view the associated data. The resulting data of the query may be exported to Excel.

5.2.4.2 Standard Reports

The DMS can be configured to support wide-ranging reporting needs through the Reports tool. Standard report formats may be generated based on a predetermined format and may be created at the click of a button. These report formats may be configured to match state agency requirements for submittals, including annual reporting of monitoring data that must be submitted electronically on forms provided by the Department of Water Resources (DWR).

5.3 DATA INCLUDED IN THE DATA MANAGEMENT SYSTEM

Many monitoring programs exist at both the local and state/federal levels. A cross-sectional analysis was conducted within the Subbasin to document and assess the availability of data within the Subbasin, as well as statewide or federal databases that provide data relevant to the Subbasin.

The DMS is configured to include a wide variety of monitoring data types and associated parameters. Based on the analysis of existing datasets within the Subbasin and the GSP needs, the data types shown in Table 5-3 below were identified and are currently used in the DMS.

Table 5-3: Data Types and Their Associated Parameters Configured in the DMS

Data Type	Parameter	Units	Currently Has Data in DMS
Groundwater Level	Depth to Groundwater	feet	Yes
	Groundwater Elevation	feet	Yes
Groundwater Quality	Chloride	milligrams per liter	Yes
	Electrical Conductivity	umhos/cm	Yes
	Total Dissolved Solids	milligrams per liter	Yes
	Various Parameters (See Appendix 5-A)	various	
Surface Water Quality	Various Parameters (See Appendix 5-A)	various	
Streamflow	Streamflow	cubic feet per second	
Precipitation	Precipitation	inches	
	Reference Evapotranspiration (ETo)	inches per month	
	Average Air Temperature	ºF	

Additional data types and parameters can be added and modified as the DMS grows over time. The data were collected from a variety of sources, as shown in Table 5-4 below. Each dataset was reviewed for overall quality and consistency prior to consolidation and inclusion in the database.

The groundwater wells shown in the DMS are those that are included datasets provided by the monitoring data sources shown below for groundwater elevation and quality. These do not include all wells currently used for production and may include wells historically used for monitoring that do not currently exist. Care was taken to minimize duplicative wells in the DMS. As datasets were consolidated, sites were evaluated based on different criteria (e.g., naming conventions, location, etc.) to determine if the well was included in a different dataset. Datasets for the wells were then associated with the same well, where necessary.

After the data were consolidated and reviewed for consistency, it was loaded into the DMS. Using the DMS data viewing capabilities, the data were reviewed for completeness and consistency to ensure the imports were successful.

Table 5-4: Sources of Data Included in the Data Management System

Data Source	Datasets Collected	Date Collected	Activities Performed
Central Valley Salinity Alternatives for Long-Term Sustainability (CVSALTS)	Well Location Well Type (Limited) Well Depth (Limited) Groundwater Quality	8/13/2018	• Removed duplicate records • Matched existing records with other data sources (GAMA, DWR)
DWR CASGEM	Groundwater Elevation Well Type (Limited) Well Depth (Limited) Well Location	4/18/2018	• Removed duplicate records
EnviroStor	Groundwater Quality	7/23/2018	• Removed duplicate records
GeoTracker	Groundwater Quality	7/23/2018	• Removed duplicate records
GAMA	Well Type Well Depth (Limited) Well Location Groundwater Quality	8/2/2018	• Removed duplicate records
Local Data	Groundwater Elevation (Limited) Well Type (Limited) Well Depth Well Location Groundwater Quality	2/2017-10/2018	• Removed duplicate records
San Joaquin County Flood Control and Water Conservation District	Groundwater Elevation Well Type (Limited) Well Depth (Limited) Well Location	9/19/2017	• Removed duplicate records

ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Projects and Management Actions

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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Acronyms

AF	acre-feet
AF/year	acre-feet per year
AMI	Advanced Metering Infrastructure
ASR	aquifer storage and recovery
AWMP	Agricultural Water Management Plan
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CSJWCD	Central San Joaquin Water Conservation District
CVFPB	Central Valley Flood Protection Board
CVRWQCB	Central Valley Regional Water Quality Control Board
CWC	California Water Code
CWSRF	Clean Water State Revolving Fund
DACs	Disadvantaged Communities
DFW	Department of Fish and Wildlife
DMS	Data Management System
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utility District
ERTs	Encoder Receiver Transmitters
ESJGWA	Eastern San Joaquin Groundwater Authority
ESJGWA Board	Eastern San Joaquin Groundwater Authority Board of Directors
ESJWRM	Eastern San Joaquin Water Resources Model
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
IRWMP	Integrated Regional Water Management Plan
MAR	managed aquifer recharge
MGD	million gallons per day
MUD	Municipal Utilities Department
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
NSJWCD	North San Joaquin Water Conservation District
O&M	operations and maintenance
OID	Oakdale Irrigation District
PDA	Protest Dismissal Agreement
PMAs	Projects and Management Actions
RFP	request for proposal
RWQCB	Regional Water Quality Control Board
SCADA	supervisory control and data acquisition
SDACs	Severely Disadvantaged Communities
SEWD	Stockton East Water District
SGMA	the Sustainable Groundwater Management Act
SSJ	South San Joaquin
SSJID	South San Joaquin Irrigation District
SWRCB	State Water Resources Control Board
SWTF	Surface Water Treatment Facility
USACE	U.S. Army Corps of Engineers
USBR	United States Bureau of Reclamation
UWMP	Urban Water Management Plan
VFD	variable frequency drive

Water Code	California Water Code
WDR	Waste Discharge Requirement
WID	Woodbridge Irrigation District
WPCF	Water Pollution Control Facility

6. PROJECTS AND MANAGEMENT ACTIONS

This chapter includes relevant projects and management actions information to satisfy California Code of Regulations (CCR) Title 23 §354.42 and 354.44. The projects and management actions described in this chapter will help achieve the Eastern San Joaquin Subbasin's sustainability goal.

6.1 PROJECTS, MANAGEMENT ACTIONS, AND ADAPTIVE MANAGEMENT STRATEGIES

Achieving sustainability in the Eastern San Joaquin Subbasin (Subbasin) requires implementation of projects and management actions. The Eastern San Joaquin Subbasin will achieve sustainability by implementing water supply projects that either replace (offset) or supplement (recharge) groundwater to achieve the estimated pumping offset and/or recharge need of 95,000 acre-feet per year (AF/year), identified as part of the sustainable yield estimate presented in Section 2.4.6. In addition, three projects have been identified that support demand conservation activities, including water use efficiency upgrades. Currently, no pumping restrictions have been proposed for the Subbasin; however, Groundwater Sustainability Agencies (GSAs) are currently working on developing a demand reduction program and maintain the flexibility to implement such demand-side management actions in the future if need is determined.

6.2 PROJECTS

6.2.1 Project Identification

Projects were identified by the Eastern San Joaquin GSAs through a several-month process involving the Eastern San Joaquin Groundwater Authority Board of Directors (ESJGWA Board), Advisory Committee, Workgroup, and the general public. This process included a public polling and feedback solicitation process at the Projects and Management Actions Workshop, held at the October 2018 ESJGWA Board meeting. This activity allowed ESJGWA Board members, GSA staff, and members of the public to participate in a real-time online polling activity through their smart-phone devices. Hard-copy paper surveys were provided for those without online access. Additionally, a template for project feedback and suggestion was created, posted online for the public, and hard copies distributed at Informational Open House events.

Project information was provided by GSAs and compiled into a draft list. This list was discussed and presented during the October and November 2018 ESJGWA Board meetings, the October and November 2018 and January 2019 Advisory Committee meetings, and the November 2018 and January 2019 Workgroup meetings. Priorities identified included:

- Project is implementable with respect to technical complexity, regulatory complexity, institutional consideration, and public acceptance
- Project benefit is located in area of greatest overdraft
- Project is affordable and cost-effective (lowest unit cost per volume water savings)
- Project provides an environmental benefit (or reduces environmental impact)
- Project addresses Disadvantaged Communities (DACs) and/or Severely Disadvantaged Communities (SDACs)
- Project is located in an area where water quality is suitable for use

Projects with the potential to contribute to the migration of a potential contaminant plume were eliminated from consideration and removed from the GSP list of projects.

The resultant list of projects and management actions was then updated in coordination with the 5-year Periodic Evaluation and this GSP amendment. Updated project information was solicited from the GSAs, and the list of projects and management actions revised to reflect plans as of 2024.

6.2.2 Project Implementation

Projects will be administered by the GSA project proponents. GSAs may elect to implement projects individually or jointly with one or more GSAs or with the ESJGWA. As the ESJGWA develops GSA-level water budgets, the GSAs will have a better understanding of how projects will be implemented at the GSA-level and can better evaluate progress toward completion.

6.2.3 List of Projects

Several projects to increase water supply availability in the Subbasin were identified. The initial set of projects was reviewed with the ESJGWA Board, Advisory Committee, and Workgroup. A final list of 45 possible projects is included in the GSP, representing a variety of project types including direct and in-lieu recharge, intra-basin water transfers, demand conservation, water recycling, and stormwater reuse. Projects are classified into two categories based on project status as defined below.

- Category A projects - projects that were completed or are anticipated to advance in the next five years and have existing water rights or agreements.
- Category B projects - projects that are not anticipated to advance in the next five years, but may be implemented in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets or do not produce a response as simulated in the model.

This subsection of the GSP satisfies the requirements of CCR Title 23 §354.44. Consistent with SGMA requirements, the project descriptions for projects contain information regarding:

- The benefitted measurable objective
- Permitting and regulatory processes
- Time-table for initiation and completion
- Expected benefits
- How the project will be accomplished
- Legal authority
- Estimated costs and plans to meet costs
- Implementation circumstances
- Public noticing

Table 6-1 provides a summary of 41 of the 45 projects; full descriptions are included below. Figure 6-1 and Figure 6-2 shows the locations of these projects.

During the September 11, 2024 ESJGWA Board Meeting, the Board approved by resolution the addition of 5 projects to the GSP. These projects include:

- Mariposa Drain Water Delivery Improvement Project – Central San Joaquin Water Conservation District GSA
- South System Pipeline Phase 4 Improvement Project – North San Joaquin Water Conservation District GSA
- Q/Qc Conjunctive Use Project – South San Joaquin GSA
- SSJID Advanced Metering Infrastructure Project – South San Joaquin GSA
- Clements Road Pipeline Project – Stockton East Water District

The South System Pipeline Phase 4 Improvement Project is already included in the 41 projects listed in Table 6-1 and is discussed in Section 6.2.4.5. The other four are new additions that are not included in Table 6-1, nor in the write-ups included in this chapter. More information on these projects is included in Appendix 6-A. With the addition of these four projects, the GSP now includes 45 total projects.

Table 6-1: List of SGMA Projects

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Category A Projects - projects that were completed or are anticipated to advance in the next five years and have existing water rights or agreements									
Lake Grupe In-lieu Recharge	In-lieu Recharge	SEWD	Groundwater levels	Completed	2020-2023	$2.3 M	$330,000	Installation for new intake and pipeline requires permits from DFW, CVFPB, RWQCB, and USACE	4,900
SEWD Surface Water Implementation Expansion	In-lieu Recharge	SEWD	Groundwater levels	Implementation	2019-2029	$750,000	$100,000	Permit approvals from DFW, RWQCB, CVFPB, and USACE by private landowners	19,000
White Slough Water Pollution Control Facility Expansion	Recycling/ In-lieu Recharge/Direct Recharge	City of Lodi	Groundwater levels	Construction complete	2019-2020	$6 M	$4,664	None (permitting complete)	1,000
CSJWCD Capital Improvement Program	In-lieu Recharge	CSJWCD	Groundwater levels	Can be implemented immediately	2020-2027, on-going with 7-year completion cycles	N/A	$50,000	Individual applications need CSJWCD Board approval and possible streambed alteration permits	24,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
NSJWCD South System Modernization	In-lieu Recharge	NSJWCD	Groundwater levels	Environmental review complete, funding secured for Phases 1, 2 and 3. Landowner improvement district formed. Phases 1-2 complete.	2018-2025 for Phases 1, 2, 3; 2025-2028 for Phase 4; 2028-2035 for future phases	Phase 1&2: $7 M Phase 3: $4 M Phase 4: $8 M Future Phases: $10-20 M	Phase 1&2: $200,000 Phase 3: $200,000 Phase 4: $200,000 Future Phases: $200,000	Permits for pump station work have been completed; minor grading and road encroachment permits may be needed	10,000
Long-term Water Transfer to SEWD and CSJWCD	Transfers	SSJ GSA	Groundwater levels	Infrastructure is in place. CEQA completed and agreements in place	2019-2021	N/A	$9 M	Project must comply with CEQA	20,000
South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	In-lieu Recharge	NSJWCD	Groundwater levels	Pilot Dream Project will be completed in April 2024. Working on expanded banking project	2020-2024	$5 M	$400,000	SWCRB change petition for Permit 10478 and San Joaquin County groundwater export permit, and regulatory permits as needed	4,000
NSJWCD North System Modernization/ Lakso Recharge	In-Lieu Recharge	NSJWCD	Groundwater levels	Constructed Phase 1A, in progress on Phase 1B. Planning Phase 2	2021-2026	$7 M	$150,000	Regulatory permits as needed	4,000
Tecklenburg Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Substantially complete	2022-2024	$1 M	$400,000	CEQA review and possible grading permit	2,000
City of Stockton Phase 1: Groundwater Recharge Project	Direct Recharge	City of Stockton	Groundwater levels	Basin design in progress. Construction to begin spring 2025.	2022-2026	$11.5 M	To be Determined	Project must comply with CEQA	20,000

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
West Groundwater Recharge Basin	Direct Recharge	SEWD	Groundwater levels	Ongoing	2032	To be Determined	To be Determined	To be Determined	16,000
NSJWCD Private Pump Partnerships	In-Lieu Recharge/Direct Recharge	NSJWCD	Groundwater levels	Ongoing	2024	To be Determined	To be Determined	To be Determined	3,000
Oakdale Irrigation District In-lieu and Direct Recharge Project	Direct Recharge/In-Lieu Recharge	OID	Groundwater levels	Ongoing	2023-2032	To be Determined	To be Determined	To be Determined	25,000
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Groundwater levels	In progress. Contract awarded in March 2024.	2023-2028	$17 M	To be determined	Not determined	2,000
								Total Category A	*154,900*
Category B Projects - projects that are not anticipated to advance in the next five years, but may be implemented in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets or do not produce a response as simulated in the model									
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Groundwater levels	Experiencing Delays	Not determined	$650,000	$300,000	None	272
City of Lodi Surface Water Facility Expansion & Delivery Pipeline	In-lieu Recharge	City of Lodi	Groundwater levels	Planning phase	2030-2033	$4 M	$2,340,000	SWRCB permitting and CEQA required	4,750

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Groundwater levels	Planning phase	2020-2025	N/A	$50,000	Streambed alteration permit	1,000
Manaserro Recharge Project	Direct Recharge	NSJWCD	Groundwater levels	Planning phase	2023-2025	$500,000	$50,000	CEQA review, possible grading permit, possible water right change petition	8,000
City of Escalon Wastewater Reuse	Recycling/ In-lieu Recharge/ Transfers	SSJ GSA	Groundwater levels	Planning phase	2020-2028	To be determined	To be determined	CEQA review, RWQCB permits, and road encroachment permits	672
City of Ripon Surface Water Supply	In-lieu Recharge	SSJ GSA	Groundwater levels	Design complete; environmental permitting underway; negotiations for the right to connect are underway.	2028-2030	To be determined	To be determined	NEPA Categorical Exclusion, CEQA Mitigated Negative Declaration, and road encroachment permits	6,000
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-lieu Recharge	SSJ GSA	Groundwater levels	Conceptual design; environmental review complete; Council approval are pending further design work and rate study	2028-2030	To be determined	To be determined	Road encroachment permits	2,015

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Farmington Dam Repurpose Project	Direct Recharge	SEWD	Groundwater levels	Planning/Initial Study	2030-2050	To be determined	To be determined	Permits and approvals form SWRCB, USBR, DFW, RWQCB, CVFPB, and USACE	60,000
Mobilizing Recharge Opportunities	Direct Recharge	San Joaquin County	Groundwater levels	Project Development	2024-2040	Not determined	Not determined	Not determined	158,000
NSJWCD Winery Recycled Water	Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	Groundwater levels	Conceptual planning and discussion	2025-2027	To be determined	To be determined	WDR permitting through the RWCQB and minor permits for pipeline construction	750
SSJID Storm Water Reuse	Storm Water/ In-lieu Recharge/ Direct Recharge	SSJ GSA	Groundwater levels	Planning phase	2027-2030	To be determined	To be determined	CEQA review and road encroachment permits	1,100
Wallace-Burson Conjunctive Use Program	Conjunctive Use/Direct Recharge	Eastside GSA	Groundwater levels	Conceptual planning and discussion	2030-2040	To be determined	To be determined	Not determined	3,000
Calaveras River Wholesale Water Service Expansion	In-Lieu Recharge	Eastside GSA	Groundwater levels	Conceptual planning	2020-2040	To be determined	To be determined	Not determined	600

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Recycled Water to Manteca Golf Course	Recycling	City of Manteca	Groundwater levels	12-in pipeline installed. Waiting for DWR to determine grant recipients	To Be Determined	To be determined	To be determined	Not determined	406
Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	In-Lieu Recharge/Direct Recharge	Eastside GSA	Groundwater levels	Design	2025	To be determined	To be determined	Not determined	2,000
Perfecting Mokelumne River Water Right	In-Lieu Recharge	San Joaquin County	Groundwater levels	Planning	2024-2025	$125,000 (spent to date) Total TBD	To be determined	Not determined	158,000
North System Groundwater Recharge Project - Phase 2	Direct Recharge	NSJWCD	Groundwater levels	Design phase with planned construction in 2025-2026	2026-2029	$10 M	$100,000	Not determined	3,000
Stormwater Collection, Treatment, and Infiltration	Direct Recharge/ Stormwater	City of Manteca	Groundwater levels	Planning/Initial Study	To Be Determined	To be determined	To be determined	Not determined	To Be Determined
Off-Stream Regulating Reservoir	Direct Recharge	SEWD	Groundwater levels	Conceptual Phase	2026-2050	To be determined	To be determined	Not determined	To Be Determined
On-Farm Recharge Project	Direct Recharge	SEWD	Groundwater levels	Planning/Initial Study	2024-2030	N/A	$100,000	Not determined	To Be Determined

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Bellota Weir Modifications Project	Direct Recharge/ Stormwater	SEWD	Groundwater levels	SRF Loan Application Submitted. $12.3M Grant awarded. Minor construction started	2023-2030	$ 85 M	$1.5M	USACE, USFWS,CVFPB, NEPA,CEQA,RWQCB	5,200
Water Supply Enhancement Project - Distribution Pipelines	In-Lieu Recharge/Direct Recharge	SEWD	Groundwater levels	Design	2024-2040	$7M	To be determined	RWQCB,CEQA, USACE,CVFPB, CDFW	17,000
Water Treatment Plant Aquifer Storage Recovery Well - 7401	Direct Recharge	SEWD	Groundwater levels	Implementation	2024-2026	$1.5 M	To be determined	RWQCB,CEQA, NEPA	2,420
Beckman Well	Direct Recharge	SEWD	Groundwater levels	Refurbish	2024-2028	$200,000	N/A	RWQCB,CEQA	800
West Linden Project	In-Lieu Recharge/Direct Recharge	SEWD	Groundwater levels	Planning/Design	2024-2035	$60M	To be determined	CEQAmRWCQB	60,000
Water Supply Enhancement Project - Direct Recharge	Direct Recharge	SEWD	Groundwater levels	Design	2024-2030	To be determined	To be determined	Not determined	To Be Determined

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
SSJID Water Master Plan - System Improvements	In-Lieu Recharge	SSJ GSA	Groundwater levels	Feasibility study complete	2023-2040	$ 30 – 40 M	To be determined	Not determined	15,000
								Total Category B	*509,985*

[1] Acronyms defined: Stockton East Water District (SEWD), Central San Joaquin Water Conservation District (CSJWCD), North San Joaquin Water Conservation District (NSJWCD), California Department of Fish and Wildlife (DFW), Central Valley Flood Protection Board (CVFPB), Regional Water Quality Control Board (RWQCB), and U.S. Army Corps of Engineers (USACE), State Water Resources Control Board (SWRCB), California Environmental Quality Act (CEQA), U.S. Bureau of Reclamation (USBR), National Pollutant Discharge Elimination System (NPDES), Waste Discharge Requirements (WDR).

Figure 6-1: Location of Category A Projects

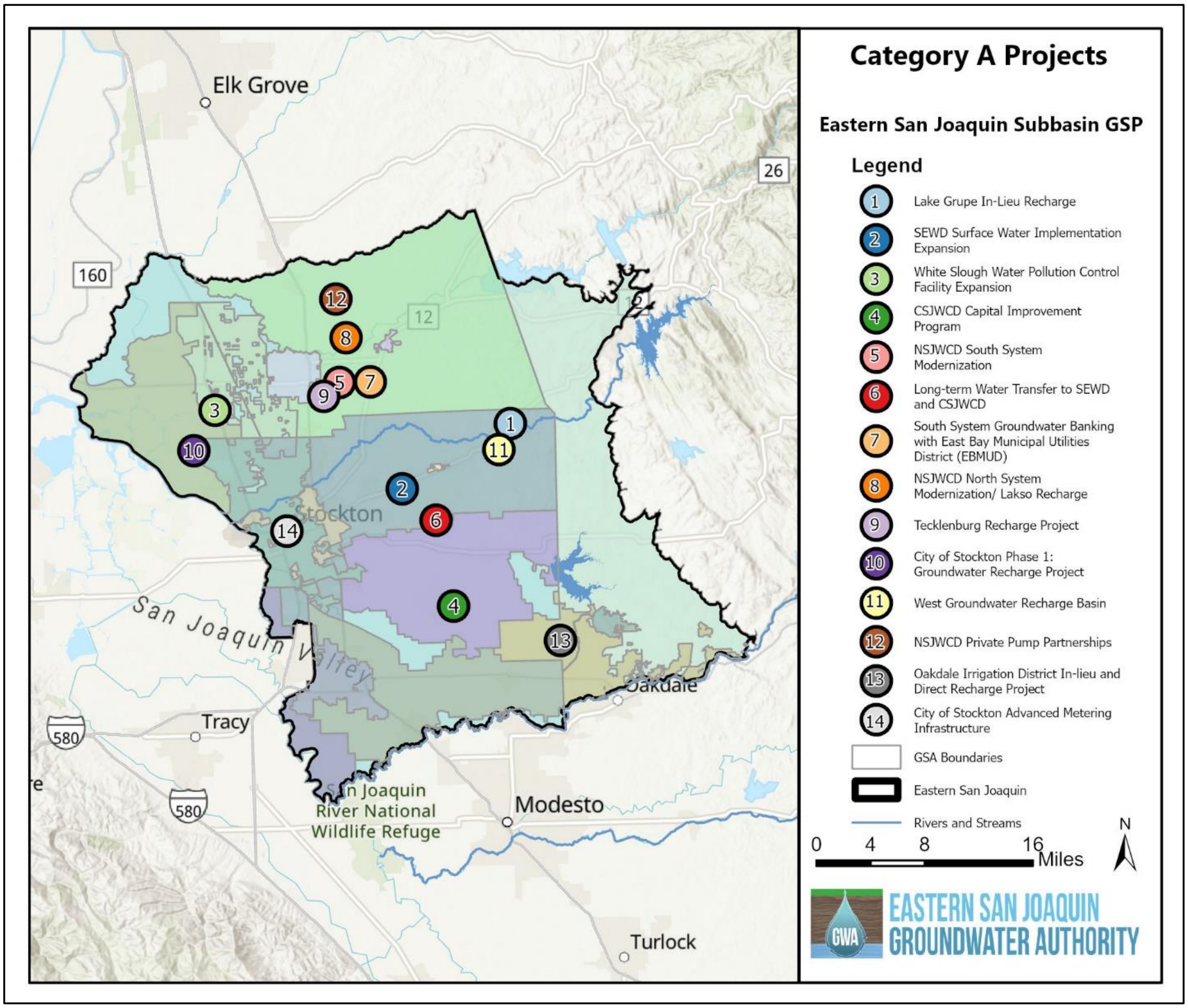
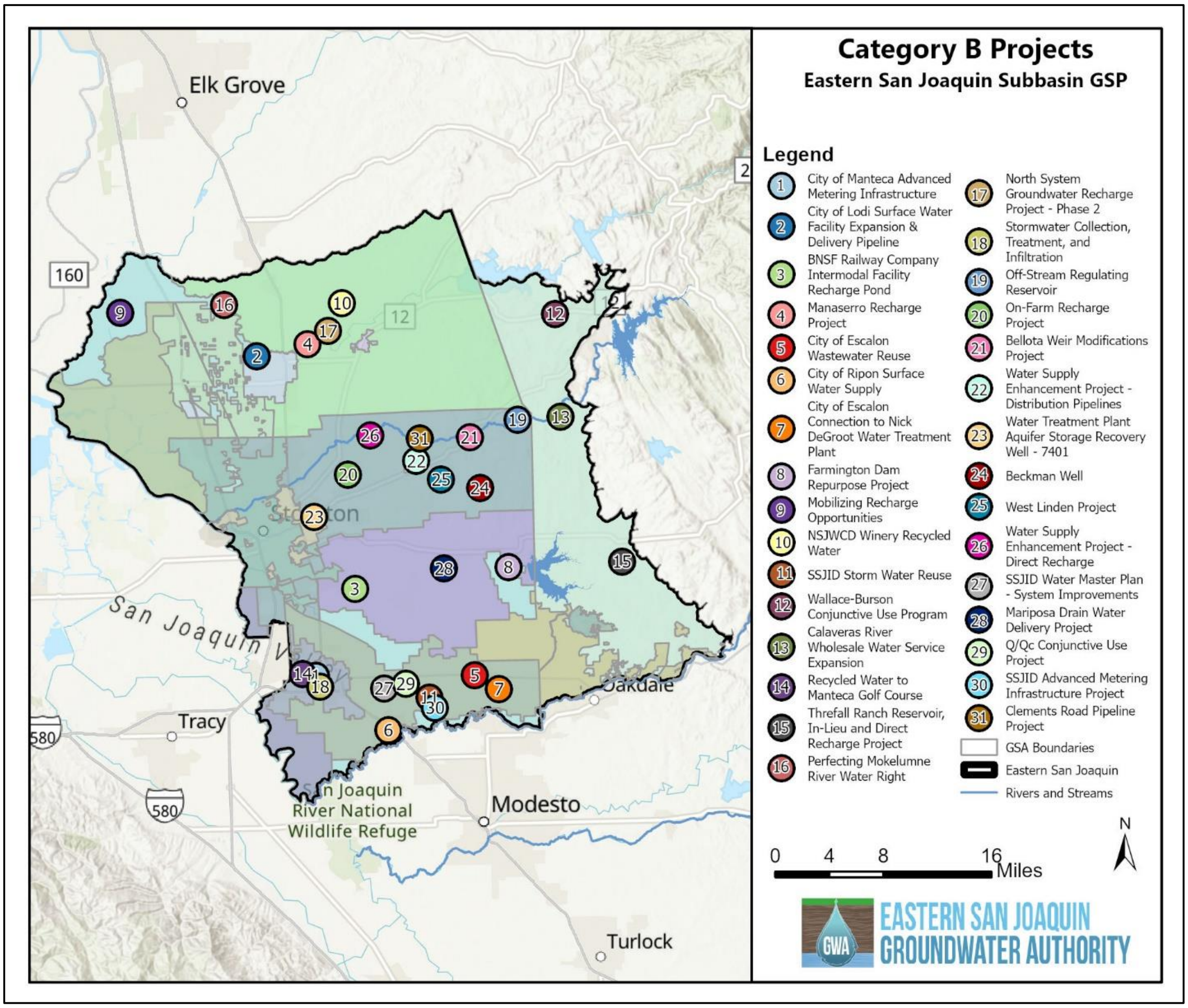


Figure 6-2: Location of Category B Projects



6.2.4 Category A Projects

As previously mentioned, Category A Projects are projects that were completed by 2024 or are anticipated to advance in the next five years and have existing water rights or agreements. The projected supply of projects in this category will be considered as offsetting the projected 2040 supply imbalance. Up to 154,900 AF/year of water is expected to be recharged in Wet years as a result of implementation of the Category A projects.

6.2.4.1 Lake Grupe In-Lieu Recharge

The Lake Grupe In-Lieu Recharge Project, proposed by SEWD, is to construct a surface water diversion turn-out on the Calaveras River, upstream of Bellota, and to supply surface water to multiple farms/growers currently using groundwater. The proposed project is to allow 2,500 acres of orchard crops to irrigate with surface water from Lake Grupe instead of using groundwater. Lake Grupe is at the end of rolling hills fed by two or more natural episodic streams. The proposed project would pump water from the Calaveras River, transport the water in a 24-inch PVC pipeline for about 5,000 feet, with an elevation gain of 170 feet through private properties, discharge the water into one of the ravines feeding Lake Grupe, and then the surrounding growers would pump the water from the Lake for irrigation. The diverted water would flow through a ravine, currently on private lands, and recharge the groundwater basin underneath. The benefit of this project is the in-lieu banking of 7,000 AF of groundwater from irrigation conversion plus additional 13,000 AF of percolation in the ravine.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	2,000 - 4,900 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project has been completed.

Required Permitting and Regulatory Process: This project requires the installation of a new intake in the Calaveras River and construction of a pipeline through private properties. The installation of a new intake in the Calaveras River would require permits from California Department of Fish and Wildlife (DFW), Central Valley Flood Protection Board (CVFPB), Regional Water Quality Control Board (RWQCB), and U.S. Army Corps of Engineers (USACE).

Time-table for Initiation and Completion: Construction on the project was completed in 2023.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 4,900 AF/year in groundwater pumping in SEWD. Benefits to groundwater levels will be evaluated through Eastern San Joaquin Water Resources Model (ESJWRM) model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The surface water source of this proposed project is from SEWD's existing contract with the U.S. Bureau of Reclamation (USBR) for the New Hogan Reservoir. Surface water is diverted from the Calaveras River. This is an existing surface water right.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $2.3 million in capital costs and $330,000 in annual operations and maintenance costs. Costs for this project will be met through SEWD District staffing and District rates to establish new accounts.

Circumstances for Implementation: Construction for this project has been completed.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this project has been constructed.

6.2.4.2 SEWD Surface Water Implementation Expansion

As part of the SEWD Surface Water Implementation Expansion Project, SEWD would require landowners adjacent to surface water conveyance systems (rivers or pipelines) to utilize surface water as part of the SGMA implementation. This would increase surface water usage by about 18,000 to 20,000 AF/year with in-lieu groundwater recharge benefits. Currently, there are about 6,000 acres irrigated with groundwater that could be converted to surface water. There are also an additional 1,500 acres with inactive surface water accounts. SEWD would be the lead agency in environmental/CEQA review and would assist landowners/growers in establishing a turnout for agricultural irrigation and acquiring necessary permits through federal and state regulatory agencies.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	4,000 – 19,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project is currently being implemented in phases. The District converted 2,505 acres to surface water and is in the planning phase to convert an additional 1,135 acres.

Required Permitting and Regulatory Process: The required permitting for this project would include acquiring permits/approvals from California DFW, RWQCB, CVFPB, and USACE by private landowners/diverters. SEWD would be the lead agency for CEQA review and would assist landowners/diverters in obtaining the permits.

Time-table for Initiation and Completion: This project is expected to begin in 2019 and be on-going, with benefits accrued by 2029.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 19,000 AF/year in groundwater pumping in SEWD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $750,000 in capital costs and $100,000 in annual operations and maintenance costs. Costs for this project will be met through staffing and rates for new accounts.

Circumstances for Implementation: This project is currently being implemented in phases. As scenarios change, the project can come online to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring currently moving forward.

6.2.4.3 White Slough Water Pollution Control Facility Expansion

This project would include the construction of a 70-acre pond expansion with a storage capacity of 388 AF. The purpose of this project is to provide tertiary-treated Title-22 effluent for use as irrigation water on approximately 890 acres of agricultural land surrounding the White Slough Water Pollution Control Facility (WPCF) to offset groundwater pumping. This project is estimated to reduce the annual volume discharged to Dredger Cut (a dead-end slough of the Sacramento-San Joaquin River Delta) by approximately 160 to 210 million gallons. Flow will be diverted from Dredger Cut at a rate up to 1,700 gallons per minute over an approximate 75- to 90-day period between October 1 and May 31 of each year. Project studies have demonstrated that the storage provided by this project will significantly offset groundwater pumping through in-lieu use.

Project Summary	
Submitting GSA:	City of Lodi
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	3,700 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by providing direct groundwater recharge opportunities.

Project Status: Construction of this project has been completed. In WY 2023, 518 AF of direct recharge was provided by this project. Roughly 3,700 AF/year of percolation recharge is expected. Additionally, the tertiary treated wastewater will be used to irrigate the on-site agricultural fields, thereby reducing groundwater pumping for irrigation.

Required Permitting and Regulatory Process: The permitting and regulatory processes required for this project have been completed.

Time-table for Initiation and Completion: Construction of this project has been completed.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset approximately up to 3,700 AF/year in groundwater pumping in the City of Lodi. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project will rely on the use of recycled water, in the form of tertiary-treated Title 22 effluent form the White Slough WPCF Expansion. No additional water source will be utilized for this project.

Legal Authority: The City of Lodi has legal authority to administer this project through Water Code §71000-73000.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $6 million in capital costs and $4,664 in annual operations and maintenance costs. This project will be financed through the DWR Proposition 84 Grant Funding Program.

Circumstances for Implementation: The construction of this project has been completed. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: There is no plan to terminate this project, as it has been completed and the operations and maintenance cost is minimal.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable, this is a Category A project that is currently moving forward.

6.2.4.4 CSJWCD Capital Improvement Program

CSJWCD assists users to convert groundwater fields to surface water use. The user applies for water credits based upon new surface water acres. The user is responsible for constructing a diversion facility. As water is diverted the District reduces the water charge until credit is used or seven years since implementation have elapsed. The Capital Improvement Program has been on-going since 1996.

Project Summary	
Submitting GSA:	Central San Joaquin Water Conservation District

Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 24,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project has been implemented and is on-going each year with available water delivery.

Required Permitting and Regulatory Process: CSJWCD is not required to comply with permits or regulatory processes to implement and oversee the Capital Improvement Program. However, individual applicants are required to have approval of the CSJWCD Board of Directors and may be required to obtain streambed alteration permits.

Time-table for Initiation and Completion: The Capital Improvement Program has been on-going since 1996. New individual projects are anticipated to begin each year. Individual applicants are expected to complete their projects 7 years after initiation.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 24,000 AF/year in groundwater pumping in CSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 24,000 AF/year in groundwater pumping in CSJWCD. Benefit to the groundwater aquifer has already accrued and will continue to accrue as new projects are implemented. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on this use of surface water from the New Melones Unit Central Valley Project. The surface water source is based upon a contract with the United States for delivery of surface water from the New Melones Unit of the Central Valley Project. The contract is long-term; however, water availability is subject to drought conditions. This is an existing water right.

Legal Authority: The Water Code, Division 21 §74000 et seq. authorizes CSJWCD to acquire, sell, and distribute water and fix rates for service throughout the District.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $50,000 in annual operations and maintenance costs. This project provides for the payment of delivered surface water at a reduced rate. Any deficit in cost of water is recovered by full cost of surface water to other users, groundwater extraction fees, and acre assessments.

Circumstances for Implementation: This project has been implemented and continues move forward. As scenarios change, the project can be adapted to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this is a Category A project that is currently in operation.

6.2.4.5 NSJWCD South System Modernization

This project will modernize the South System Pump and Distribution System to facilitate delivery of 9,000 AF/year of additional surface water to farmers in-lieu of groundwater pumping. Water would come from NSJWCD Permit 10477 supplies, which are available in about 55 percent of years.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 10,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This Project is progressing. Phase 1 was completed in 2019-2021 and included a new pump station, variable frequency drive (VFD), meters, automation equipment, SCADA, and a new main junction box at Tretheway and Brandt Roads. Phase 2 was completed in early 2024 and included new sections of the main pipeline and the addition of meters and SCADA. ID3A, formed in 2021 for construction of the Pixley lateral, was completed in 2022. NSJWCD is working on the formation of ID3B for the Handel lateral for which NSJWCD received $1M federal grant. Additionally, NSJWCD was just awarded a $3M IRWM grant for Phase 3 South System improvements to focus on more mainline replacements and increased groundwater recharge capacity. Phase 3 was awarded in 2024 and will be constructed in 2024-25. NSJWCD applied for a $3M WaterSmart Grant for Phase 4. Future phases will include additional laterals and recharge capacity along the south system to expand capacity to take additional wet year water for recharge, including MICUP water.

Required Permitting and Regulatory Process: All permits for the pump station work have been obtained. Minor grading and road encroachment permits may be needed for on-going work to the distribution system.

Time-table for Initiation and Completion: This project began in 2018. Phases 1,2,3, and the Pixley and Handel Laterals are expected to be completed by 2025. Phase 4 is expected to begin by 2025 and be completed by 2028, with future phases anticipated from 2028-2035.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. Phases 1-4 of this project are anticipated to offset up to 10,000 AF/year in groundwater pumping in NSJWCD, with future phases offsetting an additional 15,000 AF/year. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on surface water from NSJWCD Permit 10477 (Mokelumne River water). This is an existing surface water right.

Legal Authority: The legal authority for this project is covered under Water Code §74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $7 million in capital costs and $200,000 in annual operations and maintenance costs for Phases 1 & 2; $4 million in capital costs and $200,000 in annual operations and maintenance costs for Phase 3; $13 million in capital costs and $200,000 in annual operations and maintenance costs for Phase 4, and $10-20 million in capital costs and $200,000 in annual operations and maintenance costs for future phases. Costs for this project will be met through grant funding, landowner assessments, district property taxes, and water charges.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the full project can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable, this is a Category A project that is currently moving forward.

6.2.4.6 Long-Term Water Transfer to SEWD and CSJWCD

Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID) have historically participated in long-term water transfers of surplus, pre-1914, surface water rights to other entities within the Eastern San Joaquin Subbasin. These transfers have included one-year transfers to CSJWCD, as well as a nearly 10-year transfer to SEWD for both agricultural and urban purposes. The most recent transfer with SEWD occurred in 2019. These areas of the Subbasin have surface water available from the USBR's Central Valley Project; however, project water allocations become significantly reduced in below normal and dry water years. When surface water is not available, many of the agricultural customers in these areas have typically turned to groundwater in order to meet their annual and permanent crop water demands. Providing long-term water transfers from OID/SSJID to other agencies within the Subbasin would allow for increased average annual surface water deliveries to the Subbasin area, reducing groundwater reliance and overdraft within the Subbasin, especially during drought years. SEWD and CSJWCD overlie a significant portion of the Subbasin dependent on groundwater and subject to historical overdraft conditions.

No new facilities would need to be constructed to convey water from OID/SSJID to SEWD, and CSJWCD receives water through diversions from a tunnel just upstream of the OID/SSJID owned Goodwin Dam on the Stanislaus River. Historical transfers have been accomplished through the use of these existing facilities. Additional infrastructure may be necessary to increase distribution of surface water supplies to irrigated agriculture and to achieve adequate improvement toward sustainability goals.

Project funding could be provided directly from the districts participating in the water transfers. Additional infrastructure to promote additional surface water use and capital payments for surface water transfers could be provided indirectly by groundwater reliant entities, thereby providing a means of continuing to utilize groundwater while investing in a Subbasin-wide project that assures continued sustainability within the Subbasin.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	Intrabasin Transfer/In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	Up to 20,000 AF/year
Other Participating Entities:	Oakdale Irrigation District, Stockton East Water District, Central San Joaquin Water Conservation District

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: No design is needed for this project, as the infrastructure is in place. Environmental review may need to be completed.

Required Permitting and Regulatory Process: This project must comply with CEQA. Temporary transfers may have less rigorous permitting requirements.

Time-table for Initiation and Completion: A 10-year water transfer project was approved by SEWD, OID, and SSJID in April 2023. Transfers from OID/SSJID to SEWD/CSJWCD have historically been agreed to, with historical transfer amounts varying from 0 to 40,000 AF/year.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 20,000 AF/year in groundwater pumping in SEWD and CSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations. Participating districts would report annually the amount agreed to be transferred and the amount diverted under transfer.

How Project Will Be Accomplished/Evaluation of Water Source: OID and SSJID hold pre-1914 water rights on the Stanislaus River. USBR is junior in right to OID and SSJID. This is an existing surface water right.

Legal Authority: OID and SSJID are irrigation districts formed in accordance with State law and hold pre-1914 water rights on the Stanislaus River. SEWD and CSJWCD are water conservation districts also formed in accordance with State law. Historically, water transfers occurring between OID/SSJID and SEWD/CSJWCD are approved by mutual agreement.

Estimated Costs and Plans to Meet Costs: Costs for this project are estimated at up to $9 million annually ($200 per acre-foot for agricultural use, and $300 per acre-foot for urban). Costs for this project will be met by recipients of water or groundwater pumping benefit.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin. Short-term transfers are expected to occur on an as-needed basis.

Trigger for Implementation and Termination: Transfers may take place upon mutual agreement. Termination would be subject to the terms of the agreement if applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this is a Category A project that is currently underway.

6.2.4.7 South System Groundwater Banking with EBMUD

NSJWCD, East Bay Municipal Utility District (EBMUD), and other entities in San Joaquin County entered into a Protest Dismissal Agreement (the "PDA") in 2014 to resolve various water right protests. The PDA Agreement includes a commitment to undertake a pilot-level groundwater banking project and a longer-term groundwater banking project. The pilot level banking project is called the "DREAM" project and is now complete. The DREAM project involved the delivery of 1,000 AF of EBMUD water into the NSJWCD service area along the South System to use for irrigation, effectuating 1,000 AF of in-lieu groundwater recharge. EBMUD received a banked water credit of 50 percent of the amount of water recharge, not to exceed 500 AF. EBMUD withdrew the banked water between January and April of 2024. NSJWCD controlled the withdrawal of the banked water by pumping groundwater from a well that is centrally located in the area of recharge and then conveyed the pumped groundwater to the EBMUD Mokelumne Aqueduct. The extraction and return of the banked water were subject to a San Joaquin County groundwater export permit. The permit placed additional conditions and restrictions on the extraction of the banked water, including a 5 percent per year annual loss factor and pumping restrictions to prevent impacts to other groundwater users.

EBMUD and NSJWCD have started the preliminary planning for the longer-term banking project. The longer-term banking project may use the same concept as the pilot project but will involve larger quantities of water and potential additional facilities to deliver and use the water for in-lieu recharge and potentially direct recharge within the NSJWCD service area, and to extract and return banked water credits to EBMUD. The longer-term project contemplates EBMUD providing surface water supplies of 3,000 AF/year to 6,000 AF/year in dry years and 8,000 AF/year in wet years to NSJWCD. These surface water supplies would come from EBMUD's water rights on the Mokelumne River and would be in addition to surface water available under NSJWCD's water right. EBMUD would receive a banked water credit for 50 percent of the additional supplies provided, leaving a net surface/groundwater increase to the NSJWCD area of 50 percent of all additional supplies provided.

The PDA also provides that the wet year water supplies could be used by SEWD for groundwater banking if they cannot be used in NSJWCD.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 4,000 AF/year
Other Participating Entities:	East Bay Municipal Utility District, Eastern Water Alliance, San Joaquin County and Stockton East Water District

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: The demonstration portion of the project is complete. Parties need to finalize design, perform environmental review, and obtain necessary permits to operate the permanent project.

Required Permitting and Regulatory Process: The permanent project requires a SWRCB Change Petition for Permit 10478, a San Joaquin County Groundwater Export Permit, and regulatory permits as needed for facilities such as pipelines.

Time-table for Initiation and Completion: The pilot Dream Project was completed in April 2024. A larger project is currently in the planning stages, with implementation expected by 2030.

Expected Benefits and Evaluation: Subbasin groundwater recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 4,000 AF/year in groundwater pumping in NSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would use water supplies from EBMUD Permit 10478 (Mokelumne River water). This is an existing surface water right. EBMUD has a right tied to hydrology, with amounts set by contract.

Legal Authority: The legal authority for this project is covered under Water Code §74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $5 million in capital costs and $400,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding, banking fees, and water charges.

Circumstances for Implementation: This project is anticipated to move forward. As scenarios change, the project can come online to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA and their partners or Subbasin. Short-term transfers are expected to occur on an as-needed basis.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: The pilot portion of this project has been completed. Implementation of this project will be based on long-term management or changing needs of the GSA and their partners and/or Subbasin.

6.2.4.8 NSJWCD North System Modernization/Lakso Recharge Project

This project will repair, upgrade, and modernize the North System Pump and Distribution System to facilitate delivery of 4,000 to 6,000 AF/year of surface water to farmers in-lieu of groundwater pumping and direct recharge. Water would come from NSJWCD Permit 10477 supplies, which are available in about 55 percent of years. Average deliveries would vary around 1,000 AF/year to 4,000 AF/year in about half of the years. In addition, there is a small, sandy recharge pond location on the Lakso property located along the upper portion of the North System pipeline along Tretheway Road. The pond is about 2 acres in size and can recharge about 2 AF/day. The Lakso Project is under negotiations for expansion as the landowner recently removed 160 acres of vineyards with no immediate plans to replant. Capacity could expand to over 6 AF/day year-round if negotiations are successful. NSJWCD could convey water through the NSJWCD North System, to the Lakso recharge pond, to directly recharge surface water during times that water is available but there is not irrigation demand, such as during the December through May time period or during the interim period of years before the remainder of the North System pipeline is repaired or replaced.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-lieu Recharge/Direct Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 4,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and direct recharge opportunities.

Project Status: This first phase (Phase 1A) of this project has been completed and is operational. Phase 1B is under construction, and Phase 2 is in the planning stages.

Required Permitting and Regulatory Process: This project would require regulatory permitting as needed for minor construction related to rehabilitation of existing water delivery infrastructure.

Time-table for Initiation and Completion: This project began in 2021 and is anticipated to be completed by 2026.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 4,000 AF/year in groundwater pumping in NSJWCD. In addition, there are opportunities to directly recharge surface water to the groundwater basin at specified times. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would use water supplies available through NSJWCD Permit 10477 (Mokelumne River water). This is an existing surface water right.

Legal Authority: The legal authority for this project is covered under Water Code §74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $7 million in capital costs and $150,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding, landowner assessments, district property taxes, and water charges.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can bring additional resources for adaptive management. Short-term transfers are expected to occur on an as-needed basis.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation this project is phased and is currently underway.

6.2.4.9 Tecklenburg Recharge Project

This project involved the construction and operation of a 10-acre recharge pond on the south side of the Mokelumne River on property purchased by NSJWCD from the Tecklenburg family. NSJWCD is using Permit 10477 water available during December 1 through June 30, and not needed for irrigation, for recharge. This project could recharge up to 2,000 AF/year in years when water is available. Because this project can use water available during the direct diversion flood season, water is expected to be available more frequently under the NSJWCD water right for this project, or 80 percent of years. Capital costs include the purchase of the 10-acre property for this project.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 2,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is substantially complete. NSJWCD acquired a 10-acre parcel in 2023 and has constructed and operated the recharge basin since July 2023. NSJWCD is currently working on a new lateral from the South System mainline which would increase the project's capacity.

Required Permitting and Regulatory Process: This project would require CEQA review and a possible grading permit.

Time-table for Initiation and Completion: This project was substantially completed in 2024.

Expected Benefits and Evaluation: This project is anticipated to directly recharge up to 2,000 AF/year to the groundwater basin in NSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would use water supplies available through NSJWCD Permit 10477 (Mokelumne River water). Once Permit 10477 supplies are fully committed to in-lieu recharge projects, NSJWCD could apply to appropriate Mokelumne River flood flows for this direct recharge project. This is an existing surface water right.

Legal Authority: The legal authority for this project is covered under Water Code §74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $1 million in capital costs and $400,000 in annual operations and maintenance costs. Costs for the current project will be met by water charges. Funding for additional phases has not been identified at this time.

Circumstances for Implementation: This project is currently substantially complete. As scenarios change, the project can be adapted to bring additional resources online. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin and availability of surface water.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project is ongoing.

6.2.4.10 City of Stockton Phase 1: Groundwater Recharge Project

This project involves the development of a groundwater recharge and recovery operation adjacent to the Delta Water Treatment Plant. The project would enhance the City of Stockton's water supply reliability by allowing for the direct recharge of surface water into the underlying groundwater basin. This project received a 2022 SGMA Implementation Round 1 grant for $250,000 to conduct a geotechnical investigation of the recharge site to determine the suitability of the site for groundwater recharge and recovery. A feasibility study was completed in December 2023 and determined a recharge potential of approximately 22,000 AFY.

A feasibility memorandum completed in 2009 that estimated that Mokelumne River water purchased from WID, along with stormwater from the City of Lodi available via the Wilkerson Lateral could be utilized for recharge purposes. An estimated amount of up to 6,500 AFY between March 1 and October 15 would be available from WID, with water assumed to be available only during water year types that are "Wet" or "Above Normal." Additionally, Lodi stormwater is a potential source for groundwater recharge and an estimated 1,545 AFY is available mostly during winter months when precipitation occurs. The estimated recharge rate at the site was 0.8 AF/day.

In order to expand the use of Permit 21176 water, City of Stockton's water supply from the San Joaquin River could also be utilized. With an assumed infiltration pond size of 70 acres and a wetted period of 228 days, an estimated 12,768 AFY could potentially be stored to the groundwater basin. Though if water was available during only a 90-day application period, the potential recharge volume would be 5,040 AFY. In the City of Stockton's water rights petition[2], an annual total of 5,102 AFY was estimated to be available for groundwater banking with zero in April through June. As assumed in the feasibility study, if the recharge system can be used four times per year, than the project could provide approximately 20 TAF of recharge annually. Though this project has been called groundwater banking in the past, there are no firm plans to extract water and no more water would be extracted than was recharged. A more detailed technical analysis of the timing and quantity of water supply will be conducted in the future.

Due to the varying sources of water supply that may be available for recharge (WID water, Lodi stormwater, and Stockton water), water is expected to be able to be recharged year-round.

Project Summary	
Submitting GSA:	City of Stockton
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	20,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: A feasibility study for this project was completed in December 2023. The design is in progress and construction of the recharge basins will begin in spring 2025.

Required Permitting and Regulatory Process: This project would require CEQA review.

Time-table for Initiation and Completion: This project is anticipated to be completed by 2026.

Expected Benefits and Evaluation: This project is anticipated to provide water for direct recharge in the critically overdrafted subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: Delta Water Treatment Plant

Legal Authority: The City of Stockton has legal authority to administer this project through Water Code §71000-73000.

Estimated Costs and Plans to Meet Costs: The estimated capital costs for this project are $11,500,000.

Circumstances for Implementation: This project is currently moving forward. As scenarios change and the project progresses, the project can come online to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project is ongoing.

6.2.4.11 West Groundwater Recharge Basin

The West Groundwater Recharge Basin will provide additional opportunities for direct recharge of surface water into the underlying groundwater basin. Between 1,500 and 16,000 acre-feet per year may be available for direct recharge, depending on available water. Due to the varying sources of water for the project (surface water and stormwater runoff), the project is anticipated to be able to recharge project water year-round.

This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir. In addition to Calaveras River and Stanislaus River water, stormwater runoff will also contribute to the volume of water available for recharge. Water would be recharged at a recharge basin located near SEWD's water treatment plant.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,500 - 16,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: Construction on the project started in 2024.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: This project is anticipated to be completed by 2032.

Expected Benefits and Evaluation: This project is anticipated to provide water for direct recharge in the critically overdrafted subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project are unknown at this time. USACE is paying SEWD for soil excavation costs. The remainder of the project will be funded by SEWD or additional grant funds.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can come online to bring additional resources for adaptive management. Implementation of project will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Construction of the project has begun. Implementation of this project will ultimately be based on long-term management or changing needs of the GSA or Subbasin.

6.2.4.12 NSJWCD Private Pump Partnerships

This project involves agreements between NSJWCD and existing riparian pumpers along the Mokelumne River to use their existing pumps to pump NSJWCD's Permit 10477 water for delivery to adjacent non-riparian lands or recharge basins/on-farm recharge. This project leverages existing infrastructure to achieve increased surface water use and reduced groundwater pumping in the district. NSJWCD is implementing this project for one landowner in 2024 to irrigate 200 acres and plans to add an additional 200 acres each year for five years.

Since the project plans to add an additional 200 acres every year, by 2030 there will be an estimated 1,000 acres of land receiving surface water from private pumps. The estimated volume of water for 1,000 acres is 1,500 AFY in normal years and 3,000 AFY in wet years. The project is not expected to run in drought or dry years.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 3,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and direct recharge opportunities.

Project Status: The first phase of this project was completed in early 2024. NSJWCD is planning to add an additional 200 acres each year for 5 years.

Required Permitting and Regulatory Process: A Minor Change Petition was submitted to the State in 2024 and is awaiting approval.

Time-table for Initiation and Completion: The first phase of this project was completed in 2024 and is anticipated to be completed by 2030.

Expected Benefits and Evaluation: This project is anticipated to provide water for in-lieu and direct recharge in the critically overdrafted subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on water from the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).

Legal Authority: The legal authority for this project is covered under Water Code §74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project are unknown at this time. Costs will be met by District general revenue sources, and individual landowner contributions.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can be expanded to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project has begun; subsequent phases will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.4.13 Oakdale Irrigation District In-lieu and Direct Recharge Project

The Oakdale Irrigation District In-lieu and Direct Recharge Project is intended to be a cooperative long-term project between OID and landowners to the east of OID's boundaries within the East Side San Joaquin GSA. The purpose of this project is to allow OID to facilitate surface water deliveries for in-lieu use or direct recharge for East Side San Joaquin GSA landowners during times and conditions that will not impact OID's existing agricultural customers.

The project envisions the development of up to approximately 25,000 AF of surface water from the Stanislaus River being made available to landowners east of OID's service area boundaries in both the Eastern San Joaquin and Modesto Subbasins in all, except Critically Dry, water years. Water deliveries would occur through a limited number of existing and newly constructed private irrigation conveyance infrastructure for use between March 1st and September 30th. Some direct recharge is expected to occur from the project as canal or reservoir seepage in the conveyance network. OID surface water will not be delivered as part of the project between October 1st and March 1st. The OID Board of Directors will continue to consider and define the volume of water (if any) available to this Project on an annual basis in non-Critically Dry water years.

The OID 10-Year out-of-District Water Sales Program (10-Year Program) began in 2023 and includes 4,292 irrigated acres in the Eastern San Joaquin Subbasin within the East Side San Joaquin GSA. Under the 10-Year Program, participating landowners are required to purchase a minimum of 1.5 acre-feet per irrigated acre when surplus surface water is available from OID resulting in a minimum of 6,438 acre-feet being purchased each year. The landowners also have the opportunity to purchase and use additional surplus surface water throughout the irrigation season if available.

Project Summary	
Submitting GSA:	Oakdale Irrigation District
Project Type:	In-lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	0 - 25,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and direct recharge opportunities to out-of-district lands in the Subbasin.

Project Status: The project is ongoing.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The project began in 2023 and is anticipated to be completed by 2032.

Expected Benefits and Evaluation: This project is anticipated to provide water for in-lieu and direct recharge in the critically overdrafted subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: Surface water from Stanislaus River

Legal Authority: The legal authority for this project is covered under Water Code §20500 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project are unknown at this time. Landowners participating in the 10-year program are responsible for the costs of new turnouts, private conveyance systems, and surplus surface water purchased for out-of-district irrigation.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can come online to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA, its growers, or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.4.14 City of Stockton Advanced Metering Infrastructure

The City of Stockton Municipal Utilities Department (MUD) provides treated drinking water through approximately 48,000 water meters, of which a portion are read via a touch-read system and the remainder are read manually by staff every month. Manual meter reading is the least efficient method of meter reading and the costliest. AMI using improved technology is far more efficient and generally very cost effective when compared to manual reading. AMI also provides several other benefits beyond simple cost savings including improved customer service, leak detection, and real-time consumption information to the customer. Documented customer water savings and improved demand-side water conservation has occurred when real-time consumption information is available.

This project would apply AMI to water meters in the City of Stockton Service Area. Improved technology would increase efficiency and decrease costs associated with manual reading. Additional benefits beyond cost savings include improved leak detection and demand-side water conservation.

Project Summary	
Submitting GSA:	City of Stockton
Project Type:	Conservation
Estimated Groundwater Demand Reduction:	2,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing demand-side water conservation opportunities.

Project Status: An initial study for this project was completed in 2011. The contract for this project was awarded in March 2024, and is anticipated to be completed by 2028.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not yet been determined.

Time-table for Initiation and Completion: This project will be completed by 2028.

Expected Benefits and Evaluation: This project is anticipated to reduce groundwater demand by 2,000 AF/year in the City of Stockton through leak detection and real-time consumption information to the customer. Benefits to groundwater levels will be evaluated by quantifying resulting demand reduction.

How Project Will Be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project. No additional water source will be utilized for this project.

Legal Authority: This project would be under the authority of the City of Stockton and implemented within the service area.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $17 million in capital costs and $550,000 in annual operations and maintenance costs. Costs for this project would be met by ratepayers and through grants or other funding sources.

Circumstances for Implementation: This project is currently moving forward. As scenarios change, the project can be expanded to bring additional resources for adaptive management. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5 Category B Projects

Category B projects are defined as projects that are not anticipated to advance in the next five years, but may be implemented in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets or do not produce a response as simulated in the model. Together these projects result in a total maximum benefit of 509,985 AF/year in groundwater offset/recharge/conservation that could potentially be made available to the Subbasin if funding and water rights are secured.

6.2.5.1 City of Manteca Advanced Metering Infrastructure

The City of Manteca provides treated drinking water through approximately 20,696 service connections. In order to improve the efficiency and reliability of water meters, the City has been replacing existing meters and upgrading the Encoder Receiver Transmitters (ERTs) on meters when required. The ERTs and new meters allow for remote reading of flows via a radio signal to a radio receiver inside a city vehicle or at a fixed location. The City also plans to construct the infrastructure for an Advanced Metering Infrastructure (AMI) network to further increase efficiency. AMI also provides several other benefits beyond simple cost savings including improved customer service, leak detection, and real-time consumption information to the customer. Documented customer water savings and improved demand-side water conservation has occurred when real-time consumption information is available.

This project would apply advanced metering infrastructure to water meters in the City of Manteca service area. Improved technology would increase efficiency and decrease costs associated with manual reading. Additional benefits beyond cost savings include improved leak detection and demand-side water conservation.

Project Summary	
Submitting GSA:	City of Manteca
Project Type:	Conservation
Estimated Groundwater Demand Reduction:	272 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing demand-side water conservation opportunities and reducing pumping.

Project Status: This project is currently experiencing delays due to higher priority projects needed.

Required Permitting and Regulatory Process: There are no permitting or regulatory requirements for this project at this time.

Time-table for Initiation and Completion: This project has experienced delays due to higher priority projected needed. The project's implementation will continue once funding is available.

Expected Benefits and Evaluation: This project is anticipated to reduce groundwater demand by 272 AF/year in the City of Manteca through leak detection and real-time consumption information to the customer. Benefits to groundwater levels will be evaluated by quantifying resulting demand reduction.

How Project Will be Accomplished/Evaluation of Water Source: This project is a demand-side conservation project. No additional water source will be utilized for this project.

Legal Authority: This project is under the authority of the City of Manteca and implemented within the City's service area.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $650,000 in capital costs and $300,000 in annual operations and maintenance costs. The AMI Project is a Capital Improvement Project; however, funding is currently not available due to the need for higher priority projects.

Circumstances for Implementation: The City of Manteca has started to implement the AMI infrastructure in phases by purchasing meters that have the capability to be read remotely. Installation of other components, like fiber optic cable and radio tower antennas, is in the planning stage.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Not applicable; this project is currently in the planning stage.

6.2.5.2 City of Lodi Surface Water Facility Expansion & Delivery Pipeline

This project would extend the filter room at the City of Lodi Surface Water Facility and add an additional 10 million gallons per day (MGD) capacity of surface water treatment. In addition to the filter room extension, the City will construct a second sedimentation basin and add pumps throughout the facility to handle the additional volume of water being moved. This project also includes an extension of the 36-inch transmission pipeline leaving the water plant approximately 5,000 feet to facilitate water deliveries to locations further from the water treatment facility.

There is potential to reduce dependency on groundwater during summer months when the City of Lodi is still pumping as much as 10 MGD from the ground to support the water plant. Groundwater savings could be as high as 6,000 AF/year; however, 4,500 to 5,000 AF/year of savings is expected. The delivery of additional raw surface water will need to be secured for this project to proceed.

Project Summary	
Submitting GSA:	City of Lodi
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	4,750 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project is in the planning/initial study phase. The required plumbing and infrastructure exist; however, pumps and corresponding equipment would need to be purchased. The City has not completed a study or performed engineering modelling related to feasibility. Increasing capacity would allow for more surface water diversion during summer months, but it is unlikely that during the winter months demand would exceed the current plant capacity. The City anticipates meeting peak summer demand with more surface water, which currently exceeds the 4,000 AF that is supplied by wells.

Required Permitting and Regulatory Process: This project requires SWRCB permitting and re-classification for plant upsizing. CEQA review will also need to be completed.

Time-table for Initiation and Completion: The timeline for this project has not yet been developed, but it is estimated that this project could begin in 2030 and be completed by 2033. Benefits would be realized beginning the first summer following the plant expansion and remain in perpetuity.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply (surface water) will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 4,750 AF/year in groundwater pumping in the City of Lodi through the expansion of treated surface water. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The City of Lodi relies on Woodbridge Irrigation District (WID) for surface water deliveries and does not currently have a contract allowing for higher volumes to be supplied. This project relies entirely on the availability of additional surface water deliveries from WID (Mokelumne River water), which will need to be negotiated at the onset of this project.

Legal Authority: The City of Lodi has legal authority to administer this project through California Water Code (CWC) §71000-73000. Additional legal and contract negotiations will be needed with WID for additional surface water deliveries.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $4 million in capital costs, $240,000 in fixed annual operations and maintenance costs, and $2.1 million in annual variable costs (amount is variable depending on water purchase, power, and chemical needs). This project is a Capital Improvement Project Budgeted item, to be paid for from the water enterprise fund.

Circumstances for Implementation: This project is a Planned Project that is anticipated to move forward. As scenarios change, the Potential Projects can come online to bring additional resources for adaptive management. Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin.

Trigger for Implementation and Termination: Expansion of the Surface Water Treatment Facility (SWTF) will be initiated when the City of Lodi is unable to meet its growing water demand with the current infrastructure. There is no expectation that this project would be terminated based on a decision made by the City of Lodi. The potential for reduced availability of surface water supply from WID would be the only potential cause for a reduction in SWFT production.

Process for Determining Conditions Requiring the Project have Occurred: In reviewing current water demands, as well as future projections of use, City of Lodi staff will determine whether an expansion of the SWTF is appropriate or not and make a recommendation to City Council. This is currently a planned project that is anticipated to move forward and be online by 2040.

6.2.5.3 BNSF Railway Company Intermodal Facility Recharge Pond

Under this proposed project, CSJWCD would form an agreement with the BNSF railroad owner to access an existing drainage pond near the CSJWCD delivery channel to be used as a recharge area. This project would contribute an estimated 1,000 AF/year of groundwater offset through direct recharge to the groundwater aquifer.

Project Summary	
Submitting GSA:	Central San Joaquin Water Conservation District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,000 AF/year
Other Participating Entities:	BNSF Railway

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is in the planning stages.

Required Permitting and Regulatory Process: A streambed alteration permit would be required to construct a diversion structure from the District delivery channel to feed the recharge pond.

Time-table for Initiation and Completion: This project is anticipated to proceed in WY 2024, subject to available funding.

Expected Benefits and Evaluation: This project is anticipated to directly recharge 1,000 AF/year to the groundwater basin in CSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project will rely on water from the New Melones Unit Central Valley Project. The surface water source is based upon a contract for delivery of surface water from the New Melones Unit of the Central Valley Project. The contract project is long-term; however, water availability is subject to drought conditions. This is an existing water right.

Legal Authority: The Water Code, Division 21, §74000 et seq. authorizes CSJWCD to acquire, sell, and distribute water and fix rates for service throughout the District.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $150,000 in capital costs and $50,000 in annual operations and maintenance costs. Costs for this project would be met by groundwater extraction fee revenue, private loans, and/or possible grant funding.

Circumstances for Implementation: This project is currently in the planning stages and may move forward if funding becomes available. Category B projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects. As scenarios change, this project can come online to bring additional resources for adaptive management. In this case, the project parties plan to implement this project as soon as a finalized agreement with the landowner is reached and permitting and funding are established.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Category B projects will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.4 Manaserro Recharge Project

NSJWCD is investigating constructing and operating a 10-acre recharge pond on the north side of the Mokelumne River on property owned by the Manaserro family through a long-term lease. NSJWCD would use Permit 10477 water, available during December 1 through June 30 that is not needed for irrigation, for recharge. This project could recharge 8,000 AF/year or more in years when water is available. Because this project can use water available during the direct diversion flood season, water is expected to be available more frequently under the NSJWCD water right for this project, or 80 percent of years. Capital costs assume that NSJWCD would lease the 10-acre property for this project.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	8,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is in the planning phase. NSJWCD is continuing to work on a strategic plan and funding options for the implementation of this project, and continuing negotiations with the landowner.

Required Permitting and Regulatory Process: This project would require CEQA review, a possible grading permit, and a possible water right change petition.

Time-table for Initiation and Completion: This project is anticipated to completed by 2025.

Expected Benefits and Evaluation: This project is anticipated to directly recharge 8,000 AF/year to the groundwater basin in NSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would use water supplies available through NSJWCD Permit 10477 (Mokelumne River water). This is an existing surface water right. Once Permit 10477 supplies are fully committed to in-lieu recharge projects, NSJWCD could apply to appropriate Mokelumne River flood flows for this direct recharge project.

Legal Authority: The legal authority for this project is covered under Water Code §74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $300,000 in capital costs and $400,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding and landowner assessments (pending approval).

Circumstances for Implementation: This project is a Category B project and may move forward as funding becomes available. Category B projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects. As scenarios change, the project can come online to bring additional resources for adaptive management. Circumstances for implementation include securing funding. Project may be implemented on a smaller scale depending on use of water by other projects in the District.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this will depend on funding availability, securement of the property lease and planning.

6.2.5.5 City of Escalon Wastewater Reuse

This project entails the reuse of wastewater that would include tertiary treatment of the City of Escalon’s effluent and blending in SSJID’s irrigation distribution system. This additional source of supply could then be used for groundwater recharge or transfer within the Subbasin to offset groundwater demands using SSJID facilities and/or water right entitlements to facilitate the transfer. The treated water will meet Title 22 Water Standards.

The City of Escalon’s Wastewater Treatment Plant treats approximately 600,000 gallons per day (1.84 AF per day) with peak flows up to 1 MGD. The plant is located near SSJID’s Main Distribution Canal, and the effluent would need to be pumped and a pipeline of approximately 4,000 linear feet would need installed in addition to improvements at the plant to meet Title 22 Water Standards.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	Recycling/Direct Recharge/ Intrabasin Transfer
Estimated Groundwater Offset and/or Recharge:	672 AF/year
Other Participating Entities:	City of Escalon

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing water recycling and direct recharge opportunities.

Project Status: This project is in the planning phase.

Required Permitting and Regulatory Process: This project would require CEQA review, Regional Water Quality Control Board permitting, and road encroachment permits.

Time-table for Initiation and Completion: This project would begin in 2030 and would be completed by 2035.

Expected Benefits and Evaluation: This project is anticipated to offset 672 AF/year in groundwater pumping for use in direct recharge in the City of Escalon or in inter-basin transfers to other areas of the Subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations

How Project Will Be Accomplished/Evaluation of Water Source: This project will rely on the use of recycled water, in the form of tertiary-treated Title-22 effluent form the City of Escalon’s Wastewater Treatment Plant. No additional water source will be utilized for this project.

Legal Authority: The City of Escalon is an incorporated city and provides municipal services including wastewater treatment. SSJID is an irrigation district formed in accordance with State law.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $18 million in capital costs and $400,000 in annual operations and maintenance costs. Costs for this project will be met by developer impact fees, connection fees, and sewer rate fees.

Circumstances for Implementation: This project is a Category B project, meaning it is currently in the planning stages and may move forward if funding becomes available. Category B projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects.. Provided this project is feasible, as determined in the initial planning phase, the Escalon City Council would need to approve this project as well as the SSJID Board of Directors.

Trigger for Implementation and Termination: This project would need to be determined to be feasible with adequate funding likely from multiple sources such as development impact fees, connection fees, and sewer rate fees.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project be based on the results of a feasibility analysis. The Escalon City Council would need to make the requisite findings and approve a financing package for this project.

6.2.5.6 City of Ripon Surface Water Supply

The City of Ripon serves water to 15,000 residents along with businesses and industries located within its limits. This project would supplement the City of Ripon's municipal water supply with treated surface water from SSJID. A 5-mile pipeline from the existing treated water transmission pipeline to Ripon's water distribution system and a booster pump station would need to be constructed.

The City of Ripon is currently under contract with SSJID for a maximum of 6,000 AF/year of Stanislaus River water, which is the expected water supply for this project.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	6,000 AF/year
Other Participating Entities:	City of Ripon

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: The design for this project is complete. The City is pursuing a National Environmental Policy Act (NEPA) Categorical Exclusion and CEQA Mitigated Negative Declaration. Construction of this project will begin once this project is fully funded. Construction is expected to take one year.

Required Permitting and Regulatory Process: This project will require a NEPA Categorical Exclusion and CEQA Mitigated Negative Declaration. Road encroachment permits will also be required.

Time-table for Initiation and Completion: This project would begin in 2028 and would be completed by 2030.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset 6,000 AF/year in groundwater pumping in the City of Ripon. Benefits are expected to accrue for 50 years, through 2074. Benefits to groundwater levels will be evaluated through ESJWRM model simulations. This proposed conjunctive use project would provide the community of Ripon, along with the region that relies on the groundwater Subbasin, with numerous benefits, including:

- Conservation of groundwater through in-lieu recharge
- Use of renewable energy and energy conservation
- Safer and cleaner drinking water

How Project Will Be Accomplished/Evaluation of Water Source: SSJID holds pre-1914 water rights on the Stanislaus River. This is an existing surface water right. The City of Ripon has an agreement in place to divert a maximum of 6,000 AF/year from SSJID facilitates under SSJID's existing pre-1914 water right, which is the expected water supply for this project.

Legal Authority: The City of Ripon is an incorporated city and provides municipal water service. SSJID is an irrigation district formed in accordance with State law. SSJID holds pre-1914 water rights on the Stanislaus River.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $8.6 million in capital costs. Costs for this project will be met by grants, water rates, and development impact fees.

Circumstances for Implementation: This project is a Category B project, meaning it is currently in the planning stages and may move forward if funding becomes available. Category B projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects.. The City of Ripon is in the process of completing the environmental documentation for this project and securing the necessary finances to move forward.

Trigger for Implementation and Termination: Project implementation will initiate once this project is approved by the City of Ripon and the financing is in place. Termination would be subject to the terms of the agreement if applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of Potential Projects will be based on long-term management or changing needs of the GSA or Subbasin. The Ripon City Council would need to make the requisite findings under NEPA, CEQA, and approve a financing package for project construction.

6.2.5.7 City of Escalon Connection to Nick DeGroot Water Treatment Plant

The City of Escalon partnered in the construction of the Nick DeGroot Water Treatment Plant and continues to provide financial partnership in its operation. However, Escalon has not constructed the turnout and distribution system improvements necessary to receive their surface water allotments. Finance and construction of these improvements would make it possible for Escalon to receive their contract entitlements under Phase 1 (2,015 AF) further reducing Escalon's groundwater demand. Escalon, as a partner city in the plant, could readily begin receiving water once turnout improvements and distribution pipelines are constructed. SSJID operates the Nick DeGroot Water Treatment Plant and serves treated Stanislaus River water under its pre-1914 water right to the cities of Manteca, Lathrop, and Tracy.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	2,015 AF/year
Other Participating Entities:	City of Escalon and SSJID

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project is in the conceptual design phase. Environmental review has been completed. The project is pending further design work and rate study by the Council.

Required Permitting and Regulatory Process: This project will require road encroachment permits.

Time-table for Initiation and Completion: This project would begin in 2028 (pending funding) and be completed by 2030.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and critical to establishing long-term Subbasin sustainability. This project anticipated to offset 2,015 AF/year in groundwater pumping in the City of Escalon. Benefits are expected to accrue for 50 years, through 2073. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: SSJID holds pre-1914 water rights on the Stanislaus River. This is an existing surface water right.

Legal Authority: The City of Escalon is an incorporated city and provides municipal water service. SSJID is an irrigation district formed in accordance with State law. SSJID holds pre-1914 water rights on the Stanislaus River. The City of Escalon is project partner in the Nick DeGroot Water Treatment Plant and has an existing agreement with SSJID which entitles Escalon to receive 2,015 AF/year of treated surface water.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $8,789,000 in capital costs and $250,000 in annual operations and maintenance costs. Costs for this project will be met by grants, water rates, and development impact fees.

Circumstances for Implementation: This project is a Category B project, meaning it is currently in the planning stages and may move forward if funding becomes available. Category B projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects. The environmental review for this project has been completed and the City of Escalon is in the process of securing the necessary finances to move forward.

Trigger for Implementation and Termination: Project implementation will initiate once this project is approved by the City of Escalon and the financing is in place. Termination would be subject to the terms of the agreement if applicable

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on the Escalon City Council making the requisite findings and approving a financing package and rate increase for this project.

6.2.5.8 Farmington Dam Repurpose Project

This proposed project would convert the Farmington Dam, currently a flood control structure, into a water supply reservoir. This existing Farmington Dam has a flood control capacity of 52,000 AF. The proposed project would increase the total reservoir capacity to 112,000 AF which includes 60,000 AF for water supply and 52,000 AF for flood control. The water supply could be stored and used even in drought conditions. The increased water supply would also encourage growers to switch to surface water irrigation instead of reliance on groundwater.

USACE completed a reconnaissance report in 1997 with an estimated cost of $91.4 million based on an effective pricing date of October 1996. Including environmental and cultural resources mitigation costs, which were not included in 1997, the cost today would be approximately $175 million.

Other entities that would benefit from this project includes CSJWCD and potentially OID.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	15,500 - 60,000 AF/year
Other Participating Entities:	USACE

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is in the pre-planning stage. A reconnaissance study has been completed. SEWD has been working with Congressmen Harder to include this project in the 2024 Water Resources Development Act bill to re-authorize a new feasibility study.

Required Permitting and Regulatory Process: The required permitting for this project would include acquiring permits/approvals from SWRCB, USBR, California DFW, RWQCB, CVFPB, and USACE.

Time-table for Initiation and Completion: This project would begin in 2030 and be completed by 2050.

Expected Benefits and Evaluation: This project is anticipated to directly recharge 60,000 AF/year to the groundwater basin in SEWD. Benefits to groundwater levels will be evaluated through model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: SEWD and CSJWCD have a water supply contract with USBR to use water from the New Melones Reservoir (Stanislaus River water). This is an existing surface water right.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping. Farmington Dam is owned and operated by USACE, and upon agreement, and USACE would be the agency with authority to modify the dam structure.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $175 million in capital costs and $2 million in annual operations and maintenance costs. Costs for this project will be met through the pursual of grant funding.

Circumstances for Implementation: This project is a Category B project in the early planning stages and will require significant additional work to move forward. This project could be implemented when agreements are reached with all applicable federal and state regulatory agencies and when funding is available.

Trigger for Implementation and Termination: The trigger for implementation and termination would be the water supply from New Melones Reservoir and groundwater levels in the Subbasin.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will depend on the successfully execution of agreements with applicable federal and state agencies, and after securing funding to complete design, environmental documentation and construction.

6.2.5.9 Mobilizing Recharge Opportunities

This project would put in place a framework to quickly mobilize and take advantage of recharge opportunities (e.g., existing storm ponds, lake features, temporary flood easements, agricultural field ponding, etc.) This project would provide access to funding to expedite recharge projects as opportunities arise. Additional governance and budgetary controls would need to be developed. Flood-Managed Aquifer Recharge (Flood-MAR) opportunities will be considered through ongoing coordination with existing agencies.[1]

Project Summary	
Submitting GSA:	San Joaquin County
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	110,000 – 158,000 AF/year

[1] Flood-MAR is an integrated and voluntary resource management strategy that uses flood water resulting from, or in anticipation of, rainfall or snow melt for managed aquifer recharge (MAR) on agricultural lands and working landscapes, including but not limited to refuges, floodplains, and flood bypasses. Flood-MAR can be implemented at multiple scales, from individual landowners diverting flood water with existing infrastructure, to using extensive detention/recharge areas and modernizing flood management infrastructure/operations (CA DWR, 2019).

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct and/or in-lieu recharge opportunities.

Project Status: This project is still in the early development stages. Under a SGMA Implementation Grant Program Round 1 award, the County has begun advancing the project to put to beneficial use water appropriated through the Mokelumne River Water and Power Authority's water right application using existing and new infrastructure.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation of this project may begin in 2024, with environmental review and water rights applications beginning in 2025, and expected project completion by 2040.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin in areas that are geographically dispersed throughout the Subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: [Information pending]

Estimated Costs and Plans to Meet Costs: A portion of this project has been funded through a SGMA Round 1 Implementation Grant. The remaining costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The plan to be developed under this project has just begun. Once completed, potentially feasible projects would have to undergo design, environmental review, permitting and construction prior to any operation.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of feasible projects identified in the study being conducted under the grant funding would need to be approved by the identified implementation agency(ies). Design, environmental review, permitting and construction, and the funding stream to support those efforts, would have to occur before the feasible projects can be brought online.

6.2.5.10 NSJWCD Winery Recycled Water

This project will blend NSJWCD Permit 10477 water with wastewater from winery(ies) and deliver blended water for irrigation to accomplish in-lieu recharge or put in recharge ponds and accomplish direct groundwater recharge.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	Recycling/In-lieu Recharge/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	750 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing recycling, in-lieu recharge, and direct recharge opportunities.

Project Status: This project is in the early stages of discussing concepts with a local winery.

Required Permitting and Regulatory Process: This project would require WDR permitting through the Central Valley Regional Water Quality Control Board (CVRWQCB). Minor permits would be required for pipeline construction.

Time-table for Initiation and Completion: This project would begin in 2025 and be completed by 2027.

Expected Benefits and Evaluation: This project is anticipated to offset 750 AF/year in groundwater pumping in NSJWCD for use in in-lieu or direct recharge.

How Project Will Be Accomplished/Evaluation of Water Source: This project will blend NSJWCD Permit 10477 (Mokelumne River water) with wastewater from wineries.

Legal Authority: The legal authority for this project is covered under Water Code §74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $1.5 million in capital costs and $100,000 in annual operations and maintenance costs. Costs for this project will be met by grant funding, landowner assessments (pending approval), and charges paid by the winery (pending contract).

Circumstances for Implementation: This project is a conceptual project currently in the early stages and would require significant additional work to move forward. Funding would have to be secured to advance project design, permitting, environmental review and construction, and coordination contracts with the participating winery(ies) executed before the projects can be brought online.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this will be based on long-term management or changing needs of the GSA or Subbasin, the willingness of local winery(ies) to participate, and the availability of funding.

6.2.5.11 SSJID Storm Water Reuse

SSJID and the cities of Ripon and Escalon have previously proposed storm water capture for storage and irrigation reuse, or for groundwater recharge to benefit the groundwater Subbasin. Currently, the City of Escalon, and to a limited extent the City of Ripon, discharge storm water into SSJID facilities during the winter months. This storm water is conveyed through SSJID's main canal or lateral irrigation distribution system and eventually is conveyed into the Stanislaus River or the San Joaquin River via French Camp Slough. Capturing and storing excess storm water would allow for quantities of water that could be used to offset or enhance groundwater in multiple ways. SSJID is in the process of quantifying the amount of storm water it discharges during the winter months that could be made available to be repurposed for sustainable groundwater management practices. Additional infrastructure may be needed to provide adequate storage for groundwater recharge.

The City of Escalon currently has a drainage area of approximately 1,200 acres with 10 drainage systems which accumulate to a maximum discharge capacity of approximately 50 cubic feet per second (cfs) that drains into two District Laterals. It is estimated on average that 700 AF/year of run-off comes from the City of Escalon. The City of Ripon currently has a drainage area of approximately 2,200 acres with four drainage systems. The majority of the storm run-off discharges to the Stanislaus River. A portion of storm water discharges into the District's laterals and canals. It is estimated approximately 400 AF/year of run-off discharges to District facilities. Additional monitoring will need to be implemented to obtain more accurate discharge flows from both cities.

Preliminary cost estimate includes two 20-acre storm drain retention basins in each city strategically located near District facilities.

Project Summary	
Submitting GSA:	South San Joaquin GSA

Project Type:	Storm Water/In-lieu Recharge/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,100 AF/year
Other Participating Entities:	City of Escalon, City of Ripon, SSJID

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing storm water capture, in-lieu recharge, and direct recharge opportunities.

Project Status: This project is in the planning/initial study phase.

Required Permitting and Regulatory Process: This project will require CEQA review and road encroachment permits.

Time-table for Initiation and Completion: This project would begin in 2027 and be completed by 2030.

Expected Benefits and Evaluation: This project is anticipated to offset 1,100 AF/year in groundwater pumping in SSJ GSA for use in in-lieu or direct recharge. Benefits are expected to accrue for 50 years, through 2080. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would rely on the use of captured storm water. No additional water source will be utilized for this project.

Legal Authority: The Cities of Escalon and Ripon are incorporated cities and provide municipal stormwater/drainage services. SSJID is an irrigation district formed in accordance with State law and also provides limited drainage service.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $30 million in capital costs and $30,000 in annual operations and maintenance costs. Costs for this project will be met by developer impact fees, connection fees, and sewer rate fees.

Circumstances for Implementation: This project is in the early conceptual planning stages and would require significant additional work to move forward. The project proponents are in the process of determining the feasibility of this project, including the possibility of securing the necessary finances to move forward.

Trigger for Implementation and Termination: Project implementation would begin once this project is approved by the cities of Escalon and Ripon, and the SSJID Board of Directors, and a financing plan is in place. Termination would be subject to the terms of the agreement if applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on long-term management or changing needs of the GSAs or Subbasin, and the availability of funding to further the project.

6.2.5.12Wallace-Burson Conjunctive Use Program

This project would use surface water from New Hogan Reservoir, Mokelumne State-Filed Rights Application, and/or purchased water for direct recharge into the groundwater basin and/or to offset groundwater pumping. Surface water would be recharged in the Wallace Service Area and the communities of Burson and Southworth.

Project Summary	
Submitting GSA:	Eastside GSA
Project Type:	Conjunctive Use/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	500 - 3,000 AF/year

Measurable Objective Expected to Benefit: This project addresses the chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities and/or conjunctive use.

Project Status: This project is still in the conceptual planning and discussion stages. Hydrogeology and water supply studies have been developed, and the design of specific program facilities is ongoing.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation of this project may begin by 2030 with completion by 2040, if funding is identified and the project is implemented.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin in areas that are geographically dispersed throughout the Subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: The legal authority for this project is covered under Water Code § 30000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on long-term management or changing needs of the GSA or Subbasin, the availability of funding, and the willingness of project partners to design, construct and execute the project.

6.2.5.13 Calaveras River Wholesale Water Service Expansion

Calaveras County Water District (CCWD) has available surface water supply to set up agreements that would facilitate in-lieu recharge opportunities in the Calaveras County portion of the Subbasin. This project would identify opportunities for the conjunctive use and recharge of surface water into the groundwater basin. The amount of recharge will be dependent on the opportunities identified, and projects developed and implemented.

Project Summary	
Submitting GSA:	Eastside GSA
Project Type:	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	200 - 600 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: This project is still in the conceptual development stages.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation and completion dates for this project are currently unknown.

Expected Benefits and Evaluation: This project is anticipated to recharge the groundwater basin in the Calaveras County portions of the Subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: The legal authority for this project is covered under Water Code § 30000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: This project is in the early stages of planning. Implementation of the project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.14 Recycled Water to Manteca Golf Course

In response to growing demands for recycled water projects, the City of Manteca adopted the Reclaimed Water Facilities Master Plan in January 2023. The City is pursuing recycled water projects to create a replenishable water source for irrigation and water storage. This project would send reclaimed water to irrigate the Manteca Golf Course. Once the recycled water infrastructure is in place, an estimated 5,000 AF/year of groundwater could be offset by the use of recycled water for irrigation.

Project Summary	
Submitting GSA:	City of Manteca
Project Type:	Recycling
Estimated Groundwater Offset and/or Recharge:	406 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by providing recycled water for irrigation, rather than being supplied by groundwater.

Project Status: A 12-inch pipeline that would deliver reclaimed water has been installed. The City is currently pursuing other funding, such as grants, to finance the construction of pump stations and storage tanks needed to deliver the recycled water.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The completion dates for this project are currently unknown.

Expected Benefits and Evaluation: This project is anticipated to offset groundwater pumping with the use of recycled water. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: This project is under the authority of the City of Manteca and implemented within the City's service area.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Funding is required to complete the design, environmental review, permitting and construction of project facilities. As such, implementation of this project will be based on long-term management or changing needs of the GSA or Subbasin and the fiscal feasibility of the project.

6.2.5.15 Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project

This project involves the construction of an unlined reservoir which could provide an estimated 2,000 AF/year of in-lieu recharge in the Subbasin. The reservoir is designed to be unlined, allowing an unspecified volume of water to seep into the groundwater basin through direct recharge.

Project Summary	
Submitting GSA:	Eastside GSA
Project Type:	In-Lieu Recharge/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	2,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and/or direct recharge opportunities.

Project Status: The final design of this project has been completed. Once funding has been identified, environmental review and permitting for the project will begin.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: This project is anticipated to be completed by 2025.

Expected Benefits and Evaluation: This project is anticipated to provide water for in-lieu and direct recharge in the critically overdrafted subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: The legal authority for this project is covered under Water Code § 30000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The need for funding is the key factor in the implementation of this project. Funding is required to prepare the environmental review documentation, complete permitting, and for project construction and startup.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation this project will be based on long-term management or changing needs of the GSA or Subbasin and the identification of funding required to complete environmental review documentation, permitting, and for project construction and startup.

6.2.5.16 Perfecting Mokelumne River Water Right (MICUP Project)

This project advances MRWPA's Water Right Application 29835 (A029835) to a Water Right Permit with the State Water Resources Control Board. The application aims to appropriate up 110,000 acre-feet of unappropriated wet year flows from the Mokelumne River annually, with an additional 48,000 acre-feet/year of storage. Appropriated water could be used for addressing groundwater overdraft concerns in the Subbasin by storing wet-year water for use during drier periods.

Project Summary	
Submitting GSA:	San Joaquin County
Project Type:	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	110,000 - 158,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: The water rights application for this project is in progress. A Notice of Preparation for CEQA documentation was issued in July 2024.

Required Permitting and Regulatory Process: SWRCB water rights permitting, plus other project-specific permitting as required to put the water to beneficial use.

Time-table for Initiation and Completion: Implementation of this project has begun, with an expected completion by 2025.

Expected Benefits and Evaluation: This project is anticipated to amend the water right application to provide future in-lieu recharge opportunities in the groundwater basin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project is contingent on the SWRCB Division of Water Rights approval of the water right application for the diversion of surface water from the Mokelumne River.

Legal Authority: The legal authority for this project is that accorded under the California Government Code to joint powers of authority for the provision of public services.

Estimated Costs and Plans to Meet Costs: $125,000 has been spent to date. The estimated remaining costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: SWRCB Division of Water Rights approval of the water rights application and issuance of a water right permit is required for successful implementation of this project.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this will be based on securing a water right to the MRWPA's Water Right Application 29835 (A029835) and to identifying, developing and constructing the projects to put that water right to beneficial use to address the long-term management or changing needs of the GSA or Subbasin.

6.2.5.17 North System Groundwater Recharge Project - Phase 2

The North System Master Plan will identify opportunities for direct and/or in-lieu recharge of the underlying critically overdrafted subbasin. Preliminary estimates indicate that additional 1,000-3,000 AF/year of recharge could occur off the North System in wet and normal years through either direct and/or in-lieu recharge.

Project Summary	
Submitting GSA:	North San Joaquin Water Conservation District
Project Type:	In-Lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,000 - 3,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and direct recharge opportunities.

Project Status: The Master Plan for the entire North System is currently in progress. A team has also been retained to design and build a new pump station in 2024-2026.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: Construction on this project is anticipated to begin in 2026 with completion by 2029.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin in the North System extent of NSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: The legal authority for this project is covered under Water Code §74000 et seq.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $10 million in capital costs and $100,000 in annual operations and maintenance costs. A $3 million state grant was secured to help with project costs. Additional funds for this project will be met by landowner assessments, water charges, and any further grant funds the District can obtain.

Circumstances for Implementation: Completion of the North System Master Plan will identify potential projects for direct and/or in-lieu recharge. The circumstances for implementation of projects identified in the Master Plan are unknown at this time and will be project dependent.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: The Master Plan for the North System will identify opportunities for direct and in-lieu recharge in the North System of the District's service area. Design, permitting, and environmental review will need to be completed on the most feasible projects before construction can begin.

6.2.5.18 Stormwater Collection, Treatment, and Infiltration

The City of Manteca will conduct a study to determine what space may be available for use in a stormwater recharge program, identify treatment technologies available and determine volume of rainwater available for groundwater recharge. The City is currently working on identifying a funding source for the study.

Project Summary	
Submitting GSA:	City of Manteca
Project Type:	Direct Recharge/ Stormwater
Estimated Groundwater Offset and/or Recharge:	To be determined

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by identifying potential direct recharge opportunities using captured stormwater.

Project Status: This project is still in the early planning and initial study stage.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation and completion dates for this project are currently unknown.

Expected Benefits and Evaluation: This project is anticipated to identify opportunities for direct recharge into the groundwater basin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: This project is under the authority of the City of Manteca and implemented within the City's service area.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of longer-term projects will be based on long-term management or changing needs of the GSA or Subbasin and availability of funding.

6.2.5.19 Off-Stream Regulating Reservoir

This project would provide additional opportunities for the direct recharge of surface water into the underlying groundwater basin. This project would use surface water from the New Hogan Reservoir (Calaveras River water) using existing and pending surface water rights.

This project is currently in the early design stages. SEWD has identified a preliminary list of ideal locations based on the operational benefits to the distribution system. These locations will be compared against areas most suitable for recharge. Discussions with landowners are necessary, and land acquisition may also be required. The amount of recharge that this project may provide is still unknown at this time.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	To be determined

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by providing additional direct recharge opportunities.

Project Status: This project is still in the early conceptual stages.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation and completion dates for this project are currently unknown.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on water from New Hogan Reservoir (Calaveras River water under existing and possible future surface water rights.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping

Estimated Costs and Plans to Meet Costs: The estimated costs for this project are unknown at this time. The project would hopefully be funded through grant funds.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this longer-term project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.20 On-Farm Recharge Project

The District has developed and approved an On-Farm Recharge Policy to incentivize farmers to participate in Flood-MAR opportunities. The project would use existing farm infrastructure to divert surface water for direct recharge through FloodMAR, or potentially dry wells. SEWD is currently looking for agricultural customers to participate in this program. As such, the amount of water that may be recharged through this program is unknown at this time.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	To be determined

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is still in the early project planning stages.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation and completion dates for this project are currently unknown.

Expected Benefits and Evaluation: This project is anticipated to directly recharge water into the groundwater basin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $100,000 in annual operations and maintenance costs. Costs for this project will be met by district staffing, district rates created to establish a new Flood-MAR project, and other district funding for on-farm incentive programs.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this longer-term project will be based on long-term management or changing needs of the GSA or Subbasin.

6.2.5.21 Bellota Weir Modifications Project

The purpose of the Bellota Weir Modifications Project is to provide fish passage for the Central Valley Steelhead in addition to providing more efficient water diversion and flow metering of agricultural, municipal and ecological water. The project will conserve approximately 1,100 AF annually of surface water upon completion of Phase 1 with the installation of the concrete sill. The project will increase the Old Calaveras River recharge from 6,300 acre-feet (AF) to 11,500 AF annually per the SEWD's water rights on the Calaveras River.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge/ Stormwater
Estimated Groundwater Offset and/or Recharge:	2,000 - 5,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is still in the design stages. SEWD has promoted the project in Washington DC in order to secure funding through appropriations.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: This District is looking to secure funding for the project. The anticipated completion of this project is by 2030.

Expected Benefits and Evaluation: The project will allow for the controlled flow into the Old Calaveras River to increase infiltration of surface water into the underlying critically overdrafted Subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $85 million in capital costs. Costs for annual operations and maintenance are still unknown. SEWD is looking to obtain grant funding and state and federal loans to cover the costs of this project.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this longer-term project will be based on the availability of funding and the long-term management or changing needs of the GSA or Subbasin.

6.2.5.22 Water Supply Enhancement Project - Distribution Pipelines

This project aims to enhance water supply accessibility for on-farm in-lieu recharge by distributing surface water to the Linden area through a network of proposed pipelines, including the Clements Gravity pipeline, Houston Gravity pipeline, Demartini pipeline, and Mosher pipeline. By providing surface water to farmers who currently lack access, the project will significantly reduce groundwater overdraft in these regions. The estimated water offset ranges from 5,000 to 17,000 acre-feet per year, depending on the water year type. SEWD is coordinating with landowners in the project area to secure easements and gauge interest in participation.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-Lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	17,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu and direct recharge opportunities.

Project Status: This project is still in the early design stages.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation dates for this project are currently unknown.

Expected Benefits and Evaluation: This project is anticipated to provide access to surface water to those who currently don’t have access, thereby greatly reducing groundwater overdraft. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: The project is currently in the preliminary design phase. The environmental review and permitting of the project remain to be completed ahead of construction.

6.2.5.23 Water Treatment Plant Aquifer Storage Recovery Well – 7401

This project will recharge treated water directly into the groundwater basin and store it until periods of drought, when the water can be extracted and used. A new aquifer storage and recovery (ASR) well will be installed near SEWD's water treatment plant, capable of recharging up to 350 gpm and producing 1,500 gpm. The well will serve as a supplemental water source for the water treatment plant in dry years and will be used to directly recharge groundwater in wet years. The estimated range of water available for recharge is between 1,000 and 2,420 acre-feet per year, depending on the water year type and availability.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	1,000 - 2,420 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is currently being implemented. Design has been completed, and funding has been secured. Construction is scheduled to begin in 2025, with anticipated completion by 2026.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: This project has been initiated and expected to be completed by 2026.

Expected Benefits and Evaluation: This project is anticipated store excess water in wet years for later use in drought periods, thereby reducing the groundwater deficit. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: Supply to this well for aquifer storage will be treated water from the Cal Water distribution system.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $1.5 million in capital costs. Funding sources for this project have not yet been identified.

Circumstances for Implementation: Environmental documentation and permitting remain to be completed before the project can be bid and constructed.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: This project is a Category B project on which design has been completed. Additional work, including environmental documentation and permitting, is required to move the project forward. Additionally, a contract with Cal Water will be required to obtain treated water for injection. .

6.2.5.24 Beckman Well

The Beckman well was a project implemented in the early 2000's as a collaboration between the East Bay Municipal Utilities District and SEWD along the Mokelumne Aqueduct. SEWD is looking assess the current status of the well and determine the requirements to revive it as a functioning aquifer storage and recovery (ASR) well. If implemented, this project would recharge surface water from the East Bay Mud Aqueduct or the New Hogan Reservoir (Calaveras River water) for storage in the aquifer, to be later extracted during drought periods. Estimates of the amount of water available for recharge are currently unknown.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	To be determined

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is still in the early project development stages. SEWD is looking to hire a company to understand the current status of the well and what would be required to revive it as a function ASR well.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation and completion dates for this project are currently unknown. If implemented, this project may be completed by 2028.

Expected Benefits and Evaluation: This project is anticipated to directly recharge water during wet periods for storage and later extraction. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project would recharge surface water from the East Bay Mud Aqueduct or the New Hogan Reservoir (Calaveras River water).

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $20,000 million in capital costs. Costs for annual operations and maintenance are unknown. SEWD and MICUP will provide funds for this project.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: The proposed well needs to be assessed to determined its suitability for use as an injection well. Therefore, the status of the well will determine if the project is feasible for construction.

6.2.5.25 West Linden Project

This project would provide surface water for in-lieu and direct recharge in the area west of Linden, where the groundwater table is at its lowest. Surface water would be provided using Mokelumne Aqueduct Water and New Hogan Reservoir (Calaveras River) water. Estimates of the amount of water that would be available for direct or in-lieu recharge range from 5,000-60,000 AF/year, depending on water year type and availability.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-Lieu/ Direct Recharge
Estimated Groundwater Offset and/or Recharge:	5,000 - 60,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct and/or in-lieu recharge opportunities.

Project Status: This project is still in the early planning and design stages. SEWD is working on discussion with MICUP and EBMUD to discuss collaboration and funding.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: If implemented, this project may be completed by 2035.

Expected Benefits and Evaluation: This project is anticipated to provide direct and in-lieu recharge opportunities for the groundwater basin in areas where the groundwater table is typically at its lowest. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: Mokelumne Aqueduct Water and New Hogan Reservoir (Calaveras River) water

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project and approach for meeting costs are unknown at this time.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this longer term project will be based on long-term management or changing needs of the GSA or Subbasin and coordination with participating partners.

6.2.5.26 Water Supply Enhancement Project - Direct Recharge

This project would use surface water from the New Hogan distribution system to implement direct recharge projects, such as dry wells or recharge basins along SEWD's distribution system. SEWD is currently engaging with landowners of potential sites to assess their interest in participating. At this stage, the estimated volume of water that could be recharged remains undetermined.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	Direct Recharge
Estimated Groundwater Offset and/or Recharge:	To be determined

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing direct recharge opportunities.

Project Status: This project is still in the early project development stages.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: If implemented, this project may be completed by 2030.

Expected Benefits and Evaluation: This project is anticipated to directly recharge the groundwater basin in areas along SEWD's distribution area. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: New Hogan Reservoir (Calaveras River) water

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project are unknown at this time. Costs would be provided by SEWD and any grants the District is able to secure.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: This project is in the preliminary stages. Additional analyses need to be conducted to identify appropriate areas for recharge, and coordination agreements with property owners and/or land acquisitions will be required before the project can move forward.

6.2.5.27 SSJID Water Master Plan - System Improvements

Several thousand acres within SSJID are unable to utilize surface water or have limited access due to capacity issues and evolving irrigation practices. To address this, SSJID has identified numerous capital projects aimed at improving capacity and utilizing flow controls to accommodate additional growers returning to SSJID surface water deliveries.

SSJID has embarked on a comprehensive Water Master Plan to address its aging infrastructure and make strategic improvements to its irrigation systems. The plan includes increasing lateral capacity, constructing new reservoirs, and implementing additional SCADA controls. In total, SSJID has identified $191 million in capital improvements. To fund these projects, SSJID completed a substantial Prop 218 rate increase in July 2023. Through 2040, SSJID expects to implement several capital projects outlined in the Water Master Plan. Estimates of the benefit to the groundwater basin range from 10,000 – 15,000 AF/year.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	In-lieu Recharge
Estimated Groundwater Offset and/or Recharge:	10,000 - 15,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by providing surface water to additional customers in the District for use in-lieu of groundwater.

Project Status: A feasibility study for this project has been completed.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: SSJID is anticipating completing several projects outlined in the Water Master Plan through 2040.

Expected Benefits and Evaluation: This project is anticipated to provide surface water to district growers for use in-lieu of groundwater. This will indirectly recharge the groundwater basin in areas that are geographically dispersed throughout the Subbasin. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as projects develop but will be utilizing SSJID permitted water supplies.

Legal Authority: SSJID is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SSJID is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $30-40 million in capital costs. Costs for annual operations and maintenance are unknown at this time. Funding will be provided through existing revenue sources such as hydropower generation, user fees, and water charges. Enhanced sources such as increased user fees and additional water transfers may also contribute. External funding may also be secured through grants, earmarks, or other water transfers.

Circumstances for Implementation: The circumstances for implementation of this project are unknown at this time.

Trigger for Implementation and Termination: The triggers for implementation and termination of this project are unknown at this time.

Process for Determining Conditions Requiring the Project have Occurred: The feasibility study to identify potential in-lieu recharge projects has been completed. Implementation of projects identified in the study will be based on long-term management or changing needs of the GSA or Subbasin and the availability of funding and willing growers.

6.2.6 Mokelumne River Loss Study

The Mokelumne River Loss Study, proposed by NSJWCD, will study reaches of the Mokelumne River downstream of Camanche Reservoir to better understand and account for losses due to percolation, evaporation, riparian evapotranspiration, and more to inform management actions and SGMA basin accounting. Results of the study will be used to support model refinement and validation (described in Section 7.4.1) in this region and will help to fill the interconnected surface water data gap discussed in Section 4.7.3. The project cost about $100,000 and will take two years to complete once funding has been identified.

6.2.7 Notification Process

Notification and public outreach around projects will be conducted at the GSA level. GSAs will post project updates to their websites to notify the public that the implementation of projects is being considered or has been implemented. This will include a description of the actions to be taken. These updates will also be provided to the other GSAs and will be published on the ESJGWA website and other appropriate locations. Additional noticing for the public will be conducted consistent with permitting requirements in the case of the enactment of fees or assessments. Outreach may include public notices, meetings, website or social media presence, and email announcements.

6.3 MANAGEMENT ACTIONS

Management actions are generally administrative, locally implemented actions that the GSAs could take that affect groundwater sustainability. Management actions typically do not require outside approvals, nor do they involve capital projects. No management actions currently related to pumping activities or groundwater allocations have been completed to date for the Subbasin; however, Subbasin GSAs are planning to develop a Demand Management Program that will provide needed structure and flexibility to implement such demand-side management actions in the future if need is determined. As part of the development of the demand reduction program, public outreach and education on the potential structure of the program, as well and feasible monitoring and enforcement mechanisms, will be conducted as necessary to enable a successful program. Outreach could include public notices, meetings, website or social media presence, workshops and email announcements.

There are a number of conservation and demand management actions currently in place in the Subbasin, including those outlined in Urban Water Management Plans (UWMPs) and Agricultural Water Management Plans (AWMPs), as identified below.

- CCWD Urban Water Management Plan (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, rebates and giveaways) (CCWD, 2021).
- City of Lodi Urban Water Management Plan (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system loss, water conservation program coordination and staffing support, rebate program) (City of Lodi, 2021)
- Cal Water Urban Water Management Plan (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, and other demand management measures) (Cal Water, 2021).
- City of Ripon Urban Water Management Plan (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, and other demand management measures) (City of Ripon, 2017).
- SEWD Urban Water Management Plan (Demand management measures include metering, public education and outreach, water conservation program coordination and staffing support, asset management, and wholesale supplier assistance programs) (SEWD, 2021).
- SSJID Urban Water Management Plan (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, asset management, wholesale supplier assistance programs, and other demand management measures) (SSJID, 2021).
- City of Stockton Urban Water Management Plan (Demand management measures include water waste prevention ordinance, metering, conservation pricing, public education and outreach, programs to assess and manage distribution system real loss, water conservation program coordination and staffing support, water survey programs for residential customers, residential plumbing retrofit, conservation programs for commercial, industrial, and institutional accounts; and landscape conservation programs and incentives) (City of Stockton, 2021).
- OID Agricultural Water Management Plan (Efficient water management practices include delivery measurement accuracy, volumetric pricing, alternative land use, recycled water use, capital improvements for on-farm irrigation systems, incentive pricing structures, increasing water ordering and delivery flexibility, supplier spill and tailwater recovery systems, increase planned conjunctive use, automate canal control, facilitate customer pump testing, designate water conservation coordinator, provide for availability of water management services, evaluate supplier policies to allow more flexible deliveries and storage, and evaluate and improve efficiencies of supplier's pumps) (OID, 2021).
- SEWD Agricultural Water Management Plan (Efficient water management practices include water measurements, volume-based pricing, alternate land use, recycled water use, on-farm irrigation capital improvements, incentive pricing structure, infrastructure improvement, order/delivery flexibility, supplier spill

and tailwater systems, conjunctive use, automated canal controls, customer pump test/evaluation, water conservation coordinator, water management services to customers, identify institutional changes, and supplier pump improved efficiency) (SEWD, 2021).

- SSJID Agricultural Water Management Plan (Efficient water management practices include delivery measurement accuracy, volumetric pricing, alternative land use, recycled water use, capital improvements for on-farm irrigation systems, incentive pricing structures, lining or piping of distribution system and construction of regulating reservoirs, increasing water ordering and delivery flexibility, supplier spill and tailwater recovery systems, increase planned conjunctive use, automate canal control, facilitate pump testing, designate water conservation coordinator, provide for availability of water management services, evaluate supplier policies to allow more flexible deliveries and storage, and evaluate and improve efficiencies of supplier's pumps) (SSJID, 2021).

In the 2024 GSP Amendment, two new management actions were added:

- Dewatered Domestic Well Mitigation Program: This program will provide a formalized process through which the ESJGWA can track and mitigate the dewatering of domestic wells as a result of subbasin management activities. The program was adopted by the ESJGWA in September 2024 and is expected to be implemented starting in 2025. Additional detail on this program can be found in Appendix 3-J.

- Demand Management Program: A framework for a Subbasin-wide Demand Management Program will be developed as part of this management action. This program will serve as a backstop that can be activated if projects fall short of meeting expected supply-side targets. The program will be developed and preliminarily implemented, if needed, by GSAs between 2025 and 2030. The program is expected to rely on an iterative process that incorporates analysis of hydrologic conditions, assessment of PMA progress, development of a demand reduction target using ESJWRM, and distribution of demand reduction goals amongst the GSAs. An initial program outline is included in Appendix 6-B, but the program is expected to evolve significantly by 2030.

Additional management activities are discussed in Chapter 7: Plan Implementation, including:

- Monitoring and recording of groundwater levels and groundwater quality data
- Maintaining and updating the Subbasin Data Management System (DMS) with newly collected data
- Addressing identified data gaps
- Annual monitoring of progress toward sustainability
- Annual reporting of Subbasin conditions to DWR as required by SGMA

6.4 ADAPTIVE MANAGEMENT STRATEGIES

Although the ESJGWA does not provide direct authority to require GSAs to implement projects, the GWA will be working on GSA-level water budgets and will be requesting annual or biannual reports to evaluate progress. It was stated in the 2020 GSP that if the projects do not progress, or if monitoring efforts demonstrate that the projects are not effective in achieving stated recharge and/or offset targets, the GWA will convene a working group to evaluate supply-side and demand-side management actions such as the implementation of groundwater pumping curtailments, land fallowing, etc. In the 2024 GSP Amendment, a new management action is being added to the GSP to formalize the development of a Demand Management Program that can be used as a backstop, if necessary, to ensure the recovery of the principal aquifer if the Subbasin falls short on project implementation and groundwater offset targets. It is the still the overall theme and goal of the ESJ GSP to first implement PMAs to manage overdraft and reach basin sustainability. However, this management action is intended to respond to direction provided by DWR and to outline the demand side action that would be taken if supply side actions are not effective in meeting overall basin sustainability goals. Based on comments from DWR in their November 18, 2021 Consultation Initiation Letter (Letter) requesting additional detail on management actions that could be implemented, the ESJGWA has developed descriptions of adaptive management measures to be considered for implementation if projects are demonstrated to not be effective in achieving Subbasin sustainability targets. After implementation of the Category A projects (as described herein and in Chapter 2 of this revised GSP), the adaptive management actions identified below could be implemented in coordination with Category B projects if additional measures are required to sustainably manage groundwater in the Subbasin. These alternative adaptive management actions are programs that are not currently ready for implementation, are in the early planning stages, and do not have firm schedules for development but rather would be implemented as needed sometime after 2031 following reevaluation of Subbasin sustainability during the 5-Year Periodic Evaluation in 2030. The following describes these potential programs as they are currently contemplated; none of these programs are planned for implementation in the Subbasin at this time.

- Groundwater Extraction Fee with Land Use Modifications – A groundwater extraction fee or groundwater production charge could be collected from entities that own or operate an agricultural well. Revenue from these fees could then be used to pay for a variety of activities such as the construction of water infrastructure, groundwater conservation initiatives, proper construction and destruction of wells to prevent contamination, groundwater recharge and recovery projects, purchase of imported water or other supplies to replenish the groundwater basin through direct or in-lieu recharge, and/or purchasing and permanent fallowing of marginally-productive agricultural lands dependent on groundwater. Several agencies in California have already implemented such a program and have seen success in utilizing revenue to benefit the local groundwater basin. A similar methodology could be applied within the Eastern San Joaquin Subbasin.

- Rotational Fallowing or Permanent Fallowing of Crop Lands – Agricultural water use can be temporarily reduced by fallowing crop lands. While this can have economic impacts to a region, the benefits may also include improved water supply reliability, improved groundwater quality, increased groundwater levels, reduced subsidence, and operational flexibility. Rotational fallowing of crop lands reduces the economic impacts to any one area by rotating the areas of fallowing. This management action could be combined with a recharge project through the application of surplus water supplies to the fallowed lands resulting in in-lieu groundwater recharge or the repurposing of the permanently fallowed lands to create wildlife habitat or some other land use benefit that is not reliant on groundwater as a supply. This management action could be implemented, if needed, to help the Subbasin work towards its sustainability goals. However, the rules by which this management action would be implemented would have to be developed by the GSAs within the Subbasin.

- Conservation Programming for Demand Reduction – A demand reduction measure serves to reduce water demand, surface water losses, and/or nonessential water uses. Demand reduction measures may include a conservation rate structure or a uniform rate structure with a conservation program that achieves demand reduction. Conservation and demand management programs have been a priority for utility providers across the state for decades. Water conservation programs can by implemented by utilities to help offset the increasing demands being placed on water resources. Actions that may be considered a demand reduction measure include, but are not limited to, the following activities:
    - Conservation rates
    - Water efficient landscaping
    - Smart meters
    - Water efficient fixtures and appliances
    - Water conservation education effort

  Many of the GSAs in the Subbasin are currently implementing conservation programming for demand reduction. Under this management action, additional resources would be directed toward conservation programming for demand reduction such that these programs can be enhanced or expanded.

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Additionally, the ESJGWA will conduct regular 'calls for projects' to identify additional potential projects and management actions that may be implemented to support Subbasin sustainability, and will, as part of this process, update information regarding projects already identified herein.

6.5 SIMULATION OF PROJECTS AND MANAGEMENT ACTIONS IN PROJECTED WATER BUDGET

The November 18, 2021 Letter from DWR identified two potential deficiencies with the Subbasin GSP which may preclude DWR's approval of a 2022 Revised GSP, as well as potential corrective actions to address each potential deficiency. Potential Deficiency 1 related to the GSP's requirement of two consecutive non-dry (i.e., below normal, above normal, or wet) water year types and the exclusion of dry and critically dry water-year types in the identification of undesirable results. (Please see Chapter 3, Sustainable Management Criteria, for revisions that addressed this deficiency). Potential Deficiency 1 also requested additional detail on how projects and management actions, in conjunction with the proposed chronic lowering of groundwater levels sustainable management criteria, will offset drought related groundwater reductions and avoid significant and unreasonable impacts. Specifically, Potential Correction Action 1(b) stated that the GSP "fails to identify specific extraction and groundwater recharge management actions the GSAs would implement or otherwise describe how the Subbasin would be managed to offset...dry year reductions of groundwater storage". As a Potential Corrective Action, the following is suggested: "The GSP should be revised to include specific projects and management actions the GSAs would implement to offset drought year groundwater level declines."

As part of the process to respond to DWR, the ESJGWA worked with each GSA individually to update GSP project descriptions with new information that had become available in the two years after the GSP was first adopted in 2020. These revised projects were divided into two categories: Category A projects (projects that are likely to advance in the next five years and have existing water rights or agreements) and Category B projects (projects that are not anticipated to advance in the next five years, but could be leveraged in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets). Category A projects and Category B projects are shown in Table 6-1, along with project assumptions. As part of the 5-year Periodic Evaluation, the ESJGWA again worked with each GSA to update the GSP project and management action descriptions included in the 2022 Revised GSP, to add new projects and management actions to the PMA list, and to remove any project that is no longer feasible. This updated information is also reflected in Table 6-1. Please see Chapter 2, Basin Setting, and Appendix 2-D for information as to how the Category A projects were simulated in the projected water budget and for a description of their effectiveness on addressing overdraft in the Subbasin.[1] Category B projects may be elevated to a Category A project should feasibility studies or other assessments demonstrate a viable project, if water rights or contracts are firmly identified, if partnerships are formed, and if economic evaluation demonstrate that the projects are cost effective.

6.6 POTENTIAL AVAILABLE FUNDING MECHANISMS

The SWRCB has identified potential funding mechanisms that can be used toward the planning, construction, and implementation of GSP projects. Several funding types may be applicable to the current list of projects and management actions and to potential future projects for the Eastern San Joaquin GSP, including projects included in an Integrated Water Resource Management Plan (IRWMP), projects addressing drinking water, stormwater recharge, water recycling projects, wastewater and system improvement projects, and projects that focus on DAC or SDAC areas.

The range of applicable projects, per SWRCB Funding Opportunities fact sheet and per Water Code §10727.4(h), include recharge projects, groundwater contamination remediation, water recycling projects, in-lieu use, diversions to storage, conservation, conveyance, and extraction projects. Additional projects or management actions outside of this

[1] City of Stockton's Advanced Metering Infrastructure project was added as a Category A project during the Public Comment period of the 2024 GSP Amendment. Therefore, it is not included in the PMA simulation results shown in the 2024 GSP Amendment. It will be simulated in future GSP Amendments.

list may also be applicable if a GSA determines it will help achieve the sustainability goal for the Subbasin (see GSP Regulations §354.44). Many of the available funding mechanisms accept applications on a continuing basis. Table 6-2 provides an overview of the project types and available funding and programs as well as important dates to consider for implementation. Funding options are explained in greater detail in Chapter 7: Plan Implementation.

Table 6-2: Overview of Project Types and Available Funding Mechanisms

Project Type and Purpose	Funding Type	Program	Important Dates
Water recycling projects	Planning and construction grants and financing	Water Recycling Funding Program (CWSRF)	Planning applications accepted on continuous basis. Construction applications received by December 31st of each year will be used to develop a priority score. Projects which receive a priority score equal to or greater than the yearly fundable list cutoff score will be placed on the fundable list for the upcoming fiscal year.
Wastewater treatment for DAC & SDAC projects	Planning and construction grants and financing	Small Community Grant Fund (CWSRF)	Applications accepted on continuous basis.
Drinking Water	Planning and implementation grants	Groundwater Grant Program (SDWSRF)	There are no solicitations currently available under this program.
Public water system improvements	Planning and construction grants and financing	Drinking Water Grants	Applications accepted on continuous basis.
Stormwater recharge projects	Implementation grants	Storm Water Grant Program	There are no solicitations currently available under this program.
IRWM projects (included and implemented in an adopted IRWMP)	Implementation Grant	IRWM Implementation Grant Program	There are no solicitations currently available under this program.
Sustainable Groundwater Management	Planning and implementation grants	SGMA-related grant program	There are no solicitations currently available under this program.
Various	Planning and implementation grants	WaterSMART grant program	There are multiple programs under the USBR WaterSMART grant program with varying requirements. Individual projects should visit grants.gov to look at open funding opportunities.

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: Plan Implementation

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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Acronyms

AF	acre-feet
AMI	automated metering infrastructure
Bay-Delta Plan	Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CGPS	continuous global positioning system
CSJWCD	Central San Joaquin Water Conservation District
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWSRF	Clean Water State Revolving Fund
DAC	Disadvantaged Community
DDW	Division of Drinking Water
Delta	Sacramento-San Joaquin River Delta
DMS	data management system
DPR	Department of Pesticide Regulation
DWR	Department of Water Resources
EBMUD	East Bay Municipal Utility District
ESJGWA	Eastern San Joaquin Groundwater Authority
ESJGWA Board	Eastern San Joaquin Groundwater Authority Board of Directors
GAMA	Groundwater Ambient Monitoring and Assessment
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCM	hydrogeologic conceptual model
ILRP	Irrigated Lands Regulatory Program
InSAR	Interferometric Synthetic Aperture Radar
IRWM	Integrated Regional Water Management
MICUP	Mokelumne River Integrated Conjunctive Use Program
NSJWCD	North San Joaquin Water Conservation District
O&M	operations and maintenance
OID	Oakdale Irrigation District
RMN	representative monitoring network
SEWD	Stockton East Water District
SGM	Sustainable Groundwater Management
SGMA	Sustainable Groundwater Management Act
SSJ	South San Joaquin
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
WIIN	Water Infrastructure Improvements for the Nation
WRFP	Water Recycling Funding Program

7. PLAN IMPLEMENTATION

The Eastern San Joaquin Groundwater Sustainability Agency (GSAs) will work together in mutual cooperation to implement the Eastern San Joaquin Subbasin Groundwater Sustainability Plan (GSP) in compliance with the Sustainable Groundwater Management Act (SGMA). Implementing the GSP includes implementation of the projects and management actions included in Chapter 6: Projects and Management Actions, as well as the following items:

- Eastern San Joaquin GSP implementation program management
- Eastern San Joaquin GSAs administration and management
- Implementation of the monitoring program and annual reporting
- Data collection and analysis
- Public outreach
- Development of 5-year Periodic Evaluation and GSP amendments as needed
- Grant writing

This chapter provides a description of the above items, including contents of the annual and 5-year Periodic Evaluation reports that will be provided to the Department of Water Resources (DWR) as required under SGMA regulations.

7.1 IMPLEMENTATION SCHEDULE

Development and adoption of an initial GSP by the January 31, 2020 deadline was a large task. During GSP development, the Eastern San Joaquin Groundwater Authority Board of Directors (ESJGWA Board) identified key areas that would need to be further developed as GSP implementation continued.

Table 7-1 illustrates the Eastern San Joaquin GSP's schedule for implementation from 2020 to 2040, highlighting the high-level activities anticipated for each 5-year period. A more detailed schedule is provided in Figure 7-1, updated to reflect current understanding as of the 2024 GSP Amendment. These activities are necessary for ongoing GSP monitoring and updates; Figure 7-1 also includes tentative schedules for projects and management actions. Additional details on the activities included in the timeline are provided in the activities' respective sections of this GSP.

Table 7-1: GSP Schedule for Implementation 2020 to 2040

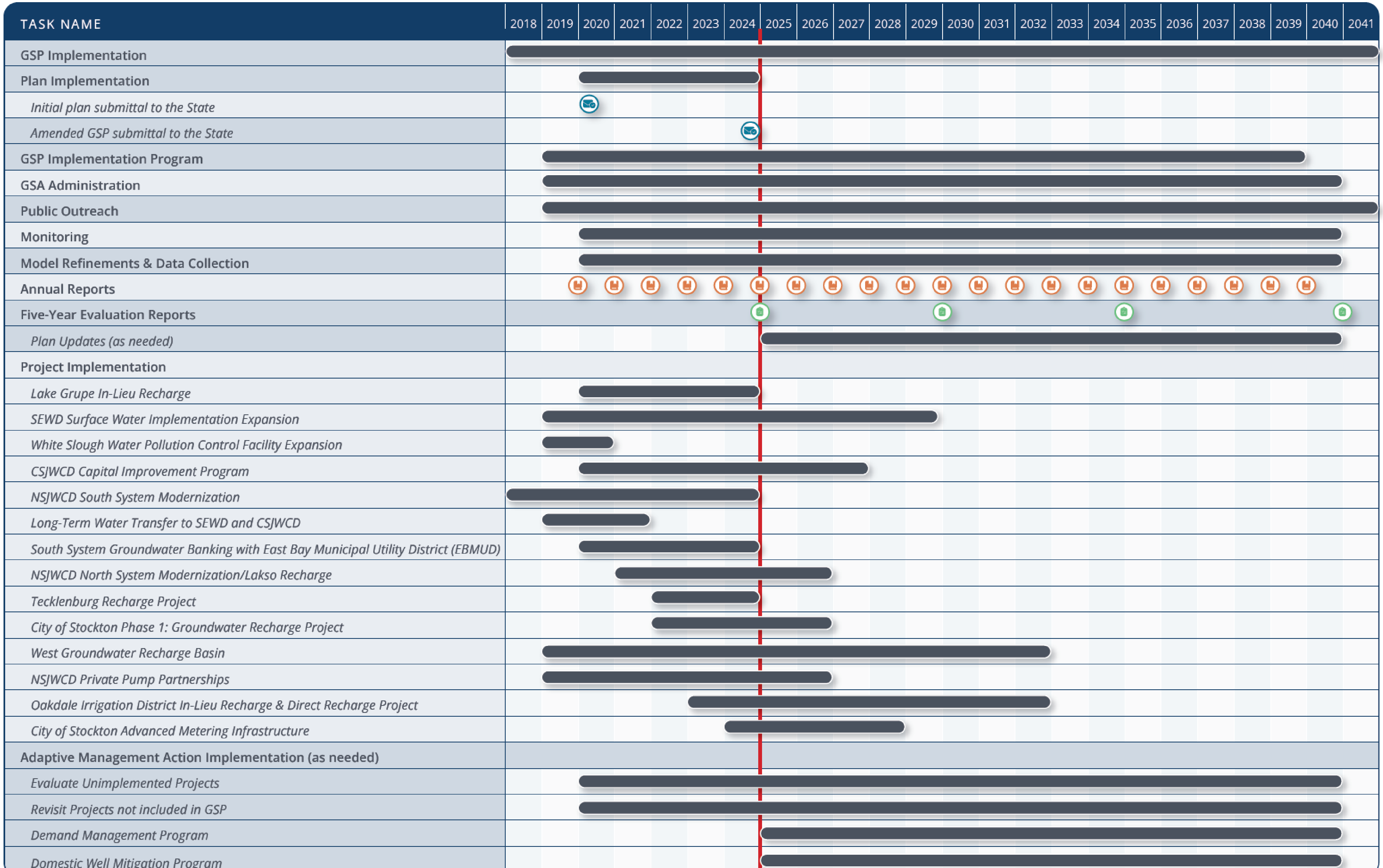
2020	2025	2030	2035 2040
Monitoring and Reporting	Project Implementation	Prepare for Sustainability	Implement Sustainable Operations
• Establish monitoring networks • Construct new wells • Model refinement and verification studies • Initial project implementation • Ongoing outreach regarding GSP and projects	• GSAs conduct 5-year periodic evaluation/update • Project implementation continues • Model refinement continues as needed • Demand management policy/plan developed • Demand reduction implemented where possible • Monitoring and reporting continue • Outreach regarding GSP and projects continues	• GSAs conduct 5-year periodic evaluation/update • Longer-term/ conceptual project evaluation • Project implementation continues • Demand management policy/plan implementation begins • Model refinement continues as needed • Monitoring and reporting continue • Outreach continues	• GSAs conduct 5-year periodic evaluation/update • Demand management policy/ plan implemented as needed • Project implementation completed

In the five years since the 2020 GSP was adopted, the ESJGWA has dedicated significant resources to the tasks identified in the first column in Table 7-1. A high-level summary of these efforts is summarized below. For a current understanding of GSP implementation work, please consult the most recent Annual Report and 5-Year Periodic Evaluation.

- Establish and improve monitoring networks
  - Three additional wells were added to the groundwater level Representative Monitoring Network (RMN), for a total of 23 representative monitoring wells.
  - The water quality RMN was expanded into a larger combined network, which now includes 2 new wells in Stockton, 3 new wells from the groundwater level RMN, one nested well from the previous (2020) broad monitoring network for water quality, and five additional wells that fill data gaps on the eastern and southern portions of the Subbasin, for a total of 11 wells. Chloride will also be monitored at these wells in addition to total dissolved solids going forward.
  - The seawater intrusion sustainable indicator was deemed an inapplicable sustainability indicator, and the associated sustainable management criteria and monitoring were removed from the GSP.
  - A new RMN for subsidence was established in the 2024 GSP Amendment. Direct subsidence monitoring will occur at four continuous global positioning system (CGPS) stations and 6 survey benchmark locations going forward. Basin-wide InSAR will also be downloaded and analyzed on an annual basis as part of monitoring for subsidence in the Subbasin.

  - A new RMN for interconnected surface water was established in the 2024 GSP Amendment. This new network includes 6 groundwater levels RMN wells that are within 5 miles of streams, 5 new wells installed specifically for interconnected surface water monitoring, and 1 new well installed in the Delta. Stream gages and other shallow wells adjacent to streams will also be analyzed, but do not have sustainability criteria established.
- Construct new wells
  - Constructed two new multi-completion wells through the Technical Support Services grant with DWR in the NSJWCD and SEWD service areas (2021)
  - Constructed five new wells through the Prop 1 SGM grant through DWR to capture information related to interconnected surface waters (2022)
  - Constructed one new multi-completion well in the Delta (northwestern) area of the Subbasin (2024)
- Model refinement and verification studies
  - Extended hydrology as part of the development of the Annual Reports (2019, 2020, 2021, 2022, 2023)
  - Major model update and calibration (2021-2022)
  - New model scenarios development and calibration (2022)
  - Major model update and calibration (2024)
- Project implementation
  - CCWD Automated Metering Infrastructure (AMI) Replacement and Conversion has been completed (2022).
  - Construction is completed for the White Slough Water Pollution Control Facility Expansion project (2020).
  - Phases 1, 2 and 3 completed for the NSJWCD South System Modernization project (2024).
  - Pilot Dream Project was completed in February 2024 for the South System Groundwater Banking with East Bay Municipal Utilities District project.
  - Phase 1A was constructed and began operation for the NSJWCD North System Modernization/Lakso Recharge project (2024).
  - Tecklenburg Recharge Project began operation in 2023 and is substantially completed.
  - One agreement was executed in 2024 with an existing riparian pumper for the NSJWCD Private Pump Partnerships project.
  - OID in-lieu and Direct Recharge program began deliveries of surface water to be used in-lieu of groundwater in 2023.
  - OID and SSJID long-term transfer to SEWD was approved in 2023 and is set to begin operation in non-wet years.
  - Construction on the Lake Grupe in-lieu recharge project has been completed (2023).
  - SEWD completed conversion of 2,505 acres to surface water through the SEWD Surface Water Implementation Expansion project (2024).
  - Construction began on the West Groundwater Recharge Basin (2024).
  - The City of Stockton Groundwater Recharge Basin design is in progress.
  - The City of Stockton Advanced Metering Infrastructure was contracted in March 2024.
- Ongoing outreach regarding GSP and projects
  - GSA-specific targeted outreach to their constituencies regarding SGMA and ongoing projects to support groundwater sustainability
  - Ongoing webpage updates
  - Public survey to inform future outreach and engagement activities
  - Public meetings and open house during development of the 2024 GSP Amendment

Figure 7-1: GSP Implementation Schedule



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7.2 IMPLEMENTATION COSTS

In implementing the GSP, the GSAs will incur costs which will require funding. Table 7-2 summarizes these activities and their estimated costs. The areas associated with Subbasin-wide management and GSP implementation will be borne by the ESJGWA through contributions from the member GSAs under a cost-sharing arrangement developed following adoption of the 2020 GSP. Projects will continue to be administered by the GSA project proponents. GSAs may elect to implement projects individually or jointly with one or more GSAs, or with the ESJGWA.

The table includes both Category A and Category B projects. Both category types are planned projects. Category A projects however, meet the following criteria:

- Are likely to advance by 2030
- Have necessary water rights or agreements in place

Category B projects are not anticipated to advance in the next five years, but could be leveraged in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets or do not produce a response as simulated in the model.

Table 7-2: Costs to GSAs and GSP Implementation Costs

Activity	Estimated Cost[1]
GSP Implementation and Management for GSAs	
Monitoring and Reporting	
Monitoring	$150,000 - $175,000 (annually)
Annual Reporting	$65,000 - $90,000 (annually)
Data Management System Updates	$0 - $125,000 (as-needed, annually)
Data Collection and Analysis	
Model Refinements	$0 - 100,000 (annually)
Additional Wells if needed	$600,000 (as needed)
Administrative Actions	$140,000 - $230,000 (annually)
Developing 5-Year Evaluation Reports	$800,000 - $2,000,000 every 5 years
Public Outreach and Website Maintenance	$35,000 - $60,000 (annually)
Grant Writing	By application type: $45,000 - $60,000 (State) $50,000+ (Federal)
Implementing GSP: Projects (Category A)	
Lake Grupe In-Lieu Recharge	$2.3 million (one time) $330,000 (annually)
SEWD Surface Water Implementation Expansion	$750,000 (one time) $100,000 (annually)
White Slough Water Pollution Control Facility Expansion	$6 million (one time) – complete $4,664 (annually)
CSJWCD Capital Improvement Program	$50,000 (annually)

NSJWCD South System Modernization	Phase 1&2: $7 million (one time) $200,000 (annually) Phase 3: $4 million (one-time), $200,000 (annually) Phase 4: $8 million (one-time), $200,000 (annually) Future Phases: $10-20 million (one-time), $200,000 (annually)
Long-term Water Transfer to SEWD and CSJWCD	Up to $9 million (annually)
South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	Phase 1: $3,000,000 (one-time) Phase 2: Estimated $5-15 million (one-time), annual cost to be determined
NSJWCD North System Modernization/Lakso Recharge	$4,000,000 (one-time) $100,000 (annually)
Tecklenburg Recharge Project	Phase 1: $750,000 (one-time), $100,000 (annually) Phase 2: $1,500,000 (one-time), $100,000 (annually)
City of Stockton Phase 1: Groundwater Recharge Project	$11,500,000 (one-time), annual costs to be determined, as of 2024.
West Groundwater Recharge Basin	To be determined, as of 2024.
NSJWCD Private Pump Partnerships	To be determined, as of 2024.
Oakdale Irrigation District In-lieu and Direct Recharge Project	To be determined, as of 2024.
City of Stockton Advanced Metering Infrastructure	$17,000,000 (one-time), annual costs to be determined, as of 2024.
Implementing GSP: Projects (Category B)	
City of Manteca Advanced Metering Infrastructure	$650,000 (one time) $300,000 (annually)
City of Lodi Surface Water Facility Expansion and Delivery Pipeline	$ 4 million (one time) $2,340,000 (annually)
BNSF Railway Company Intermodal Facility Recharge Pond	$ 50,000 (annually)
Manaserro Recharge Project	Approximately $500,000 (one-time) $50,000 (annually)
City of Escalon Wastewater Reuse	To be determined, as of 2024.
City of Ripon Surface Water Supply	To be determined, as of 2024.
City of Escalon Connection to Nick DeGroot Water Treatment Plant	To be determined, as of 2024.
Farmington Dam Repurpose Project	To be determined, as of 2024.
Mobilizing Recharge Opportunities (MICUP)	$2,700,000 (one-time) To be determined (annually)
NSJWCD Winery Recycled Water	To be determined, as of 2024.
SSJID Storm Water Reuse	To be determined, as of 2024.
Wallace-Burson Conjunctive Use Program	To be determined, as of 2024.
Calaveras River Wholesale Water Service Expansion	To be determined, as of 2024.
Recycled Water to Manteca Golf Course	To be determined, as of 2024.

	Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	To be determined, as of 2024.
	Perfecting Mokelumne River Water Right	$125,000 spent to date, Total to be determined (one-time) To be determined (annually)
	North System Groundwater Recharge Project - Phase 2	$10,000,000 (one-time) $100,000 (annually)
	Stormwater Collection, Treatment, and Infiltration	To be determined, as of 2024.
	Off-Stream Regulating Reservoir	To be determined, as of 2024.
	On-Farm Recharge Project	$0 (one-time) $100,000 (annual)
	Bellota Weir Modifications Project	$85,000,000 (one-time)
	Water Supply Enhancement Project - Distribution Pipelines	To be determined, as of 2024.
	Water Treatment Plant Aquifer Storage Recovery Well - 7401	$1,500,000 (one-time)
	Beckman Well	$200,000 (one-time)
	West Linden Project	To be determined, as of 2024.
	Water Supply Enhancement Project - Direct Recharge	To be determined, as of 2024.
	SSJID Water Master Plan - System Improvements	Approximately $30,000,000 - $40,000,000 (one-time)
Implementing GSP: Management Actions		
	South Stockton Well Rehabilitation Program	To be determined, as of 2024.
	Mokelumne River Loss Study	To be determined, as of 2024.
	AMI Replacement and Conversion	To be determined, as of 2024.
	Groundwater Monitoring Plan	$500,000 (one-time) $100,000 (annually)
	Demand Management Program	To be determined, as of 2024.
	Well Mitigation Program	$20,000 estimated for initial start-up. Long-term costs to be determined.

[1] Estimates are rounded and based on full implementation years (through FY2040).

7.3 MONITORING AND REPORTING

7.3.1 Monitoring

The GSAs will follow the protocols for the monitoring programs described in Chapter 4: Monitoring Networks to track conditions for the applicable sustainability indicators discussed in Chapter 3: Sustainable Management Criteria. Monitoring network data will be collected and used to determine whether undesirable results are occurring and whether minimum thresholds are being reached or exceeded, and to determine if adaptive management is necessary. These data will be managed using the Eastern San Joaquin Subbasin Data Management System (DMS) (see Chapter 5: Data Management System). The GSP monitoring networks make use of existing monitoring programs and develop further monitoring to continue characterization of the Subbasin and support development of water budgets. Key components involved in the implementation of the monitoring network activities for the GSP include:

- Semi-annual groundwater level monitoring at 23 wells
- Upload monitoring data to SGMA Portal Monitoring Network Module

- Semi-annual groundwater quality monitoring at 21 wells for both TDS and chloride
- Annual survey benchmark monitoring for subsidence at 6 locations[1]
- Semi-annual groundwater level monitoring at 12 wells for interconnected surface water
- Documentation of groundwater quality monitoring protocols

Components of the annual monitoring program costs include:

- Field crew ($80,000 - $100,000)
- Equipment rental with truck, level meter, and pumps ($7,000 - $10,000)
- Laboratory costs ($2,000 - $3,000)
- Subsidence surveying costs ($20,000-$30,0000)

7.3.2Developing Annual Reports

Annual reports must be submitted by April 1st of each year following GSP adoption. Annual reports must include three key sections: 1) General Information, 2) Basin Conditions, and 3) Plan Implementation Progress. A description of what information will be provided in each of these sections is described in the following sections. Annual reporting will be completed in a manner and format consistent with California Code of Regulations (CCR) Tile 23 § 356.2. As annual reporting continues, it is possible that this outline will change to reflect basin conditions, the priorities of GSAs, and applicable requirements from DWR. Please see the DWR guidance document entitled *Groundwater Sustainability Plan Implementation: A Guide to Annual Reports, Periodic Evaluations & Plan Amendments* (2023) for more information on the information required in annual reports per SGMA statutes. Annual reporting is estimated to cost approximately $65,000 to $90,000 annually.

7.3.2.1 General Information

General information will include an executive summary that highlights the key contents of the annual report. As part of the executive summary, this section will include a description of the sustainability goals, provide a description of GSP projects and their progress towards implementation, and an annually updated implementation schedule and map of the Subbasin. Key components as required by SGMA regulations include:

- Executive Summary
- Map of the Subbasin

7.3.2.2 Basin Conditions

Basin conditions will describe the current groundwater conditions and monitoring results. This section will include an evaluation of how conditions have changed in the Subbasin over the previous year and compare groundwater data for the most recent water year to historical groundwater data. Pumping data, effects of project implementation (e.g., recharge data, conservation, if applicable), surface water flows, total water use, and groundwater storage will be included. Key components as required by SGMA regulations include:

- Groundwater elevation data from the monitoring network
- Hydrographs and contour maps of elevation data
- Groundwater extraction data

[1] Data from CGPS stations are recorded by other entities.

- Surface water supply data
- Total water use data
- Change in groundwater storage, including maps

7.3.2.3 Plan Implementation Progress

Progress towards successful plan implementation would be included in the annual report. This section of the annual report would describe the progress made toward achieving interim milestones as well as implementation of projects and management actions. Key components as required by SGMA regulations include:

- Plan implementation progress
- Sustainability progress

7.3.3 Data Management System Updates

Updates and maintenance to the data management system (DMS) will be made annually, including import of monitoring data and export of summarized data for annual reporting.

The first year will include refinements and is expected to cost $30,000 to $50,000, with following years expected to cost $20,000 annually.

7.4 DATA COLLECTION AND ANALYSIS

7.4.1 Model Refinements

The ESJWRM integrated flow model will continue to be updated based on newly available information or additional information provided by GSAs. For instance, model updates discussed in the original 2020 GSP have been made in the intervening five years; these significant model updates were made to support the Periodic Evaluation and 2024 GSP Amendment and are documented in Appendix 2-C. Model refinement costs will vary in the future and will most likely occur in response to incorporating updated data or adding and running new model scenarios. Annual model refinements are expected to cost roughly $100,000.

7.4.2 Construction of Additional Wells

As previously mentioned, eight new wells have been constructed since the 2020 GSP. While there are currently no plans to construct additional wells, there may be a need in the future to do so. Well construction costs can vary widely based on well depth and soil conditions. An estimated average cost for siting, permitting, and constructing a groundwater level monitoring well is $300,000 per well.

7.4.3 Data Gaps and Uncertainties

The ESJGWA acknowledges that there are many factors that could affect the availability of surface water, including the voluntary agreements in the major rivers feeding Sacramento-San Joaquin Bay-Delta resulting from negotiations surrounding the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan). Such regulations will need to be evaluated by GSAs in the implementation of projects. The process of providing annual reports to DWR and of GSAs self-reporting to the ESJGWA will allow the ESJGWA to update the Plan and adjust the implementation course as needed based on changing conditions. The GSP allows project implementation to be updated as needed, and it is currently too speculative to say what the impact will be from the proposed voluntary agreements, as the SWRCB has not yet determined how they will be implemented.

Before the next 5-year Periodic Evaluation in 2030, it is expected that DWR will release the outstanding interconnected surface water (ISW) guidance documents, additional groundwater level data for the new ISW representative monitoring wells will have been collected, and the ESJWRM model will have been enhanced to allow for a reevaluation of the streams and creeks included in the ISW analysis, the definition of the ISW undesirable result, and the subsequent ISW sustainable management criteria. Additional shallow groundwater level data will also inform analysis of potential GDEs. This information will be supplemented by a field verification completed by a biologist prior to the 2030 Periodic Evaluation. More groundwater level data, in conjunction with the GDE assessment in the field, will allow the Subbasin to better evaluate potential GDEs and potential impacts to them.

7.5 ADMINISTRATIVE ACTIONS

Each of the 16 GSAs are administered independently and involve meetings and oversight of individual GSA projects and programs. GSAs can be made up of one or multiple agencies, cities, and counties, as described in Chapter 1: Agency Information, Plan Area, and Communication. GSA administration includes: coordination meetings; coordination meetings for any Ad-hoc Committees; regular email communications to update GSA members on on-going basin activities; coordination activities with the other GSAs, such as on projects or studies; administration of projects implemented by the GSA; and general oversight and coordination. Coordination meetings between the 16 GSAs are assumed to occur bi-monthly, with other oversight and administration activities occurring as needed and on an on-going basis. GSA administration is also expected to require additional effort during the annual reporting, 5-year periodic evaluations, and any associated GSP amendments. Other administrative actions may involve tracking and evaluating GSP implementation and sustainability conditions, coordinating with neighboring subbasins, as well as assessing benefits to the Subbasin. Annual costs for GSA administrative actions are estimated to range from $140,000 to $230,000. This estimate assumes $50,000 per year for annual audit and insurance expenses.

7.6 DEVELOPING 5-YEAR PERIODIC EVALUATION REPORTS

SGMA requires that GSPs be evaluated regarding their progress towards meeting the approved sustainability goals at least every 5 years, and to provide a written assessment to DWR. An evaluation must also be made whenever the GSP is amended. A description of the information that will be included in the 5-Year Periodic Evaluation is provided below and would be prepared in a manner consistent with CCR Title 23 §356.4. Annual costs for 5-Year Periodic Evaluations are estimated to range from $800,000 to $2,000,000 and depend on whether or not the GSP also requires amending.

7.6.1 New Information

New information that has become available since the last 5-year evaluation or GSP amendment would be described and the GSP evaluated in light of this new information. If the new information would warrant a change to the GSP, this would also be included.

7.6.2 Sustainability Evaluation

This section will contain a description of current groundwater conditions for each sustainability indicator and will include a discussion of overall Subbasin sustainability. Progress towards achieving interim milestones and measurable objectives will be included, along with an evaluation of groundwater quality and groundwater elevations (being used as direct or proxy measures for several sustainability indicators) in relation to minimum thresholds.

7.6.3 Status of Projects and Management Actions

This section will describe the current status of project and management action implementation since the previous 5-year report. An updated project implementation schedule will be included, along with any new projects that were developed to support the goals of the GSP and a description of any projects that are no longer included in the GSP. The benefits of projects that have been implemented will be included, and updates on projects and management actions that are underway at the time of the 5-year report will be reported.

7.6.4 Basin Setting Based on New Information or Changes in Water Use

This section of the Periodic Evaluation new information was incorporated into various parts of the Basin Setting Chapter (Chapter 2) of the GSP, including the hydrogeologic conceptual model, current groundwater conditions based on ongoing groundwater elevation monitoring, available new groundwater quality data, updates to the hydrogeological conceptual model (HCM), and data gathered from State datasets and reflecting a new understanding of regional groundwater conditions, water use changes, and model updates.

7.6.5 Monitoring Network Description

A description of the monitoring network will be provided in the 5-year periodic evaluation report. Data gaps, or areas of the Subbasin that are not monitored in a manner consistent with the requirements of the regulations, will be identified or reassessed if previously identified. An assessment of the monitoring networks' function will be provided, along with an analysis of data collected to date. If data gaps are identified, the GSP will be revised to include a program for addressing these data gaps, along with an implemented schedule for addressing data gaps and how the GSAs will incorporate updated data into the GSP.

7.6.6 Legal or Enforcement Actions

Enforcement or legal actions taken by the GSAs or their member agencies in relation to the GSP will be summarized in this section along with how such actions support sustainability in the Subbasin.

7.6.7 Coordination

The Eastern San Joaquin GSP will be implemented by the GSAs identified in Chapter 1: Agency Information, Plan Area, and Communication. These GSAs will work in collaboration with neighboring subbasins, namely: the Modesto, Cosumnes, South American, Solano, East Contra Costa, and Tracy Subbasins.

This section of the 5-year periodic evaluation report will describe coordination activities between these entities, such as meetings, joint projects, or data collection efforts. If additional neighboring GSAs have been formed since the previous report, or changes in neighboring subbasins have occurred, resulting in a need for new or additional coordination within or outside the Subbasin, such coordination activities would be included as well.

7.6.8 Other Information

The 5-year periodic evaluation also includes other information such as:

- Any additional information that helps describe progress made towards achieving the sustainability goal for the basin.
- How the Plan considers adjacent basins in its GSP implementation.
- Any technical and/or financial challenges and the most significant challenges and assistance needs.
- How the amended plan may affect relevant city and county general plans related to water resources management, natural resource management and/or land use planning.
- Any technical and/or financial resource limitations and legal matters.

7.7 OUTREACH

During GSP development, GSAs and the ESJGWA used multiple forms of outreach to communicate SGMA-related information and solicit input. The GSAs intend to continue public outreach and provide opportunities for engagement during GSP implementation. This will include providing opportunities for public participation at public meetings, providing access to GSP information online, and continued coordination with entities conducting outreach to diverse communities in the Subbasin. Announcements will continue to be distributed via email prior to public meetings. Emails will also be distributed as specific deliverables are finalized, when opportunities are available for stakeholder input and when this input is requested, or when items of interest to the stakeholder group arise, such as relevant funding opportunities. The Eastern San Joaquin SGMA website, managed as part of GSP administration, will be updated a minimum of once a month, and will house meeting agendas and materials, reports, and other program information. The website may be updated to add new pages as the program continues and additional activities are implemented. Additional public workshops will be held annually to provide an opportunity for stakeholders and members of the public to learn about, discuss, and provide input on GSP activities, progress toward meeting the sustainability goal of this GSP, and the SGMA program. More public workshops may be added as needed.

Additionally, as part of GSP Implementation, and in coordination with preparation of the Annual Reports and 5-Year Periodic Evaluations, the GSAs will collaborate and coordinate with local, state and federal regulatory agencies, as well as other interested parties, for data collection and analyses and to better understand the impacts of Subbasin groundwater pumping and management activities on the beneficial uses and users of groundwater as it relates to groundwater quality, subsidence and induced surface water depletion within the GSAs' jurisdictional areas.

Costs to support outreach are estimated to range from $35,000 to $60,000 annually.

7.8 IMPLEMENTING GSP-RELATED PROJECTS AND MANAGEMENT ACTIONS

Costs for the projects and management actions are described in Chapter 6: Projects and Management Actions of this GSP. Financing of the projects and management actions would vary depending on the activity. Potential financing for projects and management actions are provided in Table 7-3, although other financing may be pursued as opportunities arise or as appropriate. Four new additional Category B projects were approved by the ESJGWA Board at the September 11, 2024 meeting and are not included below. More information on these projects is included in Appendix 6-A.

Table 7-3: Funding Mechanisms for Proposed Projects and Management Actions

Project/Management Action Titled	Type	Responsible Agency[1]	Potential Funding Mechanisms
Projects (Category A)			
Lake Grupe In-Lieu Recharge	In-lieu Recharge	SEWD	District staffing and District rates to establish new accounts
SEWD Surface Water Implementation Expansion	In-lieu Recharge	SEWD	District staffing and District rates to establish new accounts
White Slough Water Pollution Control Facility Expansion	Direct Recharge	City of Lodi	DWR Proposition 84 Grant Funding Program
CSJWCD Capital Improvement Program	In-lieu Recharge	CSJWCD	Surface water sales, groundwater extraction fees, and acre assessments
NSJWCD South System Modernization	In-lieu Recharge	NSJWCD	Phase 1 &2: EBMUD funding, CA Prop 1 State Grant funding, Watersmart Federal Grant funding, landowner assessments, district property taxes, groundwater charge revenue Phase 3: IRWM State Grant funding, landowner assessments, district property taxes, groundwater charge revenue Phase 4: USDA Federal Funding ($1 mil); Applied for federal Watersmart grant, district property taxes, groundwater charge revenue, landowner assessments
Long-term Water Transfer to SEWD	Transfers	OID and SSJ GSA	$300 per AF Urban and $200 per AF for Ag
South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	In-lieu Recharge	NSJWCD	Phase 1: EBMUD funding, NSJWCD district property taxes and groundwater charge revenue Phase 2: To be determined. Likely to include EBMUD funding, NSJWCD district property taxes and groundwater charge revenue and potential future grant proceeds
NSJWCD North System Modernization/Lakso Recharge	In-Lieu Recharge/Direct Recharge	NSJWCD	SGMA State Grant funding, landowner assessments, and groundwater charge revenue
Tecklenburg Recharge Project	Direct Recharge	NSJWCD	Phase 1: NSJWCD Groundwater charge revenue Phase 2: To be determined, as of 2024.
City of Stockton Phase 1: Groundwater Recharge Project	Direct Recharge	City of Stockton	To be determined, as of 2024.

Project/Management Action Titled	Type	Responsible Agency[1]	Potential Funding Mechanisms
West Groundwater Recharge Basin	Direct Recharge	SEWD	Army Corp. is paying SEWD to excavate the soil. The rest of the project will be funded by SEWD or grant funds.
NSJWCD Private Pump Partnerships	In-Lieu/Direct Recharge	NSJWCD	District general revenue sources and individual landowner contributions
Oakdale Irrigation District In-lieu and Direct Recharge Project	Direct Recharge/In-Lieu Recharge	OID	Landowners participating in the 10-Year Program are responsible for the costs of any new turnouts, private conveyance systems, and surplus surface water purchased for out-of-District irrigation.
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	Met by ratepayers and through grants or other funding sources.
Projects (Category B)			
City of Manteca Advanced Metering Infrastructure	Conservation	City of Manteca	Capital Improvement Project budgeted item with available funding
City of Lodi Surface Water Facility Expansion and Delivery Pipeline	In-lieu Recharge	City of Lodi	Capital Improvement Project budgeted item with available funding
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	Groundwater extraction fee revenue, private loans, and/or possible grant funding
Manaserro Recharge Project	Direct Recharge	NSJWCD	Grant funding and groundwater charge revenue
City of Escalon Wastewater Reuse	Recycling/In-Lieu Recharge/Transfers	SSJ GSA	Developer impact fees, connection fees, and sewer rate fees
City of Ripon Surface Water Supply	In-Lieu Recharge	SSJ GSA	Grants, water rates, and development impact fees
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-Lieu Recharge	SSJ GSA	Grants, water rates, and development impact fees
Farmington Dam Repurpose Project	Direct Recharge	SEWD	Grant and or Federally directed funding
Mobilizing Recharge Opportunities (MICUP)	Direct Recharge	SJ County	One-Time cost funded through a SGMA Round 1 Implementation Grant.
NSJWCD Winery Recycled Water	Recycling/In-Lieu Recharge/Direct Recharge	NSJWCD	Grant funding, landowner assessments, and charges paid by the winery
SSJID Storm Water Reuse	Storm Water/ In-Lieu Recharge/ Direct Recharge	SSJ GSA	Developer impact fees, connection fees, and property related fees.
Wallace-Burson Conjunctive Use Program	Conjunctive Use/Direct Recharge	Eastside GSA	To be determined, as of 2024.

Project/Management Action Titled	Type	Responsible Agency[1]	Potential Funding Mechanisms
Calaveras River Wholesale Water Service Expansion	In-Lieu Recharge	Eastside GSA	To be determined, as of 2024.
Recycled Water to Manteca Golf Course	Recycling	City of Manteca	To be determined, as of 2024.
Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	In-Lieu Recharge/Direct Recharge	Eastside GSA	To be determined, as of 2024.
Perfecting Mokelumne River Water Right	In-Lieu Recharge	SJ County	San Joaquin County Assessments and member agency contributions.
North System Groundwater Recharge Project - Phase 2	Direct Recharge	NSJWCD	Secured $3 million state grant; additional funds from landowner assessments and groundwater charge revenue and any grant funds the district can obtain
Stormwater Collection, Treatment, and Infiltration	Direct Recharge/ Stormwater	City of Manteca	To be determined, as of 2024.
Off-Stream Regulating Reservoir	Direct Recharge	SEWD	Grant funding.
On-Farm Recharge Project	Direct Recharge	SEWD	District staffing and District rates to establish new Flood-MAR projects, as well as District funding for on-farm incentive programs.
Bellota Weir Modifications Project	Direct Recharge/ Stormwater	SEWD	Grant Funding and State and Federal Loans
Water Supply Enhancement Project - Distribution Pipelines	In-Lieu/Direct Recharge	SEWD	To be determined, as of 2024.
Water Treatment Plant Aquifer Storage Recovery Well - 7401	Direct Recharge	SEWD	To be determined, as of 2024.
Beckman Well	Direct Recharge	SEWD	SEWD and MICUP will fund.
West Linden Project	Direct Recharge/In-Lieu Recharge	SEWD	To be determined, as of 2024.
Water Supply Enhancement Project - Direct Recharge	Direct Recharge	SEWD	SEWD and grants.
SSJID Water Master Plan - System Improvements	In-Lieu Recharge	SSJ GSA	Existing sources (hydropower generation, user fees, water transfers), enhanced sources (additional user fees, additional water transfers), and outside sources (grants, earmarks, water transfers)
Management Actions			
South Stockton Well Rehabilitation Program	Monitoring and Reporting	City of Stockton	To be determined, as of 2024.

Project/Management Action Titled	Type	Responsible Agency[1]	Potential Funding Mechanisms
Mokelumne River Loss Study	Model Refinement and Validation	NSJWCD	To be determined, as of 2024.
Monitoring and recording of groundwater levels and groundwater quality data			ESJ GWA Budget and GSAs.
Maintaining and updating the Subbasin Data Management System (DMS) with newly collected data			ESJ GWA Budget.
Annual monitoring of progress toward sustainability			ESJ GWA Budget.
Annual reporting of Subbasin conditions to DWR as required by SGMA			ESJ GWA Budget.
Addressing Data Gaps			ESJ GWA Budget.
AMI Replacement and Conversion	Monitoring and Reporting/Conservation	Eastside GSA	To be determined, as of 2024.
Groundwater Monitoring Plan	Monitoring and Reporting	NSJWCD	SGMA grant on north system for 3 monitoring wells; use of district groundwater charge revenue for south system wells and on-going cost to gather and analyze data. District will apply for grants to obtain additional funding for more monitoring wells
Demand Management Program			ESJ GWA Budget and Individual GSAs.
Well Mitigation Program			ESJ GWA Budget.

[1] Acronyms defined: Stockton East Water District (SEWD), Central San Joaquin Water Conservation District (CSJWCD, North San Joaquin Water Conservation District (NSJWCD), and South San Joaquin Groundwater Sustainability Agency (SSJ GSA).

7.9 GSP IMPLEMENTATION FUNDING

Implementation of the GSP is projected to cost between $600,000 and $1 million per year excluding projects and management actions costs. Additional one-time costs are estimated to be on the order of $350,000. Development of the 2020 GSP was funded through a Proposition 1 Sustainable Groundwater Planning Grant. To the degree they become available, outside grants will be sought to assist in reducing the cost of implementation to participating agencies, residents, and landowners of the Subbasin. However, there will be a need to establish long-term funding mechanisms to support the implementation of the GSP and future SGMA compliance. At the April 10, 2019 ESJGWA Board Meeting, the Board approved an action to conduct monitoring, measuring, and modeling at the basin-scale subject to a financing plan that will be developed after the GSP is approved. Costs for GSP project implementation will be met by project proponents. Also at the April 10, 2019 ESJGWA Board Meeting, the Board took an action to approve development and implementation of projects in the GSP Implementation Plan at the GSA level, with the option for GSAs with projects in the GSP to work with additional parties in the development of their projects. Financing implementation of the 2024 Amendment GSP, including the projects and management actions it contains, is expected to be similar to that of the 2020 GSP and 2022 Revised GSP implementation.

Costs of overall GSP administration are expected to be shared by the GSAs. Financing options under consideration could include pumping fees, assessments, loans, and grants. Individual GSAs will create their own financing plans to address their portion of the cost share according to the ESJGWA. Table 7-4 lists examples of potential financing options.

Prior to implementing any fee or assessment program, the GSAs would complete a rate assessment study or other analysis if required by the regulatory requirements.

Table 7-4: Potential Funding Sources for GSP Implementation

Funding Source	Certainty
Ratepayers (within Project Proponent service area or area of project benefit)	**High –** User rates pay for operation and maintenance (O&M) of a utility's system. Depends upon rate structure adopted by the project proponent and, if applicable, the Proposition 218 rate approval process. Can be used for project implementation as well as project O&M.
General Funds or Capital Improvement Funds (of Project Proponents)	**High –** General or capital improvement funds are set aside by agencies to fund general operations and construction of facility improvements. Depends upon agency approval.
Special taxes, assessments, and user fees (within Project Proponent service area or area of project benefit)	**High** - Monthly user fees, special taxes, and assessments can be assessed by some agencies should new facilities directly benefit existing customers. Depends upon the rate structure adopted by the project proponent and, if applicable, the Proposition 218 rate approval process.
Clean Water State Revolving Fund (CWSRF) Loan Program administered by the California State Water Resources Control Board (SWRCB)	**Medium –** Historically, the SWRCB has had $200 to $300 million available annually for low-interest loans (typically ½ of the General Obligation Bond Rate) for water recycling, wastewater treatment, and sewer collection projects. During recent years, available funding has become limited due to high demand. Success in securing a low-interest loan depends on demand of the CWSRF Program and available funding. Applications are accepted on a continuous basis. SWRCB prepares a fundable list for each fiscal year. In order to receive funding, a project must be on the fundable list. Full applications must be submitted by the end of the calendar year to be considered for inclusion on the following year's fundable list.

Funding Source	Certainty
Water Recycling Funding Program (WRFP) – Planning and Construction Grants from SWRCB	**High** (planning) / **Low** (construction) **–** WRFP grants are funded by Proposition 1, as well as the general CWSRF Program. Planning grants (for facilities planning) are available and can fund 50% of eligible costs, up to $75,000. Construction grants have been exhausted. Low-interest loans through the CWSRF program are available and while limited, recycled water projects receive priority over wastewater projects (which are also eligible under CWSRF, the umbrella program for the WRFP).
Drinking Water State Revolving Fund Loan Program administered by the SWRCB Division of Drinking Water	**High –** Approximately $100 to $200 million is available on an annual basis for drinking water projects. Low-interest loans are available for project proponents should they decide to seek financing. Funding has become more limited; however, applicants are encouraged to apply.
Infrastructure State Revolving Fund Loan Program administered by the California Infrastructure and Economic Development Bank (I-Bank)	**High –** Low-interest loans are available from I-Bank for infrastructure projects (such as water distribution). Maximum loan amount is $25 million per applicant. Applications are accepted on a continuous basis.
Title XVI Water Recycling and Reclamation / Water Infrastructure Improvements for the Nation (WIIN) Program – Construction Grants administered by the United States Bureau of Reclamation (USBR)	**Medium –** Grants up to 25% of project costs or $20 million, whichever is less, are available from USBR for water recycling projects. A Title XVI Feasibility Study must be submitted to and approved by USBR to be eligible. USBR solicits grants annually.
WaterSMART Title XVI Water Recycling and Reclamation Program – Feasibility Study Grants administered by USBR	**Low –** Grants up to $150,000 have been available in the past for preparation of Title XVI Feasibility Studies. It is possible future rounds may be administered.
Bonds	**Medium –** Revenue bonds can be issued to pay for capital costs of projects allowing for repayment of debt service over a 20- to 30-year timeframe. Depends on the bond market and the existing debt of project proponents.
Integrated Regional Water Management (IRWM) implementation grants administered by the California Department of Water Resources (DWR)	**Low –** The Westside-San Joaquin IRWM Region and the Eastern San Joaquin IRWM region have pursued and been awarded funding through the Proposition 1 IRWM Implementation Grants. The Westside-San Joaquin IRWM Region bridges two funding areas: The San Joaquin River Funding Area and the Tulare-Kern Funding Area; the Eastern San Joaquin IRWM Region falls within the San Joaquin River Funding Area. Proposition 1, passed in 2014, was the last year IRWM funding has been made available; it is unclear at this point if future IRWM funds will be made available through a bond measure.

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ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

2024 Groundwater Sustainability Plan Amendment: References

Prepared by:

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

November 2024

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APPENDIX 1-A. EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY JPA AGREEMENT AND BYLAWS

ATTACHMENT 2
A-17-83
4/11/2017

JOINT EXERCISE OF POWERS AGREEMENT

ESTABLISHING THE EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

THIS AGREEMENT is entered into and effective this 8th day of February, 2017 (**"Effective Date"**), pursuant to the Joint Exercise of Powers Act, Cal. Government Code §§ 6500 *et seq.* (**"JPA Act"**) by and among the entities that are signatories to this Agreement.

RECITALS

A. On August 29, 2014, the California Legislature passed comprehensive groundwater legislation contained in SB 1168, SB 1319 and AB 1739. Collectively, those bills, as subsequently amended, enacted the "Sustainable Groundwater Management Act". Governor Brown signed the legislation on September 16, 2014 and it became effective on January 1, 2015.

B. Each of the Members overlie the San Joaquin Valley Groundwater Basin, Eastern San Joaquin Subbasin, California Department of Water Resources Basin No. 5-22.01 as its boundaries may be modified from time to time in accordance with Cal. Water Code Section 10722.2.

C. Each of the Members is either (i) a Groundwater Sustainability Agency (**"GSA"**) duly established in accordance with SGMA, or (ii) a "local agency" as defined in Water Code Section 10721(n) that intends to become a GSA established on or before June 30, 2017.

D. The Members desire, through this Agreement, to form a public entity to be known as the Eastern San Joaquin Groundwater Authority (**"Authority"**) for the purpose of coordinating the various GSAs' management of the Basin, in accordance with SGMA. The boundaries of the Authority are depicted on the map attached hereto as **Exhibit A**.

E. The mission of the Authority is to provide a dynamic, cost-effective, flexible and collegial organization to insure initial and ongoing SGMA compliance within the Basin.

F. The Members agree that the Authority itself is not initially intended to be a GSA but the Members may elect GSA status for the Authority in their discretion at a future time as further provided herein.

THEREFORE, in consideration of the mutual promises, covenants and conditions herein set forth, the Members agree as follows:

ARTICLE 1: DEFINITIONS

1.1 **Definitions.** As used in this Agreement, unless the context requires otherwise, the meaning of the terms hereinafter set forth shall be as follows:

a. **"Agreement"** shall mean this Joint Exercise of Powers Agreement Establishing the Eastern San Joaquin Groundwater Authority.

b. **"Authority"** shall mean the Eastern San Joaquin Groundwater Authority formed by this Agreement.

c. **"Basin"** shall mean the San Joaquin Valley Groundwater Basin, Eastern San Joaquin Subbasin, California Department of Water Resources Basin No. 5-22.01 as its boundaries may be modified from time to time in accordance with Cal. Water Code Section 10722.2.

d. **"Board of Directors"** or **"Board"** shall mean the governing body formed to implement this Agreement as established herein.

e. **"Coordination Agreement"** shall mean a legal agreement adopted between two or more GSAs that provides the basis for intra-basin coordination of the GSPs of multiple GSAs within a basin pursuant to SGMA.

f. **"Dedicated Revenue Stream"** shall mean a revenue stream dedicated to Authority activities that has been adopted by a Member or Members in the form of an assessment or charge in accordance with applicable law.

g. **"DWR"** shall mean the California Department of Water Resources.

h. **"Effective Date"** shall be as set forth in the Preamble.

i. **"Groundwater Sustainability Agency"** or **"GSA"** shall mean an agency enabled by SGMA to regulate a portion of the Subbasin cooperatively with all other Groundwater Sustainability Agencies in the Basin, in compliance with the terms and provisions of SGMA.

j. **"Groundwater Sustainability Plan"** or **"GSP"** shall have the definition set forth in SGMA.

k. **"GSA Boundary"** shall mean those lands located within the Members' boundaries.

l. **"JPA Act"** shall mean the Joint Exercise of Powers Act, Cal. Government Code §§ 6500 *et seq.*

m. **"Management Area"** shall mean the area within the boundaries of a Member or group of Members to be managed by that Member or group of Members under any GSP adopted by the Authority.

n. **"Member"** shall mean any of the signatories to this Agreement and "Members" shall mean all of the signatories to this Agreement. Each of the Members shall be either (i) a GSA established on or before the Effective Date in accordance with SGMA, or (ii) a "local agency" as defined in Water Code Section 10721(n) that intends to become a GSA established on or before June 30, 2017.

o. **"Other Basin Agencies"** shall mean all other governmental agencies whose jurisdictions include the land overlying the Basin or whose jurisdictions include some governmental authority over the Basin who are not Members.

p. **"SGMA"** shall mean the Sustainable Groundwater Management Act of 2014 and all regulations adopted under the legislation (SB 1168, SB 1319 and AB 1739) that collectively comprise the Act, as that legislation and those regulations may be amended from time to time.

ARTICLE 2: KEY PRINCIPLES

2.1 The Members intend to work together in mutual cooperation to develop a GSP in compliance with SGMA, for the sustainable management of groundwater for that portion of the Basin underlying the Members of the Authority.

2.2 The Members intend to mutually cooperate to the extent possible to jointly implement the GSP within the Basin.

2.3 To the extent the Members are not successful at jointly implementing the GSP within the Basin, or to the extent that any Member wishes to implement the GSP within its boundaries, the Authority intends to allow any individual Member to implement the GSP within its boundaries, and to work together with all Members to coordinate such implementation in accordance with the requirements of SGMA.

2.4 The Members intend that the Authority will represent the Members in discussions with Other Basin Agencies, and shall enter into Coordination Agreements with those that form GSAs as required by SGMA to achieve an integrated, comprehensive Basin-wide GSP that satisfies SGMA as to sustainable groundwater management for the entire Basin.

2.5 Each Member will retain the right to determine, in its sole discretion, whether to (i) become a GSA, or (ii) join in a GSA that is a Member of the Authority. However, if a Member fails to take action, on or before June 30, 2017, to (i) become a GSA, or (ii) join in a GSA that is a Member of the Authority, that Member shall be terminated from participation in the Authority and this Agreement in accordance with Article 6.3.

2.6 The Members expressly intend that the Authority will not have the authority to limit or interfere with the respective Member's rights and authorities over their own internal matters, including, but not limited to, a Member's legal rights to surface water supplies and assets, groundwater supplies and assets, facilities, operations, water management and water supply matters. The Members make no commitments by entering into this Agreement to share or otherwise contribute their water supply assets as part of the development or implementation of a GSP.

2.7 Nothing in this Agreement is intended to modify or limit Members' police powers, land use authorities, or any other authority.

2.8 The Members further intend through this Agreement to cooperate to obtain consulting, administrative and management services needed to efficiently develop a GSP, to conduct outreach to Other Basin Agencies and private parties, and to identify mechanisms for the management and funding commitments reasonably anticipated to be necessary for the purposes of this Agreement.

2.9 The Members acknowledge and agree that SGMA is new and complex legislation, with implementing regulations continuing to be developed by DWR. While this Agreement reflects the Members' initial approach to SGMA compliance, a great deal of data needed for implementation is unknown, necessary models are still in development, the Members may have changes in political boundaries or gain experience in the application of SGMA or discover other considerations that may affect the decision of a Member on how to best comply with SGMA within its own and its Management Area boundaries. DWR has acknowledged the need for entities to change their decisions about participating in or becoming a GSA, and it is the intent of the Members to support flexibility in admitting additional Members, accommodating voluntary withdrawals, coordinating with other multi-agency or individual GSAs, changing the form of their organizational documents, for example, or creating an independent agency through a Joint Powers Agreement, and making other types of adjustments required by the Members to achieve efficient compliance with SGMA, consistent with the schedule and requirements of SGMA for coordination throughout the Basin and the provisions of this Agreement.

2.10 Each Member acknowledges that SGMA requires that multiple GSAs within a Bulletin 118 groundwater basin designated as high- or medium-priority must coordinate, and are required to use the same data and consistent methodologies for certain required technical assumptions when developing a GSP, and that the entire subbasin must be managed under one or more GSPs or an alternative in lieu of a GSP for the basin to be deemed in compliance with SGMA.

ARTICLE 3: FORMATION, PURPOSE AND POWERS

3.1 **Recitals:** The foregoing recitals are incorporated by reference.

3.2 **Certification.** Each Member certifies and declares that it is a public agency (as defined in Government Code Section 6500 *et seq.*) that is authorized to be a party to a joint exercise of powers agreement and to contract with each other for the joint exercise of any common power under Article I, Chapter 5, Division 7, Title I of the Government Code, commencing with Section 6500.

3.3 **Formation of Authority.** Pursuant to the JPA Act, the Members hereby form and establish a public entity to be known as the Eastern San Joaquin Groundwater Authority which will function in accordance with this Agreement. The Authority will be a public entity separate from the Members to this Agreement. The Authority shall comply with all provisions of the JPA Act and shall be responsible for administration of this Agreement.

3.4 **Purpose of the Authority.** The purposes of this Authority are to:

a. provide for coordination among the Members to develop and implement a GSP and/or facilitate a coordination agreement, to the extent necessary;

b. provide for the joint exercise of powers common to each of the Members and powers granted pursuant to SGMA (subject to the restrictions contained in this Agreement);

c. cooperatively carry out the purposes of SGMA;

d. develop, adopt and implement a legally sufficient GSP covering those portions of the Basin that are within the jurisdictional boundaries of the Members, subject to the limitations set forth in this Agreement; and

e. satisfy the requirements of SGMA for coordination among GSAs.

3.5 **Powers of the Authority.** To the extent authorized by the Members through the Board of Directors, and subject to the limitations set forth in this Agreement and the limitations of all applicable laws, the Authority shall have and may exercise any and all powers commonly held by the Members in pursuit of the Authority's purpose, as described in Article 3.4 of this Agreement, including but not limited to the power:

a. To coordinate the implementation of SGMA among the Members in accordance with this Agreement;

b. To coordinate the exercise of common powers of its Members including, without limitation, powers conferred to the Members by SGMA;

c. To adopt rules, regulations, policies, bylaws and procedures related to the coordination of the Members for purposes of implementation of SGMA;

d. To perform all acts necessary or proper to carry out fully the purposes of this Agreement; and to exercise all other powers necessary and incidental to the implementation of the powers set forth herein; and

e. To borrow funds so long as a Dedicated Revenue Stream is committed by one or more Members for repayment.

3.6 **Powers Reserved to Members**. Notwithstanding anything to the contrary in this Agreement, the Authority shall not undertake any activities within the geographic or service area boundaries of any of its Members pursuant to the GSP developed or adopted hereunder (including, without limitation, the restriction or regulation of groundwater extractions), unless the Member has formally and expressly consented and agreed in writing to the activity proposed pursuant to a special project agreement between the Member and the Authority in accordance with Article 7 of this Agreement. Without limiting the generality of the previous sentence, each of the Members (or groups of Members) will have the sole and absolute right, in its or their sole discretion, to:

a. Become a GSA individually or collectively within the Member's boundaries or the Management Area managed in whole or in part by such Member;

b. Approve any portion, section or chapter of the GSP adopted by the Authority as applicable within the Member's boundaries or the Management Area managed in whole or in part by such Member or GSA of which it is a part;

c. At each individual Member's election, acting through GSAs established by Members, implement SGMA and the GSP adopted by the Authority within the Member's boundaries or the Management Area managed in whole or in part by such Member; provided that any Member may elect, in its sole discretion, to authorize the Authority to implement SGMA and the GSP or to implement any discrete element or elements of SGMA or the GSP within the Member's boundaries. In the event that a Member elects to authorize the Authority to implement SGMA and the GSP or to implement any discrete element or elements of SGMA or the GSP within the Member's boundaries, such Member and the Authority shall enter into a special project agreement in accordance with Article 7 of this Agreement; and

d. Exercise the powers, without limitation, conferred to a GSA by SGMA.

3.7 **Term.** This Agreement shall be effective as of the Effective Date and shall remain in effect until terminated in accordance with Article 6.5 of this Agreement.

3.8 **Boundaries of the Authority.** The geographic boundaries of the Authority and that portion of the Basin that will be managed by the Authority pursuant to SGMA are depicted in **EXHIBIT A**.

3.9 **Role of Member Agencies.** Each Member agrees to undertake such additional proceedings or actions as may be necessary in order to carry out the terms and intent of this Agreement. The support of each Member is required for the success of the Authority. This support will involve the following types of actions:

a. The Members will provide support to the Board of Directors and any third party facilitating the development of the GSP by making available staff time, information and facilities within available resources.

b. Policy support shall be provided by the Members to either approve, or respond quickly to, any recommendations made as to funding shares, operational decisions, fare structures, and other policy areas.

c. Each Member shall contribute its share of capital and operational fund allocations, as established by the Board of Directors in the annual budget, as approved by the Board of Directors.

d. Contributions of public funds and of personnel, services, equipment or property may be made to the Authority by any Member for any of the purposes of this Agreement provided that no repayment will be made for such contributions.

3.10 **Other Officers and Employees.** The Members do not anticipate that the Authority will have any employees. However, the Authority may do the following:

a. Provide that any employee of a Member, with the express approval of that Member, may be an *ex officio* employee of the Authority, and shall perform, unless otherwise provided by the Board, the same various duties for the Authority as for his or her other employer in order to carry out this Agreement.

b. The Board shall have the power to employ competent registered civil engineers and other consultants to investigate and to carefully devise a plan or plans to carry out and fulfill the objects and purposes of SGMA, and complete a GSP.

ARTICLE 4: GOVERNANCE

4.1 **Board of Directors.** The business of the Authority will be conducted by a Board of Directors that is hereby established and that shall be initially composed of one primary representative appointed by each Member; provided, however, that in the event multiple entities establish a single GSA pursuant to a separate agreement, the GSA so established will thereafter have one representative on the Board of Directors and the vote of the GSA will be exercised in accordance with the separate agreement. Without amending this Agreement, the composition of the Board of Directors shall be altered from time to time to reflect the withdrawal of any Member, the admission of a Member or the establishment of a GSA comprised of multiple Members. Members of the Board of Directors are not required to be members of the governing board of the appointing Member; however, it is the strong preference of the Members that members of the Board of Directors be members of the governing board of the appointing Member. Each Member may designate one alternate to serve in the absence of that Member's primary representative on the Board of Directors. Such alternate need not be a member of the governing board of the Member. All primary members of the Board of Directors and all alternates shall file a Statement of Economic Interests (FPPC Form 700). Each Member shall notify the Authority in writing of its designated primary and alternate representatives on the Board of Directors.

4.2 **Term of Directors.** Each member of the Authority Board of Directors will serve until replaced by the appointing Member.

4.3 **Officers.** The Board of Directors shall elect a chairperson and a vice chairperson. The chairperson and vice-chairperson shall be directors of the Board. The chairperson shall preside at all meetings of the Board and the vice-chairperson shall act as the chairperson in the absence of the chairperson elected by the Board. The San Joaquin County Public Works Director or designee shall be the secretary and shall prepare and maintain minutes of all meetings of the Board of Directors. The Treasurer of the County of San Joaquin shall have the duties and obligations of Treasurer of the Authority as set forth in Government Code Sections 6505, 6505.1 and 6505.5.

4.4 **Powers and Limitations.** All the powers and authority of the Authority shall be exercised by the Board, subject, however, to the rights reserved by the Members as set forth in this Agreement.

4.5 **Quorum.** A majority of the members of the Board of Directors will constitute a quorum.

4.6 **Voting.** Except as to actions identified in Article 4.7, the Board of Directors will conduct all business by majority vote. Each member of the Board of Directors will have one (1) vote. Prior to voting, the Members shall endeavor in good faith to reach consensus on the matters to be determined such that any subsequent vote shall be to confirm the consensus of the Members. If any Member strongly objects to a consensus-based decision prior to a vote being cast, the Members shall work in good faith to reasonably resolve such strong objection, and, if the same is not resolved collaboratively, then the matter will proceed to a vote for final resolution under this Section 4.6 or Section 4.7, below, as applicable.

4.7 **Supermajority Vote Requirement for Certain Actions.** The following actions will require a two-thirds (2/3) vote by the directors present:

a. Approval or modification or amendment of the Authority's annual budget;

b. Decisions related to the levying of taxes, assessments or property-related fees and charges;

c. Decisions related to the expenditure of funds by the Authority beyond expenditures approved in the Authority's annual budget;

d. Adoption of rules, regulations, policies, bylaws and procedures related to the function of the Authority;

e. Decisions related to the establishment of the Members' percentage obligations for payment of the Authority's operating and administrative costs as provided in Article 5.1;

f. Approval of any contracts over $250,000 or contracts for terms that exceed two (2) years;

g. Setting the amounts of any contributions or fees to be paid to the Authority by any Member;

h. Decisions regarding the acquisition by any means and the holding, use, sale, letting and disposal of real and personal property of every kind, including lands, water rights, structures, buildings, rights-of-way, easements, and privileges, and the construction, maintenance, alteration and operation of any and all works or improvements, within or outside the Authority, necessary or proper to carry out any of the purposes of the Authority;

i. Decisions related to the limitation or curtailment of groundwater pumping; and

j. Approval of a GSP.

4.8 **Meetings.** The Board shall provide for regular and special meetings in accordance with Chapter 9, Division 2, Title 5 of Government Code of the State of California (the "Ralph M. Brown Act" commencing at Section 54950), and any subsequent amendments of those provisions.

4.9 **By-Laws.** The Board may adopt by-laws to supplement this Agreement. In the event of conflict between this Agreement and the by-laws, the provisions of this Agreement shall govern.

4.10 **Administrator.** The Members hereby designate the County of San Joaquin to serve as administrator and secretary of, and keeper of records for, the Authority.

4.11 **Advisory Committees.** The Board of Directors may establish one or more advisory committees, technical committees or other committees for any purpose, including but not limited to the GSP purposes in Water Code Section 10727.8.

ARTICLE 5: FINANCIAL PROVISIONS

5.1 **Contributions and Expenses:** Members shall share in the general operating and administrative costs of operating the Authority in accordance with percentages determined by the Authority Board of Directors. Each Member will be assessed no more frequently than quarterly, beginning on July 1 of each year. Members shall pay assessments within ninety (90) days of receiving assessment notice from the secretary of the Authority. Each Member will be solely responsible for raising funds for payment of the Member's share of operating and administrative costs. The obligation of each Member to make payments under the terms and provision of this Agreement is an individual and several obligation and not a joint obligation with those of the other Members. Each Member shall be individually responsible for its own covenants, obligations, and liabilities under this Agreement. No Member shall be under the control of or shall be deemed to control any other Member. No Member shall be precluded from independently pursuing any of the activities contemplated in this Agreement. No Member shall be the agent or have the right or power to bind any other Member without such Member's express written consent, except as expressly provided in this Agreement. Contributions of grant funding, state, federal, or county funding may be provided as funding or a portion of funding on behalf of Members.

5.2 **Initial Contributions.** Upon execution of this Agreement, each of the Members shall contribute Five Thousand Dollars ($5,000.00) to the Authority for initial administrative costs. Such funds may be used in the discretion of the Authority Board of Directors to fund the activities of the Authority including, without limitation, engineering services. The Authority shall provide to the Members quarterly reports detailing how the Initial Contributions are spent.

5.3 **Liability of Board and Officers.** The funds of the Authority may be used to defend, indemnify and hold harmless the Authority, any Director, officer, employee, or agent for actions taken within the scope of the authority of the Authority. Nothing herein shall limit the right of the Authority to purchase insurance including but not limited to directors and officers liability insurance.

5.4 **Repayment of Funds.** No refund or repayment of the initial commitment of funds specified in Article 5.2 will be made to a Member ceasing to be a Member of this Agreement whether pursuant to removal by the Board of Directors or pursuant to a voluntary withdrawal. The refund or repayment of any other contribution shall be made in accordance with the terms and conditions upon which the contribution was made, the terms and conditions of this Agreement or other agreement of the Authority and withdrawing Member.

5.5 **Budget.** The Authority's fiscal year shall run from July 1 through June 30. Each fiscal year, the Board shall adopt a budget for the Authority for the ensuing fiscal year. Within ninety (90) days of the Effective Date of this Agreement, the Board shall adopt a budget. Thereafter, a budget shall be adopted no later than June 30 of the preceding fiscal year. The budget shall be adopted in accordance with Section 4.7 of this Agreement.

5.6 **Alternate Funding Sources.** The Board may obtain State of California or federal grants but shall not create indebtedness without securing a Dedicated Revenue Stream.

5.7 **Depositary.** The Treasurer of the County of San Joaquin shall (i) be the depositary of the Authority, (ii) have custody of all funds of the Authority, and (iii) have the duties and obligations of the Treasurer as set forth in Government Code Sections 6505, 6505.1 and 6505.5. All funds of the Authority shall be held in separate accounts in the name of the Authority and shall not be commingled with funds of any Member or any other person or entity.

5.8 **Accounting.** Full books and accounts shall be maintained for the Authority in accordance with practices established by, or consistent with, those utilized by the Controller of the State of California for like public entities. The books and records of the Authority shall be open to inspection by the Members at all reasonable times, and by bondholders and lenders as and to the extent provided by resolution or indenture.

5.9 **Auditor.** The Auditor of the County of San Joaquin shall have the duties and obligations as Auditor of the Authority as set forth in Government Code Sections 6505 and 6505.5. The Auditor shall ensure strict accountability of all receipts and disbursements of the Authority and shall make arrangements with a qualified firm to perform an annual audit of the accounts and records of the Authority. Copies of such annual audit reports shall be filed with the State Controller and each Member within six months of the end of the fiscal year under examination.

5.10 **Expenditures.** All expenditures within the designations and limitations of the applicable approved budget shall be made upon the approval of any officer so authorized by the Authority Board of Directors. The Treasurer shall draw checks or warrants or make payments by other means for claims or disbursements not within an applicable budget only upon the approval and written order of the Board. The Board shall requisition the payment of funds only upon approval of claims or disbursements and requisition for payment in accordance with policies and procedures adopted by the Board.

5.11 **Initial Staffing Contributions.** The Authority initially intends to contribute to the goals and objectives identified in this Agreement by utilizing the staff of Members at the Members' own cost to pursue those operations, investigations and programs. It is intended that no indebtedness be created unless funding is secured by a Dedicated Revenue Stream.

ARTICLE 6: CHANGES TO MEMBERSHIP, WITHDRAWAL AND TERMINATION

6.1 **Changes to Membership.** The Authority Board of Directors will have the authority to (1) approve the addition of new members to the Authority, and (2) remove a Member involuntarily, in accordance with this Article. In the event of the approval of new Members or the involuntary removal of an existing Member, the Members (and any new Members) shall execute an addendum or amendment to this Agreement describing all changes in Members. In the event of the involuntary removal of a Member the removed Member shall remain fully responsible for its proportionate share of all liabilities incurred by the Authority prior to the effective date of the removal.

6.2 **Noncompliance.** In the event any Member (1) fails to comply with the terms of this Agreement, or (2) undertakes actions that conflict with or undermine the functioning of the Authority or the preparation or implementation of the GSP, such Member shall be subject to the provisions for involuntary removal of a Member set forth in of Section 6.3 of this Agreement. Such actions of a Member shall be as determined by the Board of Directors and may include, for example, failure to pay its agreed upon contributions when due; refusal to participate in GSA activities or to provide required monitoring of sustainability indicators; refusal to enforce controls as required by the GSP; refusal to implement any necessary actions as outlined by the approved GSP minimum thresholds that are likely to lead to "undesirable results" under SGMA.

6.3 **Involuntary Termination.** The Members acknowledge that SGMA requires that multiple GSAs within Bulletin 118 groundwater basins designated as high- or medium-priority must coordinate, and are required to use the same data and consistent methodologies for certain required technical assumptions when developing a GSP, and that the entire Basin must be managed under one or more GSPs or an alternative in lieu of a GSP for the Basin to be deemed in compliance with SGMA. As a result, upon the determination by the Board of Directors that the actions of a Member (1) fail to comply with the terms of this Agreement, or (2) conflict with or undermine the functioning of the Authority or the preparation and implementation of the requirements of the GSP, the Board of Directors may terminate that Member's membership in this Authority, provided that prior to any vote to remove a Member involuntarily, all of the Members shall meet and confer regarding all matters related to the proposed removal. The Board of Directors shall terminate the membership in the Authority of any Member that fails, on or before June 30, 2017, to (i) elect to become a GSA duly established in accordance with SGMA, or (ii) participate, through a joint exercise of powers agreement or other legal agreement, in a GSA duly established in accordance with SGMA.

6.4 **Withdrawal of Members.** A Member may, in its sole discretion, unilaterally withdraw from the Authority, effective upon ninety (90) days' prior written notice to the Authority, provided that (a) the withdrawing Member will remain responsible for its proportionate share of any obligation or liability duly incurred by the Authority, in accordance with Article 5.1. A withdrawing Member will not be responsible for any obligation or liability that the Member has voted against at a Board meeting, providing that such Member shall give notice of its withdrawal from the Authority as soon after voting against the proposal as is practicable. Without limiting the generality of the previous sentence, in the event that the Authority levies or adopts any tax, assessment or property-related fee or charge (collectively "Authority Charge") the Authority Charge will not be effective within the jurisdictional boundaries of a Member that votes against the Authority Charge and withdraws in accordance with this Article 6.4. In the event the withdrawing Member has any rights in any property or has incurred obligations to the Authority, the Member may not sell, lease or transfer such rights or be relieved of its obligations, except in accordance with a written agreement executed by it and the Authority. The Authority may not sell, lease, transfer or use any rights of a Member who has withdrawn without first obtaining the written consent of the withdrawing Member. Notwithstanding any other provision of this Agreement, if a Member fails to take action, on or before June 30, 2017, to (i) elect to become a GSA, or (ii) join in a GSA that is a member of the Authority, that Member shall withdraw from the Authority and this Agreement in accordance with this Article 6.4.

6.5 **Termination.** This Agreement and the Authority may be terminated by a majority vote of the Members. However, in the event of termination each of the Members will remain responsible for its proportionate share of any obligation or liability duly incurred by the Authority, in accordance with Article 5.1. Nothing in this Agreement will prevent the Members from withdrawing as provided in this Agreement, or from entering into other joint exercise of power agreements.

6.6 **Disposition of Property Upon Termination.** Upon termination of this Agreement, the assets of the Authority shall be transferred to the Authority's successor, provided that a public entity will succeed the Authority, or in the event that there is no successor public entity, to the Members in proportion to the contributions made by each Member. If the successor public entity will not assume all of the Authority's assets, the Board shall distribute the Authority's assets between the successor entity and the Members in proportion to the any obligation required by Articles 5.1 or 5.6.

6.7 **Rights of Member to Become GSA in Event of Withdrawal or Termination.** Upon withdrawal or involuntary termination of a Member, or termination of this Agreement pursuant to Article 6.5, whether occurring before or after June 30, 2017, the withdrawing or terminated Member will retain all rights and powers to become or otherwise participate in a GSA for the lands within its boundaries. In such event the Authority and its remaining Members (i) shall not object to or interfere with the lands in the withdrawing or terminated Member's boundaries being in a GSA, as designated by the withdrawing or terminated Member or otherwise, (ii) shall facilitate such transition to the extent reasonably necessary, and (iii) shall withdraw from managing that portion of the Basin within the boundaries of the withdrawing or terminating Member and so notify the California Department of Water Resources.

6.8 **Use of Data.** Upon withdrawal, any Member shall be entitled to use any data or other information developed by the Authority during its time as a Member. Further, should a Member withdraw from the Authority after completion of the GSP, it shall be entitled to utilize the GSP for future implementation of SGMA within its boundaries.

ARTICLE 7: SPECIAL PROJECTS

7.1 Fewer than all of the Members may enter into a special project agreement to achieve any of the purposes or activities authorized by this Agreement, and to share in the expenses and costs of such special project, for example, to share in funding infrastructure improvements within the boundaries of only those Members and their Management Areas. Special project agreements must be in writing and documentation must be provided to each of the Members to this Agreement.

7.2 Members that enter into special project agreements agree that any special project expenses incurred for each such special project are the costs of the special project participants, respectively, and not of any other Members to this Agreement not participating in the special project, and the special project expenses shall be paid by the parties to the respective special project agreements.

7.3 Members participating in special project agreements, if conducted by the Authority, shall hold each of the other parties to this Agreement who are not parties to the special project agreement free and harmless from and indemnify each of them against any and all costs, losses, damages, claims and liabilities arising from the special project agreement. The indemnification obligation of Members participating in special project agreements shall be the same as specified in Article 8.1 for Members in general, except that they shall be limited to liabilities incurred for the special project.

ARTICLE 8: MISCELLANEOUS PROVISIONS

8.1 **Indemnification.** The Authority shall hold harmless, defend and indemnify the Members, and their agents, officers and employees from and against any liability, claims, actions, costs, damages or losses of any kind, including death or injury to any person and/or damage to property arising out of the activities of the Authority, or its agents, officers and employees under this Agreement. These indemnification obligations shall continue beyond the Term of this Agreement as to any acts or omissions occurring before or under this Agreement or any extension of this Agreement.

8.2 **Amendments.** This Agreement may be amended from time to time by a unanimous vote of the Members.

8.3 **Binding on Successors.** Except as otherwise provided in this Agreement, the rights and duties of the Members may not be assigned or delegated without a unanimous vote by the Members. Any approved assignment or delegation shall be consistent with the terms of any contracts, resolutions, indemnities and other obligations of the Authority then in effect. This Agreement shall inure to the benefit of, and be binding upon, the successors and assigns of the Members hereto.

8.4 **Notice.** Any notice or instrument required to be given or delivered under this Agreement may be made by: (a) depositing the same in any United States Post Office, postage prepaid, and shall be deemed to have been received at the expiration of 72 hours after its deposit in the United States Post Office; (b) transmission by facsimile copy to the addressee; (c) transmission by electronic mail; or (d) personal delivery. On the signature page of this Agreement, each party shall provide contact information for the purpose of notification.

8.5 **Counterparts.** This Agreement may be executed by the Members in separate counterparts, each of which when so executed and delivered shall be an original. All such counterparts shall together constitute but one and the same instrument.

8.6 **Choice of Law.** This Agreement shall be governed by the laws of the State of California.

8.7 **Severability.** If one or more clauses, sentences, paragraphs or provisions of this Agreement is held to be unlawful, invalid or unenforceable, it is hereby agreed by the Members that the remainder of the Agreement shall not be affected thereby. Such clauses, sentences, paragraphs or provisions shall be deemed reformed so as to be lawful, valid and enforced to the maximum extent possible.

8.8 **Headings.** The paragraph headings used in this Agreement are intended for convenience only and shall not be used in interpreting this Agreement or in determining any of the rights or obligations of the Members to this Agreement.

8.9 **Construction and Interpretation.** This Agreement has been arrived at through negotiation and each Member has had a full and fair opportunity to revise the terms of this Agreement. As a result, the normal rule of construction that any ambiguities are to be resolved against the drafting Member shall not apply in the construction or interpretation of this Agreement.

8.10 **Entire Agreement.** This Agreement constitutes the entire agreement among the Members and supersedes all prior agreements and understandings, written or oral. This Agreement may only be amended by written instrument executed by all Members.

IN WITNESS WHEREOF, the parties hereto have caused Agreement to be executed on the day and year set opposite the name of the parties:

CHARLES WINN, Chair
Board of Supervisors
of the County of San Joaquin,
State of California

MIMI DUZENSKI
Clerk of the Board of Supervisors
of the County of San Joaquin,
State of California

By ______________________
Clerk

APPROVED AS TO FORM:

By ______________________
LAWRENCE P. MEYERS
Deputy County Counsel

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

CLERK

SOUTH DELTA WATER AGENCY

John Herrick, March 1, 2017

John Herrick, Counsel & Manager
Printed Name and Title

4255 Pacific Avenue Suite 2
Stockton, CA 95207
Address

jherrlaw@aol.com
E-Mail

Phone: (209) 956-0150

Fax: (209) 956-0154

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

[signature]
CLERK

Stockton East Water District
AGENCY LEGAL NAME

[signature] 3/7/17
By: Signature Date

Thomas McGurk
Printed Name

President
Title

P.O. Box #5157
Address

Stockton / CA / 95215
City/State/Zip

smoody@sewd.net
Email

(209) 948.0423
Fax

ATTEST:

Joseph Salzman

CLERK

Lockeford Community Services District

AGENCY LEGAL NAME

Gary Gordon 7 Mar. 2017

By: Signature **Date**

Gary Gordon

Printed Name

Lockeford CSD Board President

Title

17725 Tully Road

Address

Lockeford CA 95237

City/State/Zip

lcsd@softcom.net

Email

n/a

Fax

ATTACHMENT 2

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

[signature]

CLERK

CSJWCD

AGENCY LEGAL NAME

[signature] 3-9-17

By: Signature Date

Grant Thompson

Printed Name

President

Title

11 S. San Joaquin St. #306

Address

Stockton, CA 95202

City/State/Zip

Email

209-466-7953

Fax

ATTEST:

CLERK

OAKDALE IRRIGATION DISTRICT
AGENCY LEGAL NAME

By: Signature — Date 3/10/17

Steve Knell, P.E.
Printed Name

General Manager
Title

1205 East F Street
Address

Oakdale, CA 95361
City/State/Zip

srknell@oakdaleirrigation.com
Email

(209) 847-3468
Fax

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

CLERK Dante John Nomellini
Manager

CENTRAL DELTA WATER AGENCY
AGENCY LEGAL NAME

3-14-17

By: Signature Date

George Biagi Jr.
Printed Name

President
Title

P.O.Box 1461
Address

Stockton, CA95201
City/State/Zip

ngmplcs@pacbell.net
Email

209-465-3956
Fax

ATTACHMENT 2

ATTEST:

CLERK Teresa Vargas

City of Lathrop
AGENCY LEGAL NAME

By: Signature 3-16-17
Date

Stephen J. Salvatore
Printed Name

City Manager
Title

390 Towne Centre Drive
Address

Lathrop, CA 95330
City/State/Zip

ssalvatore@ci.lathrop.ca.us
Email

(209)941-7248
Fax

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

____
CLERK

WOODBRIDGE IRRIGATION DISTRICT GSA
AGENCY LEGAL NAME

[signature] 4-13-2017
By: Signature Date

ANDERS CHRISTENSEN
Printed Name

MANAGER
Title

18750 N. LOWER SACRAMENTO RD.
Address

WOODBRIDGE, CA. 95258
City/State/Zip

widirrigation@gmail.Com
Email

(209) 625-8663
Fax

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

Mona Walker
CLERK

Calaveras County Water District
AGENCY LEGAL NAME

By: Signature 4/18/17
Date

Jeff Davidson
Printed Name

Board President
Title

PO Box 846
Address

San Andreas, CA 95249
City/State/Zip

administration@ccwd.org
Email

(209)754-1069
Fax

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

JENNIFER M. FERRAIOLO
City Clerk

APPROVED AS TO FORM:

JANICE D. MAGDICH
City Attorney

CITY OF LODI, a municipal corporation

By: STEPHEN SCHWABAUER Date
City Manager

P.O. Box 3006
Lodi, California 95241
sschwabauer@lodi.gov
Fax: (209) 333-6807

ATTACHMENT 2

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

Barbara Kascht
BARBARA KASCHT
District Secretary

LINDEN COUNTY WATER DISTRICT

Clifford Powell
CLIFFORD POWELL, President
Board of Directors, Linden County Water District

April 20. 2017
Date

Linden County Water District
18243 Highway 26
P.O. Box 595
Linden, California 95236
rmblrmn@aol.com

APPROVED AS TO FORM:

[signature]
MIA S. BROWN
District Legal Counsel

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

CLERK/Secretary

North San Joaquin Water Conservation District
AGENCY LEGAL NAME

By: Signature Date

Joe Valente
Printed Name

President
Title

Address

City/State/Zip

Email

Fax

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

[signature]
CLERK

City of Manteca
AGENCY LEGAL NAME

[signature]
By: Signature Date

Stephen F. DeBrum
Printed Name

Mayor
Title

APPROVED AS TO FORM

By [signature]
JOHN BRINTON
City Attorney

1001 W. Center St., Ste.B
Address

Manteca, CA 95337
City/State/Zip

mayorcouncilclerk@ci.manteca.ca.us
Email

209-923-8960
Fax

Eastern San Joaquin Groundwater Authority JPA

South San Joaquin
Groundwater Sustainability Agency

ATTEST:

AGENCY LEGAL NAME

CLERK

By: Signature Date

Robert A. Holmes
President

Title

11011 E. Highway 120
Manteca CA 95336

rholmes@ssjid.com

Email

209-249-4652

Fax

Eastern San Joaquin Groundwater Authority JPA

ATTEST:

CLERK

CITY OF STOCKTON
AGENCY LEGAL NAME

By: Signature 10/4/17 Date

KURT WILSON
Printed Name Kurt O. Wilson

Title City Manager

425 N. El Dorado
Address

Stockton, CA 95204
City/State/Zip

Email

209-937-7149
Fax

APPROVED AS TO FORM AND CONTENT

By
City Attorney

ATTACHMENT 2

Eastern San Joaquin Groundwater Subbasin

SAN JOAQUIN COUNTY CALIFORNIA

Eastern San Joaquin Groundwater Subbasin

-- Easterm San Joaquin Groundwater Authority "Exhibit A" --

SAN JOAQUIN COUNTY

Department of Public Works, 1810 E. Hazelton Ave., Stockton, CA 95205

The County of San Joaquin does not warrant the accuracy, completeness, or suitability for any particular purpose.
The Information on this map is not intended to replace engineering, financial or primary records research.

Public Works San Joaquin County
Working for YOU

Date 3/07/17

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY BYLAWS

Adopted August 9, 2017

BYLAWS
OF
EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

ARTICLE I
NAME

This joint powers agency shall be known as the EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY ("Authority") and shall exercise its powers within the geographical area of the Eastern San Joaquin Subbasin as set forth in the joint powers agreement entered into by Calaveras County Water District on behalf of all the members of the Eastside San Joaquin Groundwater Sustainability Agency, Central Delta Water Agency, Central San Joaquin Water Conservation District, City of Lathrop, City of Lodi, City of Manteca, City of Stockton, Linden County Water District, Lockeford Community Services District, North San Joaquin Water Conservation District, Oakdale Irrigation District, San Joaquin County, South Delta Water Agency, South San Joaquin Groundwater Sustainability Agency, Stockton East Water District, and Woodbridge Irrigation District GSA ("Member" or collectively "Members") establishing Authority.

ARTICLE II
PURPOSE

The purposes of Authority as set forth in the joint powers agreement are for the following reasons:

A. Provide for coordination among the Members to develop and implement a Groundwater Sustainability Plan (GSP) and/or facilitate a coordination agreement, to the extent necessary;

B. Provide for the joint exercise of powers common to each of the Members and powers granted to members by the Sustainable Groundwater Management Act (SGMA) (subject to the restrictions contained in the joint powers agreement);

C. Cooperatively carry out the purposes of SGMA;

D. Develop, adopt and implement a legally sufficient GSP covering those portions of the Basin that are within the jurisdictional boundaries of the Members, subject to the limitations set forth in the joint powers agreement; and

E. Satisfy the requirements of SGMA for coordination among Groundwater Sustainability Agencies (GSAs).

F. Allocation of Resources. The Members share common mission and issues, and at the same time, have different needs and priorities and are affected in different ways by these issues. The resources of Authority should be allocated in a manner so that the needs of any portion of the area within the jurisdictional boundaries of the Authority are not ignored, recognizing, however, that resources are limited and that not all needs can be met, nor all portions of the area assisted equally at any one time.

ARTICLE III
MEMBERSHIP

Section 1. Board. Authority shall be governed by a Board of Directors, herein referred to as the "Authority Board" or "Board", which shall be comprised of:

A. One (1) member appointed from each of the Members. Members of the Board of Directors are not required to be members of the governing board of the appointing Member; however, it is the strong preference that members of the Board of Directors be members of the governing board of the appointing party.

B. In the event Members establish a separate or additional GSA pursuant to a separate agreement with any Member or other entity, the GSA so established will thereafter have one representative on the Board of Directors and the vote of the GSA member will be exercised in accordance with the separate agreement (*e.g., Memorandum of Agreement*).

Section 2. Appointment. Members shall be appointed by the governing body of each Member, or in the event any Member establishes a single GSA with another Member or other entity, pursuant to the separate agreement, and shall serve at the pleasure of their appointing body or bodies or until their respective successors are appointed. If a Member of the Board of Directors is a member of the governing body of the appointing member, termination of that member's mayor, councilperson, supervisor, director or trustee status shall constitute automatic termination of that person's membership on the Authority Board. The appointing body of a Member may appoint a new member or alternate immediately upon any vacancy in the Member's representation.

Section 3. Alternates. The governing body of each Member, or in the event any Member establishes a single GSA with another Member or other entity, pursuant to the separate agreement, shall appoint an alternate member to the Authority Board. The alternate need not be a member of the governing board of the appointing member. During the absence of a regular member from any meeting of the Authority Board, the alternate shall be entitled to participate in all respects as a regular member of the Authority Board.

ARTICLE IV
OFFICERS

Section 1. Elected Officers.

The elected officers shall be chosen by the Board from the members of the Board and shall consist of a Chair and a Vice-Chair.

Section 2. Terms of Elected Officers.

Elected officers of the Board shall be elected by the Board at the June meeting and shall serve for a two (2) year term, said term to commence upon election.

Section 3. Duties of Elected Officers.

A. Chair.

1. The Chair shall preside at all meetings of the Board and such other meetings approved by the Board.

2. The Chair shall serve as official spokesperson for the Board.

3. The Chair shall appoint such committees and other working groups as prescribed by the Board.

4. The Chair shall designate Directors or others to represent the Board at various meetings, hearings, and conferences.

5. The Chair shall perform such other duties as necessary to carry out the work of the Board.

6. The Chair shall perform such duties as prescribed by law.

B. Vice-Chair.

1. The Vice-Chair shall serve in the absence of the Chair.

C. Absences.

1. In the absence of both the Chair and Vice-Chair, a majority of the Board shall select a Director to serve as Chair Pro Tem.

ARTICLE V
MEETINGS

Section 1. Regular and Special Meetings.

A. The Authority Board shall hold a regular meeting on the second Wednesday of each month, at 9:30 a.m., or at a time, specified by the Authority Board. The Authority's Board may designate the location of such regular meetings in a duly adopted Resolution of the Authority Board. Such regular meetings shall be for considering reports of the affairs of Authority and for transacting such other business as may be properly brought before the meeting. Any regular meeting may be rescheduled on an individual basis as to date, time and place, by motion of the Authority Board or at the direction of the Authority Secretary, in the event of a conflict with holidays, Directors' schedules, or similar matters, or, in the event of a lack of a quorum, as specified below.

B. Special meetings may be called in accordance with the California Ralph M. Brown Act. Special meetings may be called by the Chair, or by any nine Directors.

C. All meetings shall be conducted in accordance with the Ralph M. Brown Act.

Section 2. <u>Closed Sessions</u>.

A. All information presented in closed session shall be confidential.

B. Under Government Code section 54956.96, Authority adopts a joint powers agency limited disclosure policy as follows:

1. All information received by the legislative body of the local agency member in a closed session related to the information presented to Authority in closed session shall be confidential. However, a member of the legislative body of a member local agency may disclose information obtained in a closed session that has direct financial or liability implications for that local agency to the following individuals:

(a). Legal counsel of that member local agency for purposes of obtaining advice on whether the matter has directed financial or liability implications for that member local agency.

(b). Other members of the legislative body of the local agency present in a closed session of that member local agency.

2. Any designated alternate member of the legislative body of the Authority who is also a member of the legislative body of a local agency member and who is attending a properly noticed meeting of the joint powers agency in lieu of a local agency member's regularly appointed member may attend closed sessions of Authority.

Section 3. <u>Quorum</u>.

A. A quorum for conducting all matters of business shall be a majority of the Members.

Section 4. <u>Voting</u>.

A. Voting shall only be conducted at properly noticed meeting where a quorum has been established and members are physically present, except as provided in Government Code section 54953 for teleconferencing.

B. Voting shall be by voice, show of hands, or roll call vote. Any Director may request a roll call vote.

C. In all cases, a vote to "abstain" shall be counted as an "aye" vote unless there is a majority vote to defeat the motion and then the vote to abstain shall be counted as a "no" vote.

D. Supermajority Vote Requirement for Certain Actions. The following actions will require two-thirds (2/3) vote by the directors present:

1. Approval or modification or amendment of the Authority's annual budget;

2. Decision related to the levying of taxes, assessments or property-related fees and charges;

3. Decisions related to the expenditure of funds by the Authority beyond expenditures approved in the Authority's annual budget;

4. Adoption of rules, regulations, policies, bylaws and procedures related to the function of the Authority;

5. Decisions related to the establishment of the Members' percentage obligations for payment of the Authority's operating and administrative costs as provided in Article 5.1 of the joint powers agreement;

6. Approval of any contracts over $250,000 or contracts for terms that exceed two (2) years;

7. Setting the amounts of any contributions or fees to be paid to the Authority by any Member;

8. Decisions regarding the acquisition by any means and the holding, use, sale, letting and disposal of real and personal property of every kind, including lands, water rights, structures, buildings, rights-of-way, easements, and privileges, and the construction, maintenance, alteration and operation of any and all works or improvements, within or outside the Authority, necessary or proper to carry out any of the purposes of the Authority;

9. Decisions related to the limitation or curtailment of groundwater pumping; and

10. Approval of a GSP.

Section 5. Notice of Regular and Special Meetings.

A. Notices of regular meetings shall be sent in writing to each Director at the Director's address at least seventy-two (72) hours prior to such meetings. Directors may choose to receive notices of regular meetings electronically and such electronic notices shall also be sent at least seventy-two (72) hours prior to such meetings. Such notices shall specify the place, the day, and the hour of the meeting and accompanying the notice shall be a copy of the agenda for that meeting.

B. In the case of special meetings, the written or electronic notice shall specify the specific nature of the business to be transacted.

Section 6. Lack of Quorum.

A. If less than a quorum of the Directors are present at any properly called regular, adjourned regular, special, or adjourned special meeting, the member(s) who are present may adjourn the meeting to a time and place specified in the order of adjournment. A copy of the order or notice of adjournment shall be conspicuously posted on or near the door of the place where the meeting was to have been held within 24 hours after adjournment.

B. If all the members are absent from any regular or adjourned regular meeting, the Administrator of the Authority may so adjourn the meeting and post the order or notice of adjournment as provided, and additionally shall cause a written notice of the adjournment to be given in the same manner as for a notice of a special meeting.

C. If the notice or order of adjournment fails to state the hour at which the adjourned meeting is to be held, it shall be held at the hour specified for the regular meeting of Authority.

Section 7. Agenda.

Any Director or the Administrator may cause an item to be placed on the agenda.

Section 8. Adjournment.

Except as provided in Section 6 above, a meeting may be adjourned by the presiding officer's own action; however, any Director may object to such adjournment by the presiding officer and then a motion and action is required in order to adjourn the meeting in accordance with Rosenberg's Rules of Order.

Section 9. Decorum.

All Directors, and staff, shall conduct themselves in accordance with Rosenberg's Rules of Order and in a civil and polite manner toward other board members, employees, and the public. Using derogatory names, interrupting the speaker having the floor, or being disorderly or disruptive, are prohibited actions. If any meeting is willfully interrupted by any individual so as to render the orderly conduct of that meeting infeasible, that individual may be removed from the meeting. If any group or groups of persons willfully interrupts a meeting so as to render the orderly conduct of that meeting infeasible, the presiding officer, or a majority of the Board, may clear the meeting room in accordance with Government Code section 54957.9.

ARTICLE VI
COMMITTEES

Section 1. Advisory Committee.

A. The Board may establish an Advisory Committee which contains no more than 8 representatives from the Board of the Authority.

B. The members of the Advisory Committee shall elect one (1) of their members to serve as Chairperson.

C. A majority of the Advisory Committee members attending a meeting of the Committee, given notice in writing not less than 72 hours in advance, shall constitute a quorum for discussion and action delegated to the Committee.

D. The Advisory Committee shall conduct the preliminary review of all Federal and State mandates. In conducting such reviews, the Advisory Committee will draw upon the expertise and assistance of any persons, committees, groups, or agencies it deems appropriate.

E. The Advisory Committee shall ensure maximum inter-agency coordination and consistence with adopted comprehensive plans.

F. The Advisory Committee shall carry out any duties as assigned by the Authority Board.

Section 2. Other Committees.

The Authority Board may appoint other committees as necessary. The Chair may appoint ad hoc committees.

ARTICLE VII
REFERRALS

The San Joaquin County may accept by letter or resolution referrals for study and report from any duly constituted advisory or legislative body or their representatives. Reports will be made and returned to the referring body within a reasonable time.

ARTICLE VIII
PARLIAMENTARY AUTHORITY

Rosenberg's Rules of Order, current edition or such other authority as may be subsequently adopted by resolution of the Board is to apply to all questions of procedure and parliamentary law not specified in these Bylaws or otherwise by law.

ARTICLE IX
MISCELLANEOUS

In the case of any inconsistency between the provision of these Bylaws and the Joint Powers Agreement creating the Authority, the provisions of the Joint Powers Agreement shall govern and control. Any capitalized term used in these Bylaws and not defined herein shall have the same meaning as used in the Joint Powers Agreement.

ARTICLE X
AMENDMENTS

The Bylaws may be repealed or amended, or new Bylaws may be proposed, by the affirmative vote of two-thirds of the Board of Directors present on a resolution presented at any regular meeting of the Board, provided notice of such proposal shall have been electronically mailed to each Director at least five (5) calendar days prior to the meeting at which the matter is to be acted upon.

APPENDIX 1-B.
LEGAL AUTHORITY OF EASTERN SAN JOAQUIN GSAS

Central Delta Water Agency – The Central Delta Water Agency (CDWA) was formed by act of the California Legislature (Stats.1973, c. 1133). Among the general purposes is to assure the lands within the agency a dependable supply of water of suitable quality sufficient to meet present and future needs. A portion of the area within the Central Delta Water Agency overlies the San Joaquin Valley Groundwater Basin, Eastern San Joaquin Subbasin DWR Basin No. 5-22.01. Although the CDWA area is primarily served with surface water there are a small number of wells serving mostly domestic use. The CDWA has elected to become a GSA for such area within the Subbasin excepting those portions overlapping the Woodbridge Irrigation District, the Stockton East Water District, the City of Stockton and those San Joaquin County areas intermixed within the City of Stockton. For this GSA area, CDWA has the additional powers and authorities provided in Chapter 5 of Part 2.74 of Division 6 of the California Water Code.

Central San Joaquin Water Conservation District – Central San Joaquin Water Conservation District is a California Water Conservation District formed under Division 21 of the California Water Code with all power and authority set forth therein. CSJWCD has elected to become a GSA as to all the area within its boundary and has all power and authority provided in Chapter 5 of Part 2.74 of Division 6 of the California Water Code.

City of Lodi – The City of Lodi (Lodi) is a California municipal corporation and a local agency as that term is defined by SGMA. As a local agency, Lodi elected to become a GSA for that portion of the Eastern San Joaquin Groundwater Subbasin which overlies the area bounded by the Lodi City limits. Notice of Lodi's GSA election was timely filed with DWR as required by SGMA. As a GSA, Lodi has the additional powers and authorities set forth in Chapter 5 of Part 2.74 of Division 6 of the California Water Code.

City of Manteca – The City of Manteca is an urban water supplier as defined in California Water Code Section 10617. The City of Manteca elected to become a GSA within city limits. As a GSA, the City of Manteca has additional powers and authorities provided in the California Water Code Division 6, Part 2.74, Chapter 5.

City of Stockton – The City of Stockton (City) is a municipal corporation organized under a Charter pursuant to Government Code section 34101. The City has the power to make and enforce all ordinances and regulations in respect to municipal affairs within its jurisdictional area, subject only to the restrictions of and limitations provided in its Charter, the Constitution of the State of California and of the United States.

The City is a local agency as defined by SGMA. The City has water rights, supply, management and land use responsibilities within the Eastern San Joaquin Subbasin (designated as basin number 5-22.01 in the California Department of Water Resources Bulletin 118 basin system) under Water Code section 10721(n). The City's jurisdiction overlies a portion of the Basin that has been designated as a high-priority basin, subject to critical conditions of overdraft which must be managed by a GSP pursuant to Water Code section 10720.7(a)(1) and all other applicable laws.

In addition, Water Code section 10723.6 authorizes a combination of local agencies to form a GSA. The City of Stockton acknowledged its intent to become a GSA and participate in the formation of the Eastern San Joaquin Groundwater Authority (Resolution No. 2015-12-08-1602); approved by the City Council on December 8, 2015.

Eastside GSA – The Eastside San Joaquin Groundwater Sustainability Agency is a multi-agency GSA and includes the County of Calaveras, the County of Stanislaus, Calaveras County Water District, and Rock Creek Water District and was formed by Memorandum of Understanding pursuant to Water Code section 10723.6(a). Separate from the powers conferred to each member agency by their respective enabling acts, the Eastside San Joaquin GSA has the additional powers and authorities provided to GSAs as specified in Part 2.74 of Division 6 of the California Water Code.

Linden County Water District – Linden County Water District (LCWD) is a County Water District established pursuant to and conferred with all powers provided by Division 12 of the California Water Code. LCWD is defined as a local agency within the meaning of the Groundwater Sustainability Management Act, and pursuant to same, has elected to become a GSA for its jurisdictional area.

Lockeford Community Services District – Lockeford Community Services District is a California community services district with all powers and authorities conferred by Government Code sections 61000 to 61250, including the power to supply water for beneficial uses. Lockeford has elected to become a GSA for its service area, and within that area, Lockeford has the additional powers and authorities provided in the California Water Code sections 10725 to 10726.9.

North San Joaquin Water Conservation District – North San Joaquin Water Conservation District is a California Water Conservation District with all powers and authorities conferred through Division 21 of the California Water Code. NSJWCD has elected to become a GSA as to the majority of its jurisdictional area (excluding the portions in the City of Lodi and Lockeford Community Services District). For this GSA area, NSJWCD has the additional powers and authorities provided in Chapter 5 of Part 2.74 of Division 6 of the California Water Code.

San Joaquin County #1 and #2 – The County of San Joaquin (County) is a local public agency as defined under SGMA (Water Code section 10720 et seq.) and is authorized to serve as a GSA and implement the provisions of SGMA. The County elected to become a GSA for those portions within the Eastern San Joaquin and Tracy Subbasin as defined in DWR Bulletin 118 unrepresented by another GSA, and also including the Lincoln Village and Colonial Heights unincorporated islands within the Stockton Metropolitan Area, and the unincorporated portion of the California Water Service Company service area. The County, in addition to the powers and authorities granted pursuant to SGMA, has all of the powers and authorities granted pursuant to Government Code sections 23000–33205, particularly sections 25690–25699 as it pertains to a water system for inhabitants of the County. As it pertains to the County GSA's participation in the Eastern San Joaquin Groundwater Authority, a joint powers authority created pursuant to Government Code section 6500 et seq., the County is authorized to participate in accordance with the terms of the aforementioned statute.

Oakdale Irrigation District – Oakdale Irrigation District (OID) is an Irrigation District formed pursuant to the provisions of Division 11 of the California Water Code. OID has elected to become a GSA for that portion of its jurisdictional area lying north of the Stanislaus River. For this GSA area, OID has the additional powers and authorities provided in Chapter 5 of Part 2.74 of Division 6 of the California Water Code.

Stockton East Water District – Stockton East Water District (SEWD) is a California Water Conservation District formed by special act of the California legislature, holding the powers set forth in that special act as well as all consistent powers and authorities conferred through Division 21 of the California Water Code. SEWD elected to become a GSA as to the majority of its jurisdictional area (excluding the portions in the City of Stockton service area and Linden County Water District). For its GSA area, SEWD has the additional powers and authorities provided in Chapter 5 of Part 2.74 of Division 6 of the California Water Code.

South Delta Water Agency – South Delta Water Agency is a political division of the State of California created by the California Legislature under the South Delta Water Agency Act, chapter 1089 of the statutes of 1973 (Water Code, Appendix, 116-1.1 et.seq.). The South Delta Water Agency has elected to become a GSA as to those areas within its boundaries on the east side of the San Joaquin River (not otherwise in any other GSA). The South Delta Water Agency has the additional powers and authorities provided in Chapter 5 of Part 2.74 of Division 6 of the California Water Code.

South San Joaquin GSA – The South San Joaquin GSA (SSJ GSA) is a multi-agency GSA comprised of the cities of Escalon and Ripon and the South San Joaquin Irrigation District. The cities of Escalon and Ripon are incorporated cities operating independent municipal drinking water systems primarily served by municipal wells. SSJID is an irrigation district serving irrigation water to approximately 57,000 acres and treated drinking water to the cities of Manteca, Lathrop and Tracy. All three SSJ GSA entities are local public agencies and therefore eligible to independently become GSAs. The three entities have signed a Memorandum of Agreement to establish the multi-agency SSJ GSA. The entities comprising the SSJ GSA are in the process of converting to a Joint Exercise of Powers Agency pursuant to Chapter 5 commencing with Section 6500 of Division 7 of Title 1 of the California Government Code.

Woodbridge Irrigation District – Woodbridge Irrigation District (WID) is an Irrigation District formed pursuant to the provisions of Division 11 of the California Water Code. WID has elected to become a GSA for that portion of its jurisdictional area lying south of South Kile Road, west of City of Lodi, and not including the San Joaquin County areas not part of WID. For this GSA area, WID has the additional powers and authorities provided in Chapter 5 of Part 2.74 of Division 6 of the California Water Code.

APPENDIX 1-C.
AGENCY RESOLUTIONS TO BECOME GSAS

ATTACHMENT 2

RESOLUTION NO. 2017-3

RESOLUTION OF THE BOARD OF DIRECTORS OF THE CENTRAL DELTA WATER AGENCY ELECTING TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT WITHIN THE EASTERN SAN JOAQUIN COUNTY SUB-BASIN

WHEREAS, the California Legislature and Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act (SGMA); and

WHEREAS, the Legislature adopted the Sustainable Groundwater Management Act of 2014, that went into effect on January 1, 2015, which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the SGMA requires all high and medium priority groundwater basins, as designated by the California Department of Water Resources (DWR) Bulletin 118, to be managed by a Groundwater Sustainability Agency (GSA); and

WHEREAS, the Eastern San Joaquin County Groundwater Subbasin (Basin) has been designated by DWR as a high priority Basin; and

WHEREAS, the SGMA authorizes any local agency, or combination of local agencies overlying the Basin, to elect to become a GSA; and

WHEREAS, where more than one local agency overlies a groundwater basin, the SGMA calls on local agencies to cooperate to manage the Basin in a sustainable manner; and

WHEREAS, the Central Delta Water Agency (Agency) is a local agency as defined under the SGMA and is therefore eligible to serve as a GSA within the Basin; and

WHEREAS, Section 10723.2 of the SGMA requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing Groundwater Sustainability Plans (GSP); and

WHEREAS, Section 10723.8 of the SGMA requires that a local agency electing to be a GSA, notify the DWR of its election and intention to undertake sustainable groundwater management within the Basin, and

WHEREAS, it is the intent of the Agency to work cooperatively with other water agencies, the Stockton East Water District, the cities of Lodi and Stockton, the Woodbridge Irrigation District, the California Water Service and the County of San Joaquin, as may be appropriate, to manage the Basin in a sustainable fashion; and

WHEREAS, the Agency has provided informal notice of its interest in serving as the GSA for its boundaries by means of communications with neighboring water agencies, cities and the County of San Joaquin; and

WHEREAS, the District provided public notice, pursuant to Government Code section 6066, of its intention to hold a hearing concerning its establishment of a GSA; and

WHEREAS, the Agency held a public hearing on February 14, 2017, to consider whether it should become the GSA for the portion of the Basin underlying a portion of its boundaries; and

WHEREAS, the Agency wishes to exercise the powers and authorities of a GSA granted by the SGMA.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the Central Delta Water Agency elects that the Central Delta Water Agency become a GSA for the portion of the Eastern San Joaquin Subbasin shown on Exhibit "A"; and

BE IT FURTHER RESOLVED that the boundaries of the GSA for which the Central Delta Water Agency intends to manage is for that area within the Agency's current boundaries as indicated in the map that is attached as Exhibit "A"; and

BE IT FURTHER RESOLVED that Agency staff are hereby directed to provide notice of this election to the DWR in the manner required by law, and

BE IT FURTHER RESOLVED that Agency staff are hereby directed to coordinate with neighboring GSAs that may be established in order to begin the process of developing a GSP for the Basin, as indicated by the SGMA.

PASSED AND ADOPTED by the Board of Directors of the Central Delta Water Agency at a regular meeting on February 14, 2017, by the following vote of the members thereof:

Ayes:	George Biagi, Jr. and Rudy Mussi
Noes:	None
Absent:	Eddie Zuckerman
Abstain:	None

George Biagi, Jr., President, Board of Directors

Attest:

Dante John Nomellini, Sr.
Manager and Co-Counsel

ATTACHMENT 2

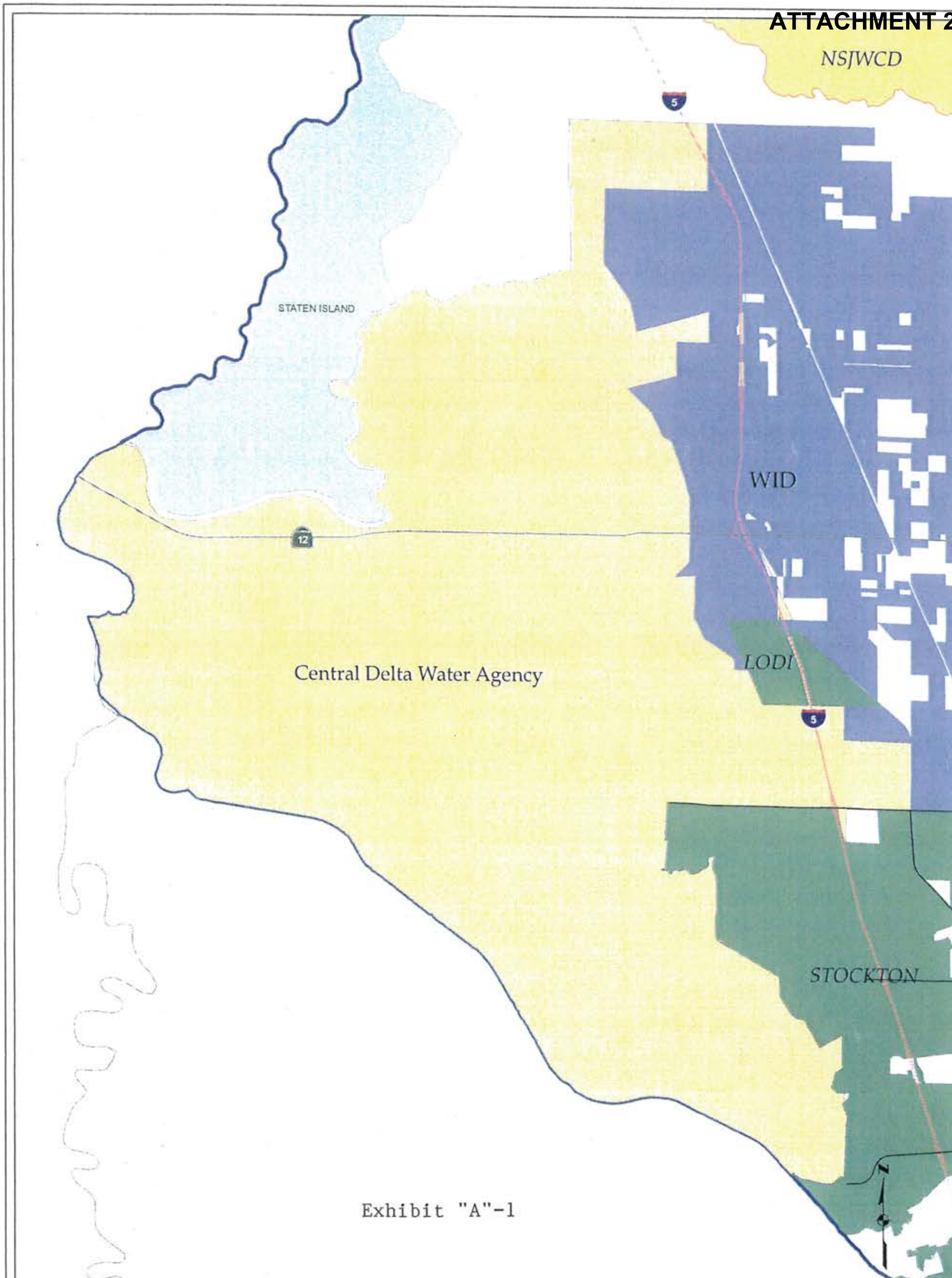

Exhibit "A"-1

CDWA | Eastern San Joaquin Groundwater Subbasin | County Limit | 1" = 7,120.1'

Eastern San Joaquin Groundwater Subbasin
(Groundwater Sustainability Agencies)

-- VICINITY MAP --

SAN JOAQUIN COUNTY

Department of Public Works, 1810 E. Hazelton Ave., Stockton, CA 95205

The County of San Joaquin does not warrant the accuracy, completeness, or suitability for any particular purpose.
The Information on this map is not intended to replace engineering, financial or primary records research.

San Joaquin County

Date 02/09/2017 GD

ATTACHMENT 2

RESOLUTION OF THE CENTRAL SAN JOAQUIN WATER CONSERVATION DISTRICT ELECTING TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT FOR THE EASTERN SAN JOAQUIN GROUNDWATER BASIN RESOLUTION 17-1

WHEREAS, the California Legislature and Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act (SGMA); and

WHEREAS, the SGMA went into effect on January 1, 2015; and

WHEREAS, the SGMA requires all high- and medium-priority groundwater basins, as designated by the California Department of Water Resources (DWR) Bulletin 118, to be managed by a Groundwater Sustainability Agency (GSA) or multiple GSAs; and,

WHEREAS, the Eastern San Joaquin Groundwater Sub-basin has been designated by DWR as a high-priority basin and in critical groundwater overdraft; and,

WHEREAS, the SGMA authorizes a local public agency overlying a groundwater sub-basin to elect to become a GSA; and,

WHEREAS, the Central San Joaquin Water Conservation District (District) is a local public agency as defined under the SGMA and overlies a portion of the Eastern San Joaquin Groundwater Sub-basin and is therefore eligible to serve as a GSA; and,

WHEREAS, Section 10723.2 of the SGMA requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans; and,

WHEREAS, Section 10723.8 of the SGMA requires that a local public agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within a sub-basin; and,

WHEREAS, the District is committed to sustainable management of its groundwater resources; and,

WHEREAS, pursuant to Government Code Section 6066, notices of a public hearing regarding whether to adopt a Resolution to elect to become a GSA were published on January 10, 2017 and January 17, 2017 in The Record; and,

WHEREAS, the District held a public hearing on January 26, 2017, after publication of notice pursuant to Government Code section 6066 to consider adoption of this Resolution; and,

WHEREAS, the District wishes to exercise the powers and authorities of a GSA granted by the SGMA;

NOW THEREFORE BE IT RESOLVED that:

1. This Board of Directors of Central San Joaquin Water Conservation District hereby elects to become a GSA for those portions of San Joaquin County within the Eastern San Joaquin Groundwater Sub-basin as defined in DWR Bulletin 118, a copy of a map of the proposed management area is attached hereto as Exhibit A; and,
2. The boundaries of the GSA for which Central San Joaquin Water Conservation District intends to manage shall be its service area and the area within its sphere of influence which lie within the Eastern San Joaquin Groundwater Sub-basin; and,
3. The Board of Directors of Central San Joaquin Water Conservation District authorizes the Secretary of the District or his designee to, within 30 days from the date of this Resolution, provide notification of this election to the DWR, including a copy of this Resolution and additional information required by Water Code Section 10723.8, in the manner required by law; and,
4. The Board of Directors of Central San Joaquin Water Conservation District supports resolving boundary overlaps among electing GSAs and also supports exploring the establishment of a coordination agreement to organize electing GSAs; and,
5. The Board of Directors of Central San Joaquin Water Conservation District directs staff to enter into discussions with agencies electing to be GSAs to resolve boundary overlaps and to develop a coordination agreement that recognizes the authority of electing GSAs to implement and enforce a GSP within their respective boundaries.

PASSED AND ADOPTED by the Board of the Central San Joaquin Water Conservation District on the 26th, of January, 2017.

GRANT THOMPSON, President of Board
Of Directors, Central San Joaquin Water
Conservation District

I certify that this is a true copy of Resolution 17-1, as passed by the Board of Directors of the Central San Joaquin Water Conservation District at the regularly scheduled in Collegeville, California, on January 26th, 2017

Dated: January 26, 2017

REID W. ROBERTS, Secretary,
Central San Joaquin Water Conservation
District

RESOLUTION NO. 2016-03

A RESOLUTION OF THE LODI CITY COUNCIL DECLARING THE FORMATION OF A GROUNDWATER SUSTAINABILITY AGENCY WITHIN LODI CITY LIMITS

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WHEREAS, the California legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the legislative intent is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, in order to exercise the authority granted in SGMA, a local agency or combination of local agencies must elect to become a Groundwater Sustainability Agency ("GSA"); and

WHEREAS, the City of Lodi (the "City") is a local agency, as SGMA defines that term; and

WHEREAS, the City is committed to sustainable management of its groundwater resources, as shown by, among other actions, its conservation efforts and substantial community investment in conjunctive use infrastructure to establish groundwater sustainability; and

WHEREAS, the City overlies the Eastern San Joaquin Groundwater Basin (designated basin number 5-22.01) in the California Department of Water Resources' (DWR) groundwater basin system; and

WHEREAS, the Eastern San Joaquin Groundwater Basin has been designated by DWR as a high-priority basin in critical overdraft; and

WHEREAS, SGMA requires that a GSA be established for all basins designated by the Department of Water Resources by June 30, 2017; and

WHEREAS, it is the intent of the City to work cooperatively with other local GSAs, as may be appropriate, to sustainably manage a portion(s) of the Eastern San Joaquin Groundwater Basin that fall outside the City's jurisdiction; and

WHEREAS, Section 10723.2 of SGMA requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans; and

WHEREAS, Section 10723.8 of the SGMA requires that a local public agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within the agency's jurisdictional boundary; and

WHEREAS, pursuant to Government Code 6066, notice of a public hearing on the City's election to become a GSA for the Basin ("Notice") has been published in the Lodi News Sentinel as provided by law; and

WHEREAS, a courtesy copy of the Notice was mailed to the Eastern San Joaquin County Groundwater Basin Authority members; and

WHEREAS, on January 6, 2016, the City held a public hearing to consider adoption of this Resolution; and

WHEREAS, the City wishes to exercise the powers and authorities of a GSA granted by SGMA and to begin the process of cooperatively preparing a groundwater sustainability plan ("Sustainability Plan") with other GSAs as appropriate; and

WHEREAS, adoption of this Resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b)(5), including organization and administrative activities of government, because there would be no direct or indirect physical change in the environment.

NOW, THEREFORE, BE IT RESOLVED by the Lodi City Council as follows:

1. The City of Lodi hereby elects to become a GSA for that portion of the Eastern San Joaquin Groundwater Basin which underlies the area bound by the Lodi City limits as shown in Exhibit A; and

2. The Lodi City Council authorizes the City Manager (or his designee) to, within 30 days of the date of this Resolution, provide notice of the City's election to be the GSA for the Basin ("Notice of GSA Election") to the California Department of Water Resources in the manner required by law; and

3. Such notification shall include the boundaries of the areas the City intends to manage, which shall include the lands within the Lodi City limits as shown in Exhibit A, a copy of this Resolution, a list of interested parties developed pursuant to Section 10723.2 of SGMA, and an explanation of how their interests will be considered in the development and operation of the GSA and the development and implementation of the GSAs groundwater sustainability plan; and

4. The City Council hereby directs staff to begin discussions with all interested stakeholders and beneficial users within the Eastern San Joaquin Groundwater Basin, resolve GSA boundary overlaps, and initiate the process of developing a coordinated Groundwater Sustainability Plan in accordance with SGMA.

Dated: January 6, 2016

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I hereby certify that Resolution No. 2016-03 was passed and adopted by the City Council of the City of Lodi in a regular meeting held January 6, 2016, by the following vote:

AYES:	COUNCIL MEMBERS –	Johnson, Kuehne, Mounce, Nakanishi, and Mayor Chandler
NOES:	COUNCIL MEMBERS –	None
ABSENT:	COUNCIL MEMBERS –	None
ABSTAIN:	COUNCIL MEMBERS –	None

JENNIFER M. FERRAIOLO
City Clerk

City of Manteca
GSA Formation Notification
Exhibit C - Resolution Electing to Become GSA

RESOLUTION R2016-236

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF MANTECA, STATE OF CALIFORNIA, DECIDING TO FORM A GROUNDWATER SUSTAINABILITY AGENCY

WHEREAS, the California legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the legislative intent is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management; and

WHEREAS, in order to exercise the authority granted in SGMA, a local agency or combination of local agencies must elect to form a Groundwater Sustainability Agency (GSA); and

WHEREAS, the City of Manteca (the City) is a local agency, as SGMA defines that term; and

WHEREAS, the City is committed to sustainable management of its groundwater resources, as shown by, among other actions, its conservation efforts and substantial community investment in conjunctive use infrastructure to establish groundwater sustainability; and

WHEREAS, the City overlies the Eastern San Joaquin Subbasin (designated basin number 5-22.01) in the California Department of Water Resources' (DWR) groundwater basin system; and

WHEREAS, the Eastern San Joaquin Subbasin has been designated by DWR as a high-priority basin in critical overdraft; and

WHEREAS, it is the intent of the City to work cooperatively with other local GSAs, as may be appropriate, to sustainably manage a portion(s) of the Eastern San Joaquin Subbasin that fall outside the City's jurisdiction; and

WHEREAS, Section 10723.2 of SGMA requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as, those responsible for implementing groundwater sustainability plans; and

WHEREAS, Section 10723.8 of the SGMA requires that a local public agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within the agency's jurisdictional boundary; and

WHEREAS, pursuant to Government Code 6066, notice of a public hearing on the City's election to form a GSA for the Eastern San Joaquin Subbasin has been published as required by law; and

WHEREAS, on December 6, 2016, the City held a public hearing to consider adoption of this Resolution; and

WHEREAS, the City wishes to exercise the powers and authorities of a GSA granted by SGMA and to begin the process of cooperatively preparing a groundwater sustainability plan (GSP) with other GSAs as appropriate.

NOW, THEREFORE, BE IT RESOLVED, by the City Council of the City of Manteca, as follows:

1. The City Council hereby finds that the facts set forth in the recitals to this Resolution are true and correct, and establish the factual basis for the City Council's adoption of this Resolution.

2. The City Council comes to a final decision to regulate groundwater within City Limits by forming a Groundwater Sustainability Agency.

3. Provides the Public Works Engineering Department authorization, within 30 days of adopting this Resolution, to inform the Department of Water Resources of the City's decision to form a Groundwater Sustainability Agency and take all of the necessary steps to comply with the SGMA and the Department of Water Resources requirements.

4. This Resolution shall take effect immediately upon its adoption.

I HEREBY CERTIFY that the foregoing Resolution was duly adopted by the City Council of the City of Manteca at a public meeting of said City Council held on the sixth day of December 2016, by the following vote:

AYES: Moorhead, Morowit, Silverman, Singh, DeBrum

NOES: None

ABSENT: None

ABSTAIN: None

MAYOR: ______________________
STEPHEN F. DEBRUM
Mayor

ATTEST: ______________________
LISA BLACKMON
City Clerk

ATTACHMENT 2

Resolution No. 2015-12-08-1602

STOCKTON CITY COUNCIL

===

RESOLUTION APPROVING THE INTENT OF CITY OF STOCKTON IN COMBINATION WITH CALIFORNIA WATER SERVICE COMPANY TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT FOR THE EASTERN SAN JOAQUIN COUNTY GROUNDWATER BASIN AND AUTHORIZING THE CITY MANAGER TO SUBMIT NOTICE OF THE INTENT TO THE CALIFORNIA DEPARTMENT OF WATER RESOURCES

The Sustainable Groundwater Management Act of 2014 (SGMA) was signed into law by Governor Jerry Brown on September 16, 2014; and

The City of Stockton (City) is a local agency, as defined under SGMA, and is authorized to serve as a Groundwater Sustainability Agency (GSA); and

Where more than one local agency overlies a groundwater basin, SGMA calls on local agencies to cooperate to manage the groundwater basin in a sustainable manner for the common good; and

The City overlies a basin, the Eastern San Joaquin Sub-Basin (designated basin number 5-22.01 in the California Department of Water Resources Bulletin 118 basin system) (Basin); and

SGMA requires all high and medium priority groundwater basins to be managed by a GSA and the California Department of Water Resources (DWR) designated the Basin as “high priority”, therefore requiring a Groundwater Sustainability Plan (GSP); and

Water Code section 10723.6 authorizes a combination of local agencies to form a GSA including a water corporation regulated by the Public Utilities Commission (PUC); and

California Water Service Company (Cal Water) is regulated by the PUC and has a general delegation of authority authorizing officers of the corporation to enter into agreements; and

The City intends to become and participate in the future formation of a GSA in combination with Cal Water for management of the Basin within the boundaries defined as the Urban Service Area until further action redefines those boundaries; and

The City in combination with Cal Water intends to work cooperatively with other water agencies and the County of San Joaquin (County), as may be appropriate, to manage the Basin in a sustainable fashion and to also explore the possibility of forming a GSA agreement; and

No other GSA is currently operating within the Basin; and

On October 22, 2015, DWR posted a Notice of Intent to Become a GSA for Stockton East Water District (Notice) and if no other Notice is filed by another agency within 90 days, Stockton East Water District will be presumed to be the exclusive GSA within the Basin; and

Pursuant to Government Code section 6066, notice of a public hearing on the City's intent to become a groundwater sustainability agency for the Basin in combination with Cal Water has been published in the Stockton Record Newspaper as provided by law; and

Courtesy copies of the Notice were mailed to the San Joaquin County Board of Supervisors, Cal Water, and Stockton East Water District; and

On this day, the Stockton City Council held a public hearing to consider the decision and intention of the City in combination with Cal Water to become a GSA for management of the Basin; and

It would be in the best interest of the City in combination with Cal Water, to become a GSA for the Basin, and to begin the process of preparing a groundwater sustainability plan in corroboration with other agencies; now, therefore,

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF STOCKTON, AS FOLLOWS:

1. The City Council hereby approves the decision and intent of the City in combination with Cal Water to become and form a GSA and participate in the future management of the Eastern San Joaquin County Groundwater Sub-Basin.

2. The City Council hereby authorizes within 30 days of the date of this Resolution, the City Manager or his designee to provide notice of the intention, a copy of this Resolution, a map showing the Basin within the Urban Service Area, and a list of beneficial users and users of groundwater, including those responsible for implementing a GSP to DWR in the manner required by SGMA.

3. The Director of Municipal Utilities (Director) is authorized to begin discussions with other local agencies to develop groundwater sustainability plans for the Basin and to ensure that all beneficial users and users of groundwater are included and considered.

4. The Director is also hereby authorized to develop a plan with other groundwater sustainability agencies in which the City might join in coordination with

other local agencies as contemplated by SGMA.

5. The City Manager is hereby authorized and directed to execute all required notices or agreements, and to submit such documents as may be required to provide for the sustainable management of the Basin.

6. The City Manager is hereby authorized and directed to take whatever actions are necessary and appropriate to carry out the purpose and intent of this Resolution.

PASSED, APPROVED, and ADOPTED December 8, 2015.

ANTHONY SILVA, Mayor
of the City of Stockton

ATTEST:

BONNIE PAIGE, City Clerk
of the City of Stockton

STOCKTON FOUNDED JUNE 1849 ★ INCORPORATED JULY 1850 ★

ATTACHMENT 2

RESOLUTION NO. 2016 - 63

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE CALAVERAS COUNTY WATER DISTRICT

DECLARING INTENTION TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT

WHEREAS, on September 16, 2014, Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act of 2014 (SGMA); and

WHEREAS, SGMA went into effect on January 1, 2015; and

WHEREAS, SGMA requires all high and medium priority groundwater basins, as designated by the California Department of Water Resources (DWR) Bulletin 118, to be managed by a Groundwater Sustainability Agency (GSA) or group of GSAs; and

WHEREAS, the Eastern San Joaquin Groundwater Subbasin (Basin) has been designated by DWR as a high priority basin; and

WHEREAS, SGMA authorizes specific local agencies overlying the Basin to elect to become a GSA within the Basin; and

WHEREAS, the Calaveras County Water District (District) is a local agency as defined under SGMA that overlies the Basin and is therefore eligible to serve as a GSA within the Basin; and

WHEREAS, Water Code section 10723.2 requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans; and

WHEREAS, Water Code section 10723.8 requires that a local agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within a basin; and

WHEREAS, the District held a public hearing on December 14, 2016 after publication of notice pursuant to Water Code section 10723 and Government Code section 6066 to consider the adoption of this Resolution; and

WHEREAS, the District wishes to exercise the powers and authorities of a GSA granted by SGMA.

NOW, THEREFORE, BE IT RESOLVED that the District hereby elects to become a GSA for those portions of the Basin lying within the District's boundaries.

BE IT FURTHER RESOLVED that the District intends to form a multi-agency GSA by Memorandum of Understanding (MOU) to be called the "Eastside San Joaquin Groundwater Sustainability Agency" with other local agencies that overlie the Basin.

BE IT FURTHER RESOLVED that the District and other signatories to the MOU will develop an outreach program to include all stakeholders to ensure that all beneficial uses and users of groundwater are considered.

BE IT FURTHER RESOLVED that the District authorizes the General Manager to enter into a Memorandum of Understanding for formation of the "Eastside San Joaquin Groundwater Sustainability Agency", and to submit to the DWR on behalf of the District and signatories to the MOU a notice of intent to undertake sustainable groundwater management in accordance with the SGMA (Part 2.74 of the Water Code).

BE IT FURTHER RESOLVED that such notification shall include the boundaries of the Basin that the District and Parties to the MOU intend to manage, which shall include the lands within the District boundaries, a copy of this resolution, a list of interested parties developed pursuant to Section 10723.2 of the SGMA, and an explanation of how their interests will be considered in the development and operation of the GSA and the development and implementation of the GSA's groundwater sustainability plan.

PASSED AND ADOPTED this 14th day of December, 2016 by the following vote:

AYES: Directors Mills, Ratterman, Undrhill, Strange and Davidson
NOES: None
ABSTAIN: None
ABSENT: None

CALAVERAS COUNTY WATER DISTRICT

President
Board of Directors

ATTEST:

Mona Walker
Clerk to the Board

ATTACHMENT 2

THE BOARD OF SUPERVISORS OF THE COUNTY OF STANISLAUS
STATE OF CALIFORNIA

2017-70

Date: February 14, 2017
On motion of Supervisor Withrow Seconded by Supervisor Monteith
and approved by the following vote,
Ayes: Supervisors: Olsen, Withrow, Monteith, DeMartini and Chairman Chiesa
Noes: Supervisors: None
Excused or Absent: Supervisors: None
Abstaining: Supervisor: None

Item # 9:10 a.m.

THE FOLLOWING RESOLUTION WAS ADOPTED:

APPROVAL OF A MEMORANDUM OF UNDERSTANDING FORMING THE EASTSIDE SAN JOAQUIN GROUNDWATER SUSTAINABILITY AGENCY FOR THE EASTERN SAN JOAQUIN GROUNDWATER SUBBASIN

WHEREAS, on September 16, 2014, Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act of 2014 (SGMA); and

WHEREAS, SGMA went into effect on January 1, 2015; and

WHEREAS, SGMA requires all high and medium priority groundwater basins, as designated by the California Department of Water Resources (DWR) Bulletin 118, to be managed by a Groundwater Sustainability Agency (GSA) or group of GSAs; and

WHEREAS, the Eastern San Joaquin Groundwater Subbasin (Basin) has been designated by DWR as a high priority basin; and

WHEREAS, SGMA authorizes specific local agencies overlying the Basin to elect to become a GSA within the Basin; and

WHEREAS, Stanislaus County (County) is a local public agency as defined under SGMA that overlies the Basin and is therefore eligible to serve as a GSA within the Basin; and

WHEREAS, Water Code section 10723.2 requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans; and

WHEREAS, Water Code section 10723.8 requires that a local agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within a basin; and

WHEREAS, on this day, the Board of Supervisors of Stanislaus County ("Board of Supervisors") held a public hearing, after publication of notice pursuant to Water Code Section 10723 and Government Code section 6066 to consider whether it should enter into the Memorandum of Understanding Forming the Eastside San Joaquin Groundwater Sustainability Agency ("GSA MOU") to form the Eastern San Joaquin Groundwater subbasin; and

WHEREAS, the County wishes to exercise the powers and authorities of a GSA granted by SGMA.

NOW, THEREFORE, BE IT RESOLVED that the County hereby elects to become a GSA for those portions of the Basin lying within the County's jurisdictional boundaries.

BE IT FURTHER RESOLVED that the County intends to form a multi-agency GSA by Memorandum of Understanding (MOU) to be called the "Eastside San Joaquin Groundwater Sustainability Agency" with other local agencies that that overlie the Basin.

BE IT FURTHER RESOLVED that the County and other signatories to the MOU will develop an outreach program to include all stakeholders to ensure that all beneficial uses and users of groundwater are considered.

BE IT FURTHER RESOLVED that the County authorizes the Board Chairman to enter into a Memorandum of Understanding for formation of the "Eastside San Joaquin Groundwater Sustainability Agency", and to submit to the DWR on behalf of the County District and Other Parties to the MOU a Notice of Intent to undertake sustainable groundwater management in accordance with the SGMA (Part 2.74 of the Water Code).

BE IT FURTHER RESOLVED that such notification shall include the boundaries of the Basin that the County and Other Parties to the MOU intend to manage, which shall include the lands within the County boundaries, a copy of this resolution, a list of interested parties developed pursuant to Section 10723.2 of the SGMA, and an explanation of how their interests will be considered in the development and operation of the GSA and the development and implementation of a Groundwater Sustainability Plan for the basin.

FEB 14 2017

I hereby certify that the foregoing is a full, true and correct copy of the Original entered in the Minutes of the Board of Supervisors.
ELIZABETH A. KING
Clerk of the Board of Supervisors of the County of Stanislaus, State of California

By Patricia Gonzalez

BOARD OF SUPERVISORS STANISLAUS COUNTY CAL.

ATTEST: ELIZABETH A. KING, Clerk
Stanislaus County Board of Supervisors,
State of California

Elizabeth A King

File No. **GSA-2-1**

ATTACHMENT 2

THE BOARD OF DIRECTORS OF THE ROCK CREEK WATER DISTRICT

STATE OF CALIFORNIA

Date: April 6, 2017

On motion of Director Orvis Seconded by Director Slicton

Ayes: Orvis, Slicton, McCurly, Orlando, and Harper

Noes: None

THE FOLLOWING RESOLUTION WAS ADOPTED:

APPROVAL OF A MEMORANDUM OF UNDERSTANDING FORMING THE EASTSIDE SAN JOAQUIN GROUNDWATER SUSTAINABILITY AGENCY FOR THE EASTERN SAN JOAQUIN GROUNDWATER SUBBASIN

WHEREAS, on September 16, 2014, Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known as the Sustainable Groundwater Management Act of 2014 (SGMA); and

WHEREAS, SGMA went into effect on January 1, 2015; and

WHEREAS, SGMA requires all high and medium priority groundwater basins, as designated by the California Department of Water Resources (DWR) Bulletin 118, to be managed by a Groundwater Sustainability Agency (GSA) or group GSAs; and

WHEREAS, the Eastern San Joaquin Groundwater Subbasin (Basin) has been designated by DWR as a high priority basin; and

WHEREAS, SGMA authorizes specific local agencies overlying the Basin to elect to become a GSA within the basin; and

WHEREAS, Rock Creek Water District (District) is a local agency as defined under SGMA that overlies the Basin and is therefore eligible to serve as a GSA within the Basin; and

WHEREAS, Water Code section 10723.2 requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans; and

WHEREAS, Water Code section 10723.8 requires that a local agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within a basin; and

WHEREAS, on this day, the Board of Directors of Rock Creek Water District held a public hearing, after publication of notice pursuant to Water Code Section 10723 and Government Code section 6066 to consider whether it should enter into the Memorandum of Understanding Forming the Eastside San

Joaquin Groundwater Sustainability Agency ("GSA MOU") to form the Eastern San Joaquin Groundwater subbasin; and

WHEREAS, Rock Creek Water District wishes to exercise the powers and authorities of a GSA granted by SGMA.

NOW,THEREFORE, BE IT RESOLVED that Rock Creek Water District herby elects to become a GSA for those portions of the Basin lying within the Districts jurisdictional boundaries.

BE IT FURTHER RESOLVED that the District intends to form a multi-agency GSA by Memorandum of Understanding (MOU) to be called the " Eastside San Joaquin Groundwater Sustainability Agnecy" with the other local agencies that overlie the Basin.

BE IT FURTHER RESOLVED that the District and other signatories to the MOU will develop an outreach program to include all stakeholders to ensure that all beneficial uses and users of the groundwater are considered.

BE IT FURTHER RESOLVED that the District authorizes the Board President to enter into a Memorandum of Understanding for formation of the "Eastside San Joaquin Groundwater Sustainability Agency", and to submit to the DWR on behalf of the District and Other Parties to the MOU a Notice of Intent to undertake sustainable groundwater management in accordance with the SGMA (Part 2.74 of the Water Code).

BE IT FURTHER RESOLVED that such notification shall include the boundaries of the Basin that the District and Other Parties to the MOU intend to manage, which shall include the lands within the District boundaries, a copy of this resolution, a list of interested parties developed pursuant to Section 10723.2 of the SGMA, and an explanation of how their interests will be considered in the development and operation of the GSA and the development and implementation of a Groundwater Sustainability Plan for the basin.

RESOLUTION 16-01

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE LINDEN COUNTY WATER DISTRICT ELECTING TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT

WHEREAS, the California Legislature enacted the Sustainable Groundwater Management Act (Water Code §§10720-10236.6) ("SGMA"), which became effective January 1, 2015; and

WHEREAS, SGMA requires all high and medium-priority groundwater basins, including the Eastern San Joaquin County Groundwater Subbasin, to be managed by one or more groundwater sustainability agencies ("GSAs"); and

WHEREAS, the Linden County Water District ("LCWD") overlies a portion of the Eastern San Joaquin County Groundwater Subbasin; and

WHEREAS, LCWD furnishes water to members of the public within the area of Linden, pursuant to its powers under the County Water District Law (Water Code §§ 30000-33901); and

WHEREAS, LCWD is a local agency, as defined under SGMA, and is therefore eligible to serve as a groundwater sustainability agency ("GSA") under SGMA; and

WHEREAS, serving as the GSA will allow LCWD to participate in the preparation and implementation of a Groundwater Sustainability Plan ("GSP") within LCWD's jurisdictional boundaries; and

WHEREAS, LCWD posted notice of the requisite public hearing in the Stockton Record on July 28 and August 4, 2016, in conformance with the requirements of Water Code section 10723(b); and

WHEREAS, on August 11, 2016, LCWD held a public hearing and elected to become a GSA for the portion of the Eastern San Joaquin County Groundwater Subbasin that lies within LCWD's jurisdictional boundaries:

NOW, THEREFORE BE IT HEREBY RESOLVED by the Board of Directors of the Linden County Water District as follows:

1. The Board of Directors finds that it is in the best interests of LCWD to become a GSA for that portion of the Eastern San Joaquin County Groundwater Subbasin that lies within the LCWD's jurisdictional boundaries; and

2. The Board of Directors authorizes the Board President, the Board Secretary, and LCWD's Engineer and Legal Counsel to perform all acts necessary and proper for carrying out the intent of this Resolution, to the extent that any such acts are not required to be undertaken by

the Board of Directors, including the preparation and submittal of the Notice of Intention to Form a GSA and all supplementary materials to the California Department of Water Resources.

PASSED AND ADOPTED by the Board of Directors of Linden County Water District at a regular meeting thereof held on the 11th day of August, 2016 by the following vote:

AYES: Powell, Brennan, Fonzi, Matthews, Fletcher

NOES: None

ABSTAIN: None

ABSENT: None

By: [signature]
Clifford Powell, Board President

ATTEST:

[signature]
Barbara Kascht, Board Secretary

RESOLUTION NO. 15-02

A RESOLUTION OF THE BOARD OF DIRECTORS OF THE LOCKEFORD COMMUNITY SERVICES DISTRICT ELECTING TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT

WHEREAS, the Legislature enacted the Sustainable Groundwater Management Act (Water Code §§ 10720-10236.6 ("SGMA")) in 2014 and SGMA took effect on January 1, 2015;

WHEREAS, retaining local jurisdiction over water management and land use is essential to sustainably manage groundwater as a critical resource, and to the vitality of the Lockeford community; and

WHEREAS, Lockeford Community Services District ("District") is authorized under the Community Services District Law (Government Code section 61000 et seq.) to, among other things, supply water for beneficial uses;

WHEREAS, the District overlies portions of the Eastern San Joaquin Subbasin of the San Joaquin Valley Groundwater Basin (designated as basin number 5-22.01 by the California Department of Water Resources) ("Subbasin");

WHEREAS, the District is eligible to be a groundwater sustainability agency under SGMA because it supplies water to the public within the Subbasin (Water Code Sections 10721, subdivision (m), and 10723, subdivision (a));

WHEREAS, groundwater planning for the Subbasin has been initiated by the Sustainable Groundwater Management Act Work Group ("SGMA Work Group") for the Eastern San Joaquin County Groundwater Basin Authority;

WHEREAS, on October 22, 2015, Stockton East Water District elected to be the groundwater sustainability agency for portions of the Subbasin within that agency's boundaries, but that agency's boundaries do not overlap with those of the District;

WHEREAS, similar to Stockton East Water District, the District can advance groundwater management within its boundaries and cooperation with other agencies in the Subbasin by designating itself as a groundwater sustainability agency and coordinating with the SGMA Work Group;

WHEREAS, the District will ensure that diverse water interests are represented in its decision-making processes and development of groundwater management policies;

WHEREAS, the District intends to continue its coordination, cooperation and outreach efforts to ensure that various stakeholder interests are taken into account in its management of the portion of the Subbasin that the District overlies;

WHEREAS, the District has published the notice and conducted the public hearing required by Water Code section 10723.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the District as follows:

1. Pursuant to SGMA, the District elects to be the groundwater sustainability agency for the portions of the Subbasin that the District overlies as shown on Exhibit A attached hereto and incorporated herein by reference.

2. The General Manager or his designee is directed to, within 30 days of the date of this Resolution, provide notification of this election to the Department of Water Resources, including a copy of this Resolution and additional information required by Water Code section 10723.8, in the manner required by law.

3. The District shall establish and maintain a list of persons interested in receiving notices regarding the preparation of any groundwater sustainability plan, meeting announcements and availability of draft groundwater sustainability plans, maps, and other relevant documents pursuant to Water Code section 10723.4. Any person may request, in writing, to be placed on this list of interested persons.

4. The District shall operate as a groundwater sustainability agency under the District's existing rules and be governed by the District's Board of Directors. The Board of Directors of the District reserves the right to consider and adopt operating bylaws, ordinances, and resolutions to facilitate its operation as a groundwater sustainability agency.

PASSED AND ADOPTED by the Board of Directors of the Lockeford Community Services District on the 10th day of December, 2015, by the following vote:

AYES: True, Granlees, Rowe, Stetson, Gordon
NOES:
ABSTAIN:
ABSENT:

By: ______________________
Mark True, Board President

Attest:
____
Joe Salzman, Secretary to the Board of Directors

NORTH SAN JOAQUIN WATER CONSERVATION DISTRICT
RESOLUTION NO. 2016 - 1
ELECTION TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY

WHEREAS, the Legislature adopted the Sustainable Groundwater Management Act (SGMA) in 2014 to, among other things, provide for the sustainable management of groundwater basins.

WHEREAS, SGMA requires all high and medium priority groundwater basins, including the Eastern San Joaquin County Groundwater Subbasin and the Cosumnes Subbasin, to be managed by a Groundwater Sustainability Agency (GSA).

WHEREAS, North San Joaquin Water Conservation District (NSJWCD or District) is a local agency, as defined under SGMA, and is authorized to serve as a GSA for the Eastern San Joaquin County Groundwater Subbasin and the Cosumnes Subbasin.

WHEREAS, NSJWCD's serving as the GSA for the area within its boundaries will allow the District to participate in the preparation and implementation of a Groundwater Sustainability Plan (GSP) that covers the District's territory.

WHEREAS, the District posted notice of public hearing in the Lodi News-Sentinel on January 6 and 13, 2016 relating to the District's intent to become a GSA.

WHEREAS, on January 25, 2016, NSJWCD held a public hearing and elected to become a GSA for those portions of the Eastern San Joaquin County Groundwater Subbasin and the Cosumnes Subbasin that lie within the District's boundaries.

NOW, THEREFORE BE IT HEREBY RESOLVED by the Board of Directors of North San Joaquin Water Conservation District as follows:

1. The Board of Directors finds that it is in the best interests of NSJWCD to become a GSA for those portions of the Eastern San Joaquin County Groundwater Subbasin and the Cosumnes Subbasin that lie within the District's boundaries.

2. The Board of Directors authorizes the Board President to do and cause to be done any and all acts necessary or convenient to carry out the purpose and intent of this resolution to the extent that any such acts do not need to be taken by the Board of Directors, including

providing to the California Department of Water Resources notice of the intention to form a GSA, a copy of this resolution, and a map showing the District and the area it intends to manage under SGMA.

Moved by Director Flinn, seconded by Director Scanlon, that the foregoing resolution be adopted.

Upon roll call the following vote was had:

Ayes: __5_ Directors

Noes: __0_ Directors

Absent: __0_ Directors

Abstain: _0__ Director

The President declared the resolution adopted.

I, David Simpson, Secretary of the Board of Directors of the NORTH SAN JOAQUIN WATER CONSERVATION DISTRICT, do hereby CERTIFY that the foregoing is a full, true and correct copy of a resolution duly adopted at an adjourned regular meeting of said Board of Directors held the 25th day of January 2016.

OAKDALE IRRIGATION DISTRICT
RESOLUTION NO. 2017-33

A RESOLUTION AUTHORIZING AND DIRECTING THE FORMATION OF A GROUNDWATER SUSTAINABILITY AGENCY FOR THE EASTERN SAN JOAQUIN SUB-BASIN

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the legislative intent of SGMA is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, SGMA requires that a GSA be formed for all basins designated by the Department of Water Resources as a high-priority basin, such as the Eastern San Joaquin Sub-basin (designated basin number 5-22.01 in the California Department of Water Resources' CASGEM groundwater basin system) ("Basin"), by June 30, 2017; and

WHEREAS, SGMA permits a local agency to form a groundwater sustainability agency ("GSA"); and

WHEREAS, the Oakdale Irrigation District (OID) is a local agency, as SGMA defines that term; and

WHEREAS, OID exercises jurisdiction upon lands overlying the Basin and is committed to the sustainable management of the Basin's groundwater resources; and

WHEREAS, OID has determined that the sustainable management of the Basin pursuant to SGMA may best be achieved through the formation of a GSA; and

WHEREAS, notice of a hearing on the OID's decision to form a GSA for its service area within the Basin ("Notice") was published in compliance with Government Code section 6066; and

WHEREAS, on February 21, 2017, OID held a public hearing to consider whether it should form the OID Eastern San Joaquin Sub-basin GSA for the Basin; and

WHEREAS, it would be in the best interests of OID to form the GSA for its service area within the Basin, and to coordinate with other GSAs within the Basin to begin the process of preparing a groundwater sustainability plan ("Sustainability Plan"); and

WHEREAS, adoption of this resolution does not constitute a "project" under California Environmental Quality Act Guidelines Section 15378(b)(5), including organization and administrative activities of government, because there would be no direct or indirect physical change in the environment.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Oakdale Irrigation District as follows:

1. OID hereby elects to form a GSA and manage groundwater for its service area within the Basin, as reflected in Exhibit "A."

2. Within thirty (30) days of the date of this resolution, the OID Board directs the General Manager to provide notice to California Department of Water Resources that OID intends to form the GSA in the manner required by law.

3. This resolution shall take effect immediately upon passage and adoption.

Upon Motion of Director Santos, seconded by Director Osmundson, and duly submitted to the Board for its Consideration, the above-titled Resolution was adopted this 21st day of February, 2017.

OAKDALE IRRIGATION DISTRICT

Steve Webb, President
Board of Directors

Steve Knell, P.E.
General Manager/Secretary

I HEREBY CERTIFY that the foregoing is a true and correct copy of the original on file with the Oakdale Irrigation District.

OAKDALE IRRIGATION DISTRICT

Steve Knell, P.E.
General Manager/Secretary

ATTACHMENT 2

BEFORE THE BOARD OF SUPERVISORS OF THE COUNTY OF SAN JOAQUIN
STATE OF CALIFORNIA

RESOLUTION

R-15-185

RESOLUTION ELECTING TO ESTABLISH THE COUNTY OF SAN JOAQUIN AS A GROUNDWATER SUSTAINABILITY AGENCY FOR THOSE PORTIONS OF THE COSUMNES, EASTERN SAN JOAQUIN AND TRACY SUB-BASINS WITHIN SAN JOAQUIN COUNTY

WHEREAS, the California Legislature and Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act (SGMA); and,

WHEREAS, the SGMA went into effect on January 1, 2015; and,

WHEREAS, the SGMA requires all high- and medium-priority groundwater basins, as designated by the California Department of Water Resources (DWR) Bulletin 118, to be managed by a Groundwater Sustainability Agency (GSA) or multiple GSAs; and,

WHEREAS, the Eastern San Joaquin Groundwater Sub-basin has been designated by DWR as a high-priority basin and in critical groundwater overdraft; and,

WHEREAS, the Cosumnes and Tracy Sub-basins have been designated by DWR as medium-priority basins; and,

WHEREAS, the SGMA authorizes a local public agency overlying groundwater sub-basin to elect to become a GSA; and,

WHEREAS, the County of San Joaquin (County) is a local public agency as defined under the SGMA and is therefore eligible to serve as a GSA; and,

WHEREAS, Section 10723.2 of the SGMA requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing groundwater sustainability plans; and,

WHEREAS, Section 10723.8 of the SGMA requires that a local public agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within a sub-basin; and,

WHEREAS, the County is committed to sustainable management of its groundwater resources; and,

WHEREAS, pursuant to Government Code Section 6066, notices of a public hearing regarding whether to adopt a Resolution to elect to become a GSA were published on November 27, 2015 and December 4, 2015 in the Manteca Bulletin, Lodi

News Sentinel, Tracy Press, and on November 27, 2015 and December 8, 2015 in The Record; and,

WHEREAS, the County held a public hearing on December 15, 2015, after publication of notice pursuant to Government Code section 6066 to consider adoption of this Resolution; and,

WHEREAS, the County wishes to exercise the powers and authorities of a GSA granted by the SGMA;

NOW, THEREFORE, BE IT RESOLVED that this Board of Supervisors of San Joaquin County hereby elects to become a GSA for those portions of San Joaquin County within the Cosumnes, Eastern San Joaquin, and Tracy Sub-basin as defined in DWR Bulletin 118, a copy of a map of the proposed management area is attached hereto as Exhibit A; and,

BE IT FURTHER RESOLVED that the San Joaquin County Board of Supervisors authorizes the Director of Public Works or his designee to, within 30 days from the date of this Resolution, provide notification of this election to the DWR, including a copy of this Resolution and additional information required by Water Code Section 10723.8, in the manner required by law; and,

BE IT FURTHER RESOLVED that such notification shall include the boundaries of the areas that the County intends to manage, which shall include the lands within the County boundaries, a copy of this Resolution, a list of interested parties developed pursuant to Section 10723.2 of the SGMA, and an explanation of how their interests will be considered in the development and operation of the GSA and the development and implementation of the GSA's groundwater sustainability plan; and,

BE IT FURTHER RESOLVED that the San Joaquin County Board of Supervisors supports resolving boundary overlaps among electing GSAs and also supports exploring the establishment of a coordination agreement to organize electing GSAs; and,

BE IT FURTHER RESOLVED that the San Joaquin County Board of Supervisors directs staff to enter into discussions with agencies electing to be GSAs to resolve boundary overlaps and to develop a coordination agreement that recognizes the authority of electing GSAs to implement and enforce a GSP within their respective boundaries.

ATTACHMENT 2

PASSED AND ADOPTED 12/15/2015, by the following vote of the Board of Supervisors, to wit:

AYES: **Winn, Elliott, Villapudua, Miller**

NOES: **None**

ABSENT: **None**

ABSTAIN: **None**

ATTEST:

MIMI DUZENSKI
Clerk of the Board of Supervisors
Of the County of San Joaquin,
State of California

By ______________________
Clerk

KATHERINE M. MILLER
Chair of the Board
of Supervisors
State of California

WR-15K047-ME4

ATTACHMENT 2

RESOLUTION NO. 1599

RESOLUTION OF THE BOARD OF DIRECTORS OF THE SOUTH DELTA WATER AGENCY ELECTING TO BECOME A GROUNDWATER SUSTAINABILITY AGENCY UNDER THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT WITHIN THE EASTERN SAN JOAQUIN COUNTY SUB-BASIN

WHEREAS, the California Legislature and Governor Jerry Brown signed into law Senate Bills 1168 and 1319 and Assembly Bill 1739, known collectively as the Sustainable Groundwater Management Act (SGMA); and

WHEREAS, the Legislature adopted the Sustainable Groundwater Management Act of 2014, that went into effect on January 1, 2015, which authorizes local agencies to manage groundwater in a sustainable fashion; and

WHEREAS, the SGMA requires all high and medium priority groundwater basins, as designated by the California Department of Water Resources (DWR) Bulletin 118, to be managed by a Groundwater Sustainability Agency (GSA); and

WHEREAS, the Eastern San Joaquin County Groundwater Subbasin (Basin) has been designated by DWR as a high priority Basin; and

WHEREAS, the SGMA authorizes any local agency, or combination of local agencies overlying the Basin, to elect to become a GSA; and

WHEREAS, where more than one local agency overlies a groundwater basin, the SGMA calls on local agencies to cooperate to manage the Basin in a sustainable manner; and

WHEREAS, the South Delta Water Agency (Agency) is a local agency as defined under the SGMA and is therefore eligible to serve as a GSA within the Basin; and

WHEREAS, Section 10723.2 of the SGMA requires that a GSA consider the interests of all beneficial uses and users of groundwater, as well as those responsible for implementing Groundwater Sustainability Plans (GSP); and

WHEREAS, Section 10723.8 of the SGMA requires that a local agency electing to be a GSA, notify the DWR of its election and intention to undertake sustainable groundwater management within the Basin, and

WHEREAS, it is the intent of the Agency to work cooperatively with the Stockton East Water District, the cities of Lodi and Stockton, the Woodbridge Irrigation District, the California Water Service, the County of San Joaquin, and other involved water agencies or interests as may be appropriate, to manage the Basin in a sustainable fashion; and

WHEREAS, the Agency has provided informal notice of its interest in serving as the GSA for its boundaries by means of communications with neighboring water agencies, cities and the County of San Joaquin; and

WHEREAS, the District provided public notice, pursuant to Government Code section 6066, of its intention to hold a hearing concerning its establishment of a GSA; and

WHEREAS, the Agency held a public hearing on March 1, 2017, to consider whether it should become the GSA for the portion of the Basin underlying a portion of its boundaries; and

WHEREAS, the Agency wishes to exercise the powers and authorities of a GSA granted by the SGMA.

NOW, THEREFORE, BE IT RESOLVED that the Board of Directors of the South Delta Water Agency elects that the South Delta Water Agency become a GSA for the portion of the Eastern San Joaquin Subbasin shown on Exhibit "A"; and

BE IT FURTHER RESOLVED that the boundaries of the GSA for which the South Delta Water Agency intends to manage is for that area within the Agency's current boundaries as indicated in the map that is attached as Exhibit "A"; and

BE IT FURTHER RESOLVED that Agency staff are hereby directed to provide notice of this election to the DWR in the manner required by law, and

BE IT FURTHER RESOLVED that Agency staff are hereby directed to coordinate with neighboring GSAs that may be established in order to begin the process of developing a GSP for the Basin, as indicated by the SGMA.

PASSED AND ADOPTED by the Board of Directors of the South Delta Water Agency at a regular meeting on March 1, 2017, by the following vote of the members thereof:

Ayes:	Jerry Robinson, Nat Bacchetti, Mary Hildebrand, Jack Alvarez
Noes:	None
Absent:	Robert Ferguson
Abstain:	None

Jerry Robinson, President, Board of Directors

Attest:

John Herrick, Esq.
Manager and Co-Counsel

MEMORANDUM OF AGREEMENT BETWEEN SOUTH SAN JOAQUIN IRRIGATION DISTRICT, THE CITY OF RIPON AND THE CITY OF ESCALON TO FORM THE SOUTH SAN JOAQUIN GROUNDWATER SUSTAINABILITY AGENCY

This Memorandum of Agreement ("MOA") dated (enter date) is entered into between the South San Joaquin Irrigation District ("SSJID"), the City of Ripon and the City of Escalon, collectively referred to as the "Parties." The Parties are located in the Eastern San Joaquin Groundwater Subbasin as defined by the Department of Water Resources Bulletin 118 ("Bulletin 118") and are subject to the Sustainable Groundwater Management Act as defined below.

RECITALS

WHEREAS, on September 16, 2014 Governor Jerry Brown signed into law the Sustainable Groundwater Management Act (Senate Bills 1168 and 1319 and Assembly Bill 1739) codified in Part 2.74 of Division 6 of the California Water Code, commencing with section 10720 ("the Act"); and

WHEREAS, the Act went into effect on January 1, 2015; and

WHEREAS, the legislative intent of the Act is to provide sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to provide local groundwater agencies with the authority and the technical and financial assistance necessary to sustainably manage groundwater; and

WHEREAS, the Parties overlie the southern portion of the Eastern San Joaquin groundwater subbasin (DWR Bulletin 118 No. 5-22.01) ("Basin"), a Bulletin 118 designated high priority basin that is in critical overdraft; and

WHEREAS, the Act requires that basins designated as high priority be managed by one or more Groundwater Sustainability Agencies ("GSA") and that GSAs develop and implement one or more Groundwater Sustainability Plans ("GSP") for such basins; and

WHEREAS, the Act provides that any local agency or combination of agencies overlying a groundwater basin may decide to become or to form a GSA ; and

WHEREAS, the Act defines a local agency as a local public agency that has water supply, water management, or land use responsibilities within a groundwater basin and each of the Parties is a local agency as defined by the Act; and

WHEREAS, the Act provides that a combination of local agencies may form a GSA through a joint powers agreement, a memorandum of agreement or other legal agreement; and

WHEREAS, the Parties share the goal of achieving cost-effective sustainable groundwater management in the Basin that meets the requirements of the Act, as it may be amended in the future, including considering the interests of all beneficial uses and users of groundwater in the Basin; and

WHEREAS, the Parties intend by this MOA to set forth the framework and agreement under which the Parties will work together to elect to become the South San Joaquin GSA (SSJGSA), in order to collectively develop a GSP for the Managed Area as defined below, whether that is a separate GSP, a regional GSP or a Basin-wide GSP and manage the groundwater in the Managed Area in accordance with the GSP, and to work cooperatively with other GSAs in the Basin as necessary to do so, and

WHEREAS, the Parties intend to negotiate and enter into coordination agreements as required by the Act.

NOW, THEREFORE, it is mutually understood and agreed as follows:

SECTION 1: PURPOSE

The Parties hereby establish the South San Joaquin Groundwater Sustainability Agency to manage the portion of the Eastern San Joaquin Subbasin within the Parties' collective jurisdictions. The purpose of this MOA is to establish a framework to govern the actions of the SSJGSA. These actions include the development and implementation of a GSP for the Managed Area. The Parties intend to collaborate with other local agencies in the potential development of a Basin-wide GSP that is consistent with the goals, interests, authorities and responsibilities of the Parties. The Parties also have discretion under this MOA to form a separate GSP for the Managed Area and to work collaboratively with other GSAs within the Basin to enter into Coordination Agreements as required by the Act. In addition, in the future, the Parties may decide to form a new entity in order to serve as the GSA under a Joint Powers Agreement.

In developing, adopting and implementing a GSP for the Managed Area, or in any coordination with other GSAs and other interests in developing and implementing a Basin-wide GSP that is consistent with the Parties' goals and objectives for the Managed Area, it is each Party's intent, goal and objective to maintain complete control and autonomy over the surface water supplies, water facilities, water operations, groundwater supplies and assets to which each Party and each Party's constituents are legally entitled. Nothing in this MOA requires any contribution or commitment by a Party to share or otherwise contribute that Party's Water Assets as part of the development or implementation of a GSP without that Party's written consent.

SECTION 2: DEFINITIONS

The following terms, whether used in the singular or plural, and when used with initial capitalization, shall have the meanings specified herein.

2.1 Act: Refers to the Sustainable Groundwater Management Act as defined in the Recitals, including any amendments to the Act.

2.2 **Governing Body**: Means the legislative body, i.e. governing board, of each Party to this MOA.

2.3 **Governing Board:** Refers to the SSJGSA Board created and described in Section 3.1 of this MOA.

2.4 **Groundwater Sustainability Agency (GSA)**: Is defined in the Recitals and refers to a groundwater sustainability agency as defined in the Act.

2.5 **Groundwater Sustainability Plan (GSP)**: Is defined in the Recitals, and refers to a groundwater plan as defined in the Act, including the groundwater management plan to be developed by the Parties to this MOA pursuant to the Act.

2.6 **Memorandum of Agreement (MOA)**: Refers to this Memorandum of Agreement.

2.7 **GSA Staff**: Refers to any Party's staff, including contracted consultants tasked with carrying out the technical work necessary to implement the Act's provisions.

2.8 **Basin**: Is defined in the Recitals and refers to the Eastern San Joaquin groundwater subbasin.

2.9 **Managed Area**: Is defined as the area reflected in the Map attached as Exhibit A and incorporated herein.

2.10 **Party**: Refers to each agency that is a signatory to this MOA.

2.11. **Water Assets:** Refers to all surface water supplies, water facilities, water operations, groundwater supplies, and any other water-related assets to which each Party and each Party's constituents are legally entitled.

2.12. **Board Member**: Refers to a member of the Governing Board, as defined in Section 2.3.

2.13. **GSP Regulations**: Refers to the Emergency Regulations for Groundwater Sustainability Plans and Alternatives that were adopted by the California Water Commission on May 18, 2016 (Cal. Code Regs., Title 23, Division 2, Chapter 1.5, Subchapter 2. Groundwater Sustainability Plans).

SECTION 3: GOVERNANCE

3.1 **Governing Board**. The GSA shall be governed by a five member Governing Board. Three Board Members will be representatives of SSJID, one Board Member shall be a representative of the City of Ripon, and one Board Member shall be a representative of the City of Escalon. Each Board Member must be appointed by the Governing Body of the Party being represented. The Members may, but are not required to be, elected members of the Governing Bodies of the Parties. Each Board Member shall certify to the Secretary in writing that he or she has been appointed to be a Board Member by the appointing Party. The Governing Body of each Party shall appoint one Alternate Board Member per Governing Board seat. Alternate Board Members have no vote at Governing Board meetings if the Board Member is present. If the Board Member is not present, the Alternate Board Member shall be entitled to participate in all respects as a regular Board Member. Agency meetings shall comply with the Ralph M. Brown Act required for meetings of the Governing Board.

3.2 Removal of Board Members. Board Members and Alternate Board Members shall serve at the pleasure of their appointing Party's Governing Body and may be removed or replaced at any time. Upon removal of a Board Member, the Alternate Board Member shall serve as a Board Member until a new Board Member is appointed by the Party's Governing Body. Parties must submit any changes in Board Member or Alternate Board Member appointments to the Secretary in writing and signed by the Member.

3.3 Quorum. Attendance of four Board Members, with at least one Member representing each Party, shall constitute a quorum for the transaction of business. In the absence of a quorum, any meeting of the Governing Board may be adjourned from time to time by a majority present, but no other business may be transacted.

3.4 Approval. Action of the Governing Board shall require the affirmative vote of a majority of Board Members voting, except for approvals of the annual budget and cost sharing agreement in Section 4, and any amendments to them, and the addition of additional parties to this MOU in accordance with Section 8.3, which must be approved unanimously by all Board Members. Affirmative action by the Governing Board is binding on each Party.

3.5 Officers. The Governing Board shall select a Chair, Vice Chair, Secretary, and any other officers as determined necessary by the Governing Board. The Secretary of the Board is not required to be a member of the Governing Board, but instead, can be a member of the staff of one of the Parties.

3.5.1. The Chair shall preside at all Governing Board Meetings.

3.5.2. The Vice Chair shall act in place of the Chair at meetings should the Chair be absent.

3.5.3. The Secretary shall prepare agendas for meetings in accordance with the Brown Act, keep minutes of all meetings of the Governing Board and shall, as soon as possible after each meeting, forward a copy of the minutes to each Board Member and Alternate Member of the Governing Board. The Secretary shall provide the agendas to each Party for posting in accordance with the Brown Act.

3.5.4. All Officers shall be chosen at the first Governing Board meeting and serve a term of two (2) years. An Officer may serve for multiple consecutive terms. Any Officer may resign at any time upon written notice to the Governing Board.

SECTION 4: FUNDING

Each Party's participation in this MOA is at that Party's sole cost and expense. The Parties shall mutually develop an annual budget and cost sharing agreement for the work to be undertaken by this MOA. Both the budget and cost sharing agreement shall be approved by the Governing Board by unanimous vote, pursuant to Section 3.4 of this Agreement, before any financial expenditures or financial obligations or liabilities may be incurred by the GSA. Expenditures, as well as any income received by the GSA, must be included within the annual budget.

SECTION 5: TECHNICAL COMMITTEE

5.1 Responsibilities of the Technical Committee.

5.1.1 The Governing Board shall establish a Technical Committee made up of GSA Staff. At least one staff member from each Party may serve on the Technical Committee. The Technical Committee shall develop a process to direct and coordinate GSA activities, including the development, planning, financing, environmental review, permitting, implementation, and long-term monitoring of the GSP for the Managed Area, and/or for the portion of a GSP developed and implemented Basin-wide that is applicable to the Managed Area. The Technical Committee may delegate tasks and responsibilities to GSA Staff. The Technical Committee shall keep the Governing Board apprised of its activities, and may from time to time be asked by the Governing Board to attend Governing Board meetings for the purpose of answering questions and providing information. In addition to being responsible for development and implementation of the GSP or portion of a Basin-wide GSP for the Managed Area, the Technical Committee shall have responsibility for the following:

5.1.1.1 Develop and implement a stakeholder participation plan, pursuant to the requirements of the Act and the GSP Regulations, that involves the public and area stakeholders in developing and implementing the GSP.

5.1.1.2 Schedule meetings of the Governing Board through the Secretary as necessary to coordinate development and implementation of the GSP. Attendance at these meetings may be augmented to include staff or consultants of all Parties to ensure that the appropriate expertise is available.

5.1.1.3 Coordinate with other entities within the Basin regarding GSP formation as required by the Act and the GSP Regulations. GSA Staff shall work cooperatively with the Parties to develop agreement on specific positions before communicating the GSA's positions on specific issues with other entities within the Basin, whenever feasible. GSA Staff shall only take positions on issues which may affect the other Parties to this MOA after majority approval of the MOA Parties and ratification by the Governing Board.

5.1.1.4 Establish financial management and review functions, and report regularly to the Governing Board. The purpose of this reporting is to assist the Parties in monitoring and managing invoicing, payments, cash flow, and other financial matters.

SECTION 6: GROUNDWATER SUSTAINABILITY PLAN

6.1 It is the intent of the Parties to develop a GSP that meets the requirements of the Act and the GSP Regulations and can be successfully implemented to achieve groundwater sustainability in the Basin. Notwithstanding the foregoing, and to the maximum extent permitted by law, each Party agrees to implement the GSP in its own service area or cause the implementation of the GSP in its own service area through written agreement, delegation or other means. Further, the Parties shall endeavor to develop a GSP that shall not prohibit or impose conditions upon the drilling or construction of any new groundwater well or operation of the water system within the sphere of influence of any Party. Nothing in this MOA or a future GSP shall be interpreted as superseding the land use authority, police power, or any other authorities of a Party.

6.2 The Parties understand that each of the Parties' respective Governing Bodies will be required to adopt the GSP.

6.3 Each Party to this MOA shall be individually responsible to implement measures to comply with the GSP as necessary in each Party's service area.

SECTION 7: COMMUNICATION

7.1 **Interagency Communication**: To provide for consistent and effective communication between Parties, each Party agrees to designate one staff representative as its central point of contact on matters relating to this MOA. Additional representatives may be appointed to serve as points of contact on specific actions or issues.

7.2 **Providing Proper Notice:** All notices, statements, or payments related to implementing the objectives of this MOA shall be deemed to have been duly given if given in writing and either delivered personally or mailed by first-class, registered, or certified mail as follows to the following individuals or their successors:

South San Joaquin Irrigation District
Peter Rietkerk, General Manager
11011 E. Highway 120
Manteca, California 95366

City of Ripon
Kevin Werner, City Administrator
259 North Wilma Avenue
Ripon, CA 95366

City of Escalon
Tammy Alcantor, City Manager
2060 McHenry Avenue
Escalon, CA 95320

SECTION 8: TERMINATION, WITHDRAWAL AND NEW PARTIES

8.1 Terminating the Agreement. This MOA may be terminated upon unanimous written consent of all the Parties.

8.2 Withdrawal. A Party may unilaterally withdraw from this MOA without causing or requiring termination of the MOA, effective upon thirty (30) days written notice to the remaining Parties' designated addresses as listed in "Providing Proper Notice" section above. A Party that has withdrawn from this MOA shall remain obligated to pay its share of expenses and obligations as outlined in the budget and cost share agreement incurred or accrued up to the date the Party provided notice of withdrawal. A Party withdrawing from this MOA shall expressly retain the right and responsibility to serve as the GSA for the groundwater basin underlying its boundary or join with other GSA entities in the basin to comply with the groundwater management activities required under the Act.

8.3 New Parties. Additional agencies may join this Agreement and become a Party to the Agreement provided that the prospective new Party, (a) is eligible to join a groundwater sustainability agency as provided by the Act, (b) negotiates necessary changes to the structure of the Governing Board with all other Parties, (c) pays all previously incurred costs that the Governing Board determines to have benefited the new Party, (d) agrees in writing to the terms and conditions of this Agreement and (e) is approved by the Parties.

SECTION 9: AMENDMENT; INSURANCE AND INDEMNIFICATION

9.1 Amendment. This MOA may be amended only by a subsequent writing, approved and signed by all Parties. Approval from a Party is valid only after that Party's Governing Body approves the amendment at a public meeting. GSA Staff, and individual Governing Board members do not have the authority, express or implied, to amend, modify, waive or in any way alter this MOA of the terms and conditions hereof.

9.2 Indemnification. No Party, nor any officer or employee of a Party, shall be responsible for any damage or liability occurring by reason of anything done or omitted to be done by another Party under or in connection with this MOA. The Parties further agree, pursuant to California Government Code section 895.4, that each Party shall fully indemnify and hold harmless the other Parties and their respective agents, officers, employees and contractors from and against all claims, damages, losses, judgments, liabilities, expenses, and other costs, including litigation costs and attorney fees, arising out of, resulting from, or in connection with any work delegated to or action taken or omitted to be taken by the indemnifying Party under this MOA. Each Party shall additionally include within any third party contract entered into in furtherance of this MOA, provisions requiring the contractor, consultant or vendor to indemnify, defend and hold harmless the other Parties to the same extent as the contracting Party is indemnified.

9.3 Insurance. Each Party shall include within any third party contract entered into in furtherance of this MOA, provisions requiring the contractor, consultant or vendor to provide insurance coverage to the other Parties equivalent to the coverage provided to the contracting Party. Without limiting the foregoing and to extent the following policies are required by the contract, the non-contracting Parties shall: (1) be named as additional insured and provided coverage on a primary and non-contributory basis on the contractor, consultant or vendor's policies of commercial general liability and business automobile liability insurance and (2) be included in any waiver of subrogation endorsements issued on the commercial general liability, business automobile liability and workers' compensation/employer's liability policies.

SECTION 10: MISCELLANEOUS

10.1 Execution in Counterparts. The Parties intend to execute this MOA in counterparts. It is the intent of the Parties to hold one (1) counterpart with single original signatures to evidence the MOA and to thereafter forward (# of Parties to MOA) other original counterparts on a rotating basis for all signatures. Thereafter, each Party shall be delivered an originally executed counterpart with all Party signatures.

10.2 Term of MOA. This MOA shall become operative upon its execution by each of the named Parties. The term of this MOA is indefinite and will cease existence only upon termination by the Parties pursuant to Section 8 of this MOA.

10.3 Choice of Law. This MOA is made in the State of California, under the Constitution and laws of such State and is to be so construed.

10.4 Severability. If any provision of this MOA is determined to be invalid or unenforceable, the remaining provisions will remain in force and unaffected to the fullest extent permitted by law and regulation.

10.5 Entire Agreement. This MOA constitutes the sole, entire, integrated and exclusive agreement between the Parties regarding the contents herein. Any other contracts, agreements, terms, understandings, promises or representations not expressly set forth or referenced in this writing are null and void and of nor force and effect.

10.6 Construction and Interpretation. The Parties agree and acknowledge that this MOA has been developed through negotiation, and that each party has had a full and fair opportunity to revise the terms of this MOA. Consequently, the normal rule of construction that any ambiguities are to be resolved against the drafting party shall not apply in construing or interpreting this MOA.

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement as of the dates set forth below.

SOUTH SAN JOAQUIN IRRIGATION DISTRICT

Dated: 3/23/2017

By: [signature]
Peter M. Rietkerk, General Manager

CITY OF RIPON

Dated: 3/27/17

By: [signature]
Kevin Werner, City Administrator

CITY OF ESCALON

Dated: 4-5-17

By: [signature]
Tammy Alcantor, City Manager

SOUTH SAN JOAQUIN IRRIGATION DISTRICT
RESOLUTION NO. 17-06-W

RESOLUTION ELECTING FORMATION OF THE SOUTH SAN JOAQUIN GROUNDWATER SUSTAINABILITY AGENCY

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which requires the sustainable management of groundwater; and

WHEREAS, the legislative intent is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management; and

WHEREAS, in order to exercise the authority granted in SGMA, a local agency or combination of local agencies may elect to form a Groundwater Sustainability Agency (GSA); and

WHEREAS, the South San Joaquin Irrigation District is a local agency, as SGMA defines that term; and.

WHEREAS, the South San Joaquin Irrigation District is committed to sustainable management of its groundwater resources; and

WHEREAS, the South San Joaquin Irrigation District overlies a portion of the Eastern San Joaquin Subbasin (designated basin number 522.01) in the California Department of Water Resources' (DWR) groundwater basin system, which has been designated by DWR as a high-priority basin in critical overdraft; and

WHEREAS, the South San Joaquin Irrigation District elected to become a GSA on October 15, 2015 and previously filed an election with DWR on or about November 12, 2015; and

WHEREAS, the South San Joaquin Irrigation District has begun to work cooperatively with other local agencies that also plan to manage groundwater in compliance with SGMA, including the City of Ripon (Ripon) and the City of Escalon (Escalon); and

WHEREAS, the South San Joaquin Irrigation District, along with its regional partners Ripon and Escalon, intend to work collaboratively to manage their respective service areas under the South San Joaquin Groundwater Sustainability Agency (SSJGSA); and

WHEREAS, Section 10723.8 of the SGMA requires that a local public agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within the agency's jurisdictional boundary; and

WHEREAS, pursuant to Government Code 6066, notice of a public hearing on the South San Joaquin Irrigation District election to participate in the SSJGSA has been published as required by law; and

WHEREAS, on March 21, 2017, the South San Joaquin Irrigation District held a public hearing to consider adoption of this Resolution; and

WHEREAS, the South San Joaquin Irrigation District wishes to exercise the powers and authorities of a GSA granted by SGMA and to begin the process of cooperatively preparing a Groundwater Sustainability Plan (GSP) with other GSAs as appropriate.

NOW, THEREFORE BE IT RESOLVED THAT:

1. The South San Joaquin Irrigation District hereby finds that the facts set forth in the recitals to this Resolution are true and correct, and establish the factual basis for the South San Joaquin Irrigation District adoption of this Resolution.

2. The South San Joaquin Irrigation District authorizes the General Manager to withdraw the previous election to facilitate its participation in the SSJGSA.

3. The South San Joaquin Irrigation District hereby elects to participate as a member in the SSJGSA to manage groundwater within the boundaries of the South San Joaquin Groundwater Sustainability Agency, including the South San Joaquin Irrigation District boundary.

4. The Board authorizes the General Manager or his designee within 30 days of adopting this Resolution, to inform the Department of Water Resources of the South San Joaquin Irrigation District's decision to participate in the SSJGSA and take such other and further steps as necessary to comply with the SGMA and the Department of Water Resources requirements.

5. This Resolution shall take effect immediately upon its adoption.

PASSED AND ADOPTED at a meeting of the Board of Directors of the South San Joaquin Irrigation District on March 21, 2017, by the following roll call vote:

AYES:	HOLBROOK HOLMES KAMPER KUIL ROOS
NOES:	NONE
ABSTAIN:	NONE
ABSENT:	NONE

ATTEST:

Peter M. Rietkerk

Peter M. Rietkerk, Secretary

RESOLUTION NO. 09-17

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF ESCALON ELECTING FORMATION OF A JOINT GROUNDWATER SUSTAINABILITY AGENCY PURSUANT TO THE SUSTAINABLE GROUNDWATER MANAGEMENT ACT

WHEREAS, the Sustainable Groundwater Management Act of 2014, California Water Code section 10720 et. seq., went into effect on January 1, 2015, and

WHEREAS, the legislative intent of the Act is to provide for the sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management, and to manage groundwater basins through the actions of local governmental agencies to the greatest extent feasible while minimizing state intervention; and

WHEREAS, the Act requires that California groundwater basins and subbasins designated by the California Department of Water Resources as high priority or medium priority be managed by one or more Groundwater Sustainability Agencies (GSAs) and that such management be accomplished pursuant to one or more approved Groundwater Sustainability Plans (GSPs) for the basin; and

WHEREAS, California Water Code Section 10721(j) defines a GSA as one or more local agencies that implement the provisions of the Act; and

WHEREAS, any local public agency that has water supply, water management or land use responsibilities within a groundwater basin may decide to become a GSA over that basin (California Water Code Sections 10721 and 10723); and

WHEREAS, SGMA provides that a combination of local agencies may form a GSA by a joint powers agreement, a memorandum of agreement, or other legal agreement (Water Code Section 10723.6); and

WHEREAS, the City of Escalon overlies a portion of the San Joaquin Valley Groundwater Basin, Eastern San Joaquin Groundwater Subbasin (defined in the Department of Water Resources' Bulletin 118 as Basin No. 5-22.01), which has been designated by the State of California as a high priority basin that is in a condition of critical overdraft; and

WHEREAS, the City of Escalon is the local agency with exclusive public drinking water supply, water quality and water production responsibilities within and for the City of Escalon; and

WHEREAS, the current exclusive source of the City of Escalon's water supply is groundwater from the Eastern San Joaquin Groundwater Subbasin; and

WHEREAS, it is beneficial to the health, safety and water supply reliability of the City of Escalon to retain local jurisdiction and control over groundwater resources within the City Limits of Escalon; and

WHEREAS, the City of Escalon previously filed notice with California Department of Water Resources (DWR) to become a GSA on February 9, 2017; and

WHEREAS, the City has been working cooperatively with other local agencies that also plan to manage groundwater in compliance with SGMA, including the South San Joaquin Irrigation District (SSJID) and the City of Ripon (Ripon); and

WHEREAS, the City, along with its regional partners SSJID and Ripon intend to jointly form the South San Joaquin Groundwater Sustainability Agency (SSJGSA) through a Memorandum of Agreement to work collaboratively to manage groundwater resources within their respective service areas and to comply with SGMA; and

WHEREAS, prior to adopting a resolution of intent to establish the City of Escalon as a member of the SSJGSA, Water Code Section 10723 requires the City to hold a public hearing, after publication of notice pursuant to California Government Code Section 6066, on whether to become a GSA; and

WHEREAS, pursuant to Government Code Section 6066, notices of a public hearing on whether or not to adopt a resolution to establish the SSJGSA through a Memorandum of Agreement were published on March 15, 2017 and March 22, 2017; and

WHEREAS, adoption of this Resolution does not constitute a project under the California Environmental Quality Act because it does not result in any direct or indirect physical change in the environment;

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Escalon does hereby:

1. Elect to participate as a member of the SSJGSA to manage groundwater within the boundaries of the SSJGSA, which includes the portion of the Eastern San Joaquin Groundwater Subbasin underlying the jurisdictions of the City of Escalon, Ripon and SSJID; and

2. Authorize the City Manager or her designee to withdraw the previous GSA election notice to DWR to facilitate the City of Escalon's participation in the SSJGSA;

3. Authorize the City Manager to execute the "Memorandum of Agreement Between South San Joaquin Irrigation District, the City of Ripon and the City of Escalon to Form the South San Joaquin Groundwater Sustainability Agency"; and

4. Authorize the City Manager or her designee to coordinate with the other members of the SSJGSA to provide a copy of this resolution, a Notice of Intent, and all other necessary documentation to DWR within 30 days and to otherwise comply with the requirements of Water Code Section 10723.8; and

4. Authorize the City Manager or her designee to coordinate with the other members of the SSJGSA to maintain a list of interested parties regarding the newly formed SSJGSA pursuant to Water Code Section 10723.4.

PASSED, APPROVED, AND ADOPTED this 3rd day of April 2017, by the following vote:

AYES: Councilmembers Swift, Fox, Alves, Murken, Mayor Laugero
NOES: None
ABSENT: None
ABSTAIN: None

JEFF LAUGERO, Mayor

ATTEST:

ADRI CRIM, Deputy City Clerk

RESOLUTION NO. 17-18

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF RIPON ELECTING FORMATION OF GROUNDWATER SUSTAINABILITY AGENCY

WHEREAS, the California Legislature has adopted, and the Governor has signed into law, the Sustainable Groundwater Management Act of 2014 ("SGMA"), which requires the sustainable management of groundwater; and

WHEREAS, the legislative intent is to provide for sustainable management of groundwater basins, to enhance local management of groundwater, to establish minimum standards for sustainable groundwater management; and

WHEREAS, in order to exercise the authority granted in SGMA, a local agency or combination of local agencies may elect to form a Groundwater Sustainability Agency (GSA); and

WHEREAS, the City of Ripon (the City) is a local agency, as SGMA defines that term; and.

WHEREAS, the City is committed to sustainable management of its groundwater resources; and

WHEREAS, the City overlies a portion of the Eastern San Joaquin Subbasin (designated basin number 522.01) in the California Department of Water Resources' (DWR) groundwater basin system, which has been designated by DWR as a high-priority basin in critical overdraft; and

WHEREAS, the City has begun to work cooperatively with other local agencies that also plan to manage groundwater in compliance with SGMA, including the South San Joaquin Irrigation District (SSJID) and the City of Escalon (Escalon);

WHEREAS, the City, along with its regional partners SSJID and Escalon, intend to work collaboratively to manage their respective service areas under the South San Joaquin Groundwater Sustainability Agency (SSJGSA);

WHEREAS, Section 10723.8 of the SGMA requires that a local public agency electing to be a GSA to notify the DWR of its election and intention to undertake sustainable groundwater management within the agency's jurisdictional boundary; and

WHEREAS, pursuant to Government Code 6066, notice of a public hearing on the City's election to participate in the SSJGSA has been published as required by law; and

WHEREAS, on March 14, 2017, the City held a public hearing to consider adoption of this Resolution; and

WHEREAS, the City wishes to exercise the powers and authorities of a GSA granted by SGMA and to begin the process of cooperatively preparing a Groundwater Sustainability Plan (GSP) with other GSAs as appropriate.

NOW, THEREFORE, the City Council of the City of Ripon does hereby resolve as follows:

1. The City Council hereby finds that the facts set forth in the recitals to this Resolution are true and correct, and establish the factual basis for the City Council's adoption of this Resolution.

2. The City Council hereby elects to participate as a member in the SSJGSA to manage groundwater within the boundaries of the SSJGSA, including the Ripon City Limits.

3. The City Council authorizes the Engineering Department within 30 days of adopting this Resolution, to inform the Department of Water Resources of the City's decision to participate in the SSJGSA and take such other and further steps as necessary to comply with the SGMA and the Department of Water Resources requirements.

4. This Resolution shall take effect immediately upon its adoption.

PASSED AND ADOPTED at a regular meeting of the City Council of the City of Ripon this 14th day of March, 2017, by the following vote:

AYES:	Zuber, Restuccia, de Graaf, Parks, Uecker
NOES:	None
ABSENT:	None
ABSTAINING:	None

The City of Ripon
A Municipal Corporation

By: ______________________
DEAN UECKER, Mayor

ATTEST:

____
LISA ROOS, City Clerk

APPENDIX 1-D.
DWR CHECKLIST

Article 5.			Plan Contents for Eastern San Joaquin Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
§ 354.			**Introduction to Plan Contents**					
			This Article describes the required contents of Plans submitted to the Department for evaluation, including administrative information, a description of the basin setting, sustainable management criteria, description of the monitoring network, and projects and management actions.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
SubArticle 1.			**Administrative Information**					
§ 354.2.			**Introduction to Administrative Information**					
			This Subarticle describes information in the Plan relating to administrative and other general information about the Agency that has adopted the Plan and the area covered by the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.4.			**General Information**					
			Each Plan shall include the following general information:					
(a)			An executive summary written in plain language that provides an overview of the Plan and description of groundwater conditions in the basin.	ES-1:ES-2,ES-3:ES-8	ES-1:ES-12			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			A list of references and technical studies relied upon by the Agency in developing the Plan. Each Agency shall provide to the Department electronic copies of reports and other documents and materials cited as references that are not generally available to the public.	8-1:8-9	8.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
§ 354.6.			**Agency Information**					
			When submitting an adopted Plan to the Department, the Agency shall include a copy of the information provided pursuant to Water Code Section 10723.8, with any updates, if necessary, along with the following information:					
(a)			The name and mailing address of the Agency.	1-2	1.1.3	1-2		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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(b)			The organization and management structure of the Agency, identifying persons with management authority for implementation of the Plan.	1-2:1-6	1.1.3:1.1.4.3	1-2:1-3		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			The name and contact information, including the phone number, mailing address and electronic mail address, of the plan manager.	1-2	1.1.3	1-2		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(d)			The legal authority of the Agency, with specific reference to citations setting forth the duties, powers, and responsibilities of the Agency, demonstrating that the Agency has the legal authority to implement the Plan.	1-10, X-X:X-X	1.1.4.4, Appendix 1-B			This field was updated to reflect changes made in the Revised GSP, updated June 2022. Pages __ reference Appendix 1-B. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(e)			An estimate of the cost of implementing the Plan and a general description of how the Agency plans to meet those costs.	1-10, 7-6:7-8	1.1.4.5, 7.2		7-2	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.8, 10727.2, and 10733.2, Water Code.					
§ 354.8.			**Description of Plan Area**					
			Each Plan shall include a description of the geographic areas covered, including the following information:					
(a)			One or more maps of the basin that depict the following, as applicable:					
	(1)		The area covered by the Plan, delineating areas managed by the Agency as an exclusive Agency and any areas for which the Agency is not an exclusive Agency, and the name and location of any adjacent basins.	1-10:1-11	1.2.1	1-3:1-5		The entire Eastern San Joaquin GSP consists of GSAs that are exclusive GSAs. This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(2)		Adjudicated areas, other Agencies within the basin, and areas covered by an Alternative.	1-11	1.2.1.1			There are no adjudicated areas within the Eastern San Joaquin GSP nor was an alternative plan prepared. This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Jurisdictional boundaries of federal or state land (including the identity of the agency with jurisdiction over that land), tribal land, cities, counties, agencies with water management responsibilities, and areas covered by relevant general plans.	1-11:1-23	1.2.1.1	1-6:1-7, 1-11		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		Existing land use designations and the identification of water use sector and water source type.	1-11:1-23	1.2.1.1	1-9:1-10		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(5)		The density of wells per square mile, by dasymetric or similar mapping techniques, showing the general distribution of agricultural, industrial, and domestic water supply wells in the basin, including de minimis extractors, and the location and extent of communities dependent upon groundwater, utilizing data provided by the Department, as specified in Section 353.2, or the best available information.	1-21:1-23, 1-44:1-45,X-X:X-X	1.2.1.1, 1.3.1, Appendix 1-E	1-12:1-14		This field was updated to reflect changes made in the Revised GSP, updated June 2022. Pages ____ references Appendix 1-E. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			A written description of the Plan area, including a summary of the jurisdictional areas and other features depicted on the map.	1-11:1-23	1.2.1			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			Identification of existing water resource monitoring and management programs, and description of any such programs the Agency plans to incorporate in its monitoring network or in development of its Plan. The Agency may coordinate with existing water resource monitoring and management programs to incorporate and adopt that program as part of the Plan.	1-23:1-25	1.2.2	1-15:1-16		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(d)			A description of how existing water resource monitoring or management programs may limit operational flexibility in the basin, and how the Plan has been developed to adapt to those limits.	1-23:1-35	1.2.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(e)			A description of conjunctive use programs in the basin.	1-34:1-35	1.2.2.9	1-16		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(f)			A plain language description of the land use elements or topic categories of applicable general plans that includes the following:					
	(1)		A summary of general plans and other land use plans governing the basin.	1-35:1-38	1.2.3.1			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		A general description of how implementation of existing land use plans may change water demands within the basin or affect the ability of the Agency to achieve sustainable groundwater management over the planning and implementation horizon, and how the Plan addresses those potential effects	1-35:1-38	1.2.3.1:1.2.3.3			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		A general description of how implementation of the Plan may affect the water supply assumptions of relevant land use plans over the planning and implementation horizon.	1-37:1-38	1.2.3.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		A summary of the process for permitting new or replacement wells in the basin, including adopted standards in local well ordinances, zoning codes, and policies contained in adopted land use plans.	1-38:1-42	1.2.3.4		1-1:1-3	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(5)		To the extent known, the Agency may include information regarding the implementation of land use plans outside the basin that could affect the ability of the Agency to achieve sustainable groundwater management.	1-38	1.2.3.3			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(g)			A description of any of the additional Plan elements included in Water Code Section 10727.4 that the Agency determines to be appropriate.	1-42:1-44	1.2.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10720.3, 10727.2, 10727.4, 10733, and 10733.2, Water Code.					
§ 354.10.			**Notice and Communication**					

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			Each Plan shall include a summary of information relating to notification and communication by the Agency with other agencies and interested parties including the following:					
(a)			A description of the beneficial uses and users of groundwater in the basin, including the land uses and property interests potentially affected by the use of groundwater in the basin, the types of parties representing those interests, and the nature of consultation with those parties.	1-44:1-57	1.3.1:1.3.5			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			A list of public meetings at which the Plan was discussed or considered by the Agency.	1-45:1-46	1.3.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			Comments regarding the Plan received by the Agency and a summary of any responses by the Agency.	1-51:1-57,X-X:X-X,X-X:X-X	1.3.4.2.4:1.3.4.2.6, Appendix 1-I, Appendix 1-J			Appendix 1-I provides public comments received on the Public Draft GSP; Appendix 1-J summarizes Eastern San Joaquin Groundwater Authority responses. This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024. Pages ___ reference Appendix 1-I, and pages ____ reference Appendix 1-J.
(d)			A communication section of the Plan that includes the following:					
	(1)		An explanation of the Agency's decision-making process.	1-46	1.3.3			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Identification of opportunities for public engagement and a discussion of how public input and response will be used.	1-46:1-57	1.3.4		1-4:1-5	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		A description of how the Agency encourages the active involvement of diverse social, cultural, and economic elements of the population within the basin.	1-46:1-57	1.3.4		1-4:1-5	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(4)		The method the Agency shall follow to inform the public about progress implementing the Plan, including the status of projects and actions.	1-51:1-57, 6-54	1.3.4.2, 6.2.7		1-5	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.8, 10728.4, and 10733.2, Water Code					
SubArticle 2.			**Basin Setting**					
§ 354.12.			**Introduction to Basin Setting**					
			This Subarticle describes the information about the physical setting and characteristics of the basin and current conditions of the basin that shall be part of each Plan, including the identification of data gaps and levels of uncertainty, which comprise the basin setting that serves as the basis for defining and assessing reasonable sustainable management criteria and projects and management actions. Information provided pursuant to this Subarticle shall be prepared by or under the direction of a professional geologist or professional engineer.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.14.			**Hydrogeologic Conceptual Model**					
(a)			Each Plan shall include a descriptive hydrogeologic conceptual model of the basin based on technical studies and qualified maps that characterizes the physical components and interaction of the surface water and groundwater systems in the basin.	2-10:2-80	2.1			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			The hydrogeologic conceptual model shall be summarized in a written description that includes the following:					
	(1)		The regional geologic and structural setting of the basin including the immediate surrounding area, as necessary for geologic consistency.	2-18:2-20	2.1.2:2.1.3	2-6		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Lateral basin boundaries, including major geologic features that significantly affect groundwater flow.	2-20:2-58	2.1.4:2.1.8	2-7:2-29		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(3)		The definable bottom of the basin.	2-58	2.1.8.2	2-20		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		Principal aquifers and aquitards, including the following information:					
		(A)	Formation names, if defined.	2-40:2-42	2.1.5.1			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(B)	Physical properties of aquifers and aquitards, including the vertical and lateral extent, hydraulic conductivity, and storativity, which may be based on existing technical studies or other best available information.	2-58:2-78	2.1.9	2-30:2-41	2-3	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(C)	Structural properties of the basin that restrict groundwater flow within the principal aquifers, including information regarding stratigraphic changes, truncation of units, or other features.	2-35:2-45, 2-58:2-78	2.1.5:2.1.6, 2.1.9	2-19	2-2	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(D)	General water quality of the principal aquifers, which may be based on information derived from existing technical studies or regulatory programs.	2-69:2-78	2.1.9.2.3	2-34:2-41		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(E)	Identification of the primary use or uses of each aquifer, such as domestic, irrigation, or municipal water supply.	2-58:2-78	2.1.9	2:30:2-31		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(5)		Identification of data gaps and uncertainty within the hydrogeologic conceptual model	2-79:2-80	2.1.10			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			The hydrogeologic conceptual model shall be represented graphically by at least two scaled cross-sections that display the information required by this section and are sufficient to depict major stratigraphic and structural features in the basin.	2-46:2-57	2.1.7	2-21:2-29		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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(d)			Physical characteristics of the basin shall be represented on one or more maps that depict the following:					
	(1)		Topographic information derived from the U.S. Geological Survey or another reliable source.	2-20	2.1.4.1	2-7		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Surficial geology derived from a qualified map including the locations of cross-sections required by this Section.	2-35:2-42	2.1.5	2-18, 2-21, 2-25, 2-13	2-2	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Soil characteristics as described by the appropriate Natural Resources Conservation Service soil survey or other applicable studies.	2-26:2-29	2.1.4.3	2-10:2-12		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		Delineation of existing recharge areas that substantially contribute to the replenishment of the basin, potential recharge areas, and discharge areas, including significant active springs, seeps, and wetlands within or adjacent to the basin.	2-30:2-35, 1-34	2.1.4.5, 1.2.2.9	2-13:2-14, 1-16		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(5)		Surface water bodies that are significant to the management of the basin.	2-20:2-25	2.1.4.2	2-8:2-9	2-1	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(6)		The source and point of delivery for imported water supplies.	2-30	2.1.4.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10733, and 10733.2, Water Code.					
§ 354.16.			**Groundwater Conditions**					
			Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes the following:					
(a)			Groundwater elevation data demonstrating flow directions, lateral and vertical gradients, and regional pumping patterns, including:					

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	(1)		Groundwater elevation contour maps depicting the groundwater table or potentiometric surface associated with the current seasonal high and seasonal low for each principal aquifer within the basin.	2-80:2-98, 2-134:2-137	2.2.1, 2.3.1	2-45:2-46, 2-84:2-86		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Hydrographs depicting long-term groundwater elevations, historical highs and lows, and hydraulic gradients between principal aquifers.	2-83,2-84, 2-91:2-98	2.2.1, Appendix 3-I	2-42:2-43, 2-48:2-63		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			A graph depicting estimates of the change in groundwater in storage, based on data, demonstrating the annual and cumulative change in the volume of groundwater in storage between seasonal high groundwater conditions, including the annual groundwater use and water year type.	2-99:2-100, 2-139:2-140	2.2.2, 2.3.2	2-64:2-65,2-89		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			Seawater intrusion conditions in the basin, including maps and cross-sections of the seawater intrusion front for each principal aquifer.	2-101,2-140:2-144	2.2.3, 2.3.3	2-91	2-12	Seawater intrusion is not considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin as the Subbasin is not in a coastal area and seawater intrusion is not currently present and is not reasonably expected to occur due to the active management of the 'X2' salinity barrier by the State. This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(d)			Groundwater quality issues that may affect the supply and beneficial uses of groundwater, including a description and map of the location of known groundwater contamination sites and plumes.	2-101:2-122,2-144:2-147	2.2.4, 2.3.4	2-66:2-76, 2-92:2-94	2-5:2-11	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(e)			The extent, cumulative total, and annual rate of land subsidence, including maps depicting total subsidence, utilizing data available from the Department, as specified in Section 353.2, or the best available information.	2-122:2-123,2-147:2-155	2.2.5, 2.3.5	2-78, 2:95:2-101		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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(f)			Identification of interconnected surface water systems within the basin and an estimate of the quantity and timing of depletions of those systems, utilizing data available from the Department, as specified in Section 353.2, or the best available information.	2-123:2-126,2-155:2-161	2.2.6, 2.3.6	2-79:2-80, 2-102:2-105		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(g)			Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information.	2-126:2-133, 2-163	2.2.7, 2.3.7	2-81:2-83, 2-106		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, and 10733.2, Water Code.					
§ 354.18.			**Water Budget**					
(a)			Each Plan shall include a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current and projected water budget conditions, and the change in the volume of water stored. Water budget information shall be reported in tabular and graphical form.	2-163:2-217	2.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			The water budget shall quantify the following, either through direct measurements or estimates based on data:					
	(1)		Total surface water entering and leaving a basin by water source type.	2-173:2-195	2.4.5	2-109:2-120	2-14:2-19	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Inflow to the groundwater system by water source type, including subsurface groundwater inflow and infiltration of precipitation, applied water, and surface water systems, such as lakes, streams, rivers, canals, springs and conveyance systems.	2-173:2-195	2.4.5	2-109:2-120	2-14:2-19	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Outflows from the groundwater system by water use sector, including evapotranspiration, groundwater extraction, groundwater discharge to surface water sources, and subsurface groundwater outflow.	2-173:2-195	2.4.5	2-109:2-120	2-14:2-19	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		The change in the annual volume of groundwater in storage between seasonal high conditions.	2-99:2-100, 2-139:2-140, 2-173:2-195	2.2.2, 2.3.2, 2.4.5	2-64:2-65, 2-89, 2-111,2-114,2-117, 2-120	2-16:2-19	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(5)		If overdraft conditions occur, as defined in Bulletin 118, the water budget shall include a quantification of overdraft over a period of years during which water year and water supply conditions approximate average conditions.	2-181:2-184, 2-188:2-191, 2-191:2-195	2.4.5.1, 2.4.5.3, 2.4.5.4		2-17:2-19	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(6)		The water year type associated with the annual supply, demand, and change in groundwater stored.	2-181:2-184, 2-188:2-195	2.4.5.1, 2.4.5.3, 2.4.5.4		2-17:2-19	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(7)		An estimate of sustainable yield for the basin.	2-195:2-201, 2-201:2-205	2.4.6, 2.4.7			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			Each Plan shall quantify the current, historical, and projected water budget for the basin as follows:					
	(1)		Current water budget information shall quantify current inflows and outflows for the basin using the most recent hydrology, water supply, water demand, and land use information.	2-170, 2-185:2-187	2.4.4.2, 2.4.5.2	2-112:2-114		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Historical water budget information shall be used to evaluate availability or reliability of past surface water supply deliveries and aquifer response to water supply and demand trends relative to water year type. The historical water budget shall include the following:					
		(A)	A quantitative evaluation of the availability or reliability of historical surface water supply deliveries as a function of the historical planned versus actual annual surface water deliveries, by surface water source and water year type, and based on the most recent ten years of surface water supply information.	2-168:2-170, 2-181:2-184	2.4.4.1, 2.4.5.1	2-109:2-111	2-17	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(B)	A quantitative assessment of the historical water budget, starting with the most recently available information and extending back a minimum of 10 years, or as is sufficient to calibrate and reduce the uncertainty of the tools and methods used to estimate and project future water budget information and future aquifer response to proposed sustainable groundwater management practices over the planning and implementation horizon.	2-168:2-170, 2-181:2-184	2.4.4.1, 2.4.5.1	2-109:2-111	2-17	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(C)	A description of how historical conditions concerning hydrology, water demand, and surface water supply availability or reliability have impacted the ability of the Agency to operate the basin within sustainable yield. Basin hydrology may be characterized and evaluated using water year type.	2-165:2-166	2.4.2	2-108		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(3)		Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components. The projected water budget shall utilize the following methodologies and assumptions to estimate future baseline conditions concerning hydrology, water demand and surface water supply availability or reliability over the planning and implementation horizon:					
		(A)	Projected hydrology shall utilize 50 years of historical precipitation, evapotranspiration, and streamflow information as the baseline condition for estimating future hydrology. The projected hydrology information shall also be applied as the baseline condition used to evaluate future scenarios of hydrologic uncertainty associated with projections of climate change and sea level rise.	2-165:2-166, 2-170:2-172, 2-188:2-191, 2-195:2-201,2-201:2-205,2-205:2-212,2-212:2-217	2.4.2, 2.4.4.3, 2.4.5.3, 2.4.6, 2.4.7, 2.4.8, 2.4.9	2-108, 2-115:2-132	2-13, 2-20:2-28	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(B)	Projected water demand shall utilize the most recent land use, evapotranspiration, and crop coefficient information as the baseline condition for estimating future water demand. The projected water demand information shall also be applied as the baseline condition used to evaluate future scenarios of water demand uncertainty associated with projected changes in local land use planning, population growth, and climate.	2-170:2-172, 2-188:2-191, 2-195:2-201,2-201:2-205,2-205:2-212,2-212:2-217	2.4.4.3, 2.4.5.3, 2.4.6, 2.4.7, 2.4.8, 2.4.9	2-115:2-132	2-20:2-28	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(C)	Projected surface water supply shall utilize the most recent water supply information as the baseline condition for estimating future surface water supply. The projected surface water supply shall also be applied as the baseline condition used to evaluate future scenarios of surface water supply availability and reliability as a function of the historical surface water supply identified in Section 354.18(c)(2)(A), and the projected changes in local land use planning, population growth, and climate.	2-165:2-166, 2-170:2-172, 2-188:2-191, 2-195:2-201,2-201:2-205,2-205:2-212,2-212:2-217	2.4.2, 2.4.4.3, 2.4.5.3, 2.4.6, 2.4.7, 2.4.8, 2.4.9	2-115:2-132	2-13, 2-20:2-28	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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(d)			The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:					
	(1)		Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.	2-165:2-166,2-168:2-170	2.4.2, 2.4.4.1	2-108		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Current water budget information for temperature, water year type, evapotranspiration, and land use.	2-165:2-166,2-168:2-170	2.4.2, 2.4.4.2	2-108		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Projected water budget information for population, population growth, climate change, and sea level rise.	2-170:2-172, 2-188:2-191, 2-195:2-201,2-201:2-205,2-205:2-212,2-212:2-217	2.4.4.3, 2.4.5.3, 2.4.6, 2.4.7, 2.4.8, 2.4.9			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(e)			Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change, sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions.	2-163:2-165, 2-166:2-167, X-X:X-X	2.4.1, 2.4.3, Appendix 2-A:2-C			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.Pages ____reference Appendix 2-A:2-C: Eastern San Joaquin Water Resources Model reports.
(f)			The Department shall provide the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the Integrated Water Flow Model (IWFM) for use by Agencies in developing the water budget. Each Agency may choose to use a different groundwater and surface water model, pursuant to Section 352.4.	2-163:2-165, 2-166:2-167, X-X:X-X	2.4.1, 2.4.3, Appendix 2-A:2-C			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.Pages ____reference Appendix 2-A:2-C: Eastern San Joaquin Water Resources Model reports.
			Note: Authority cited: Section 10733.2, Water Code.					

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			Reference: Sections 10721, 10723.2, 10727.2, 10727.6, 10729, and 10733.2, Water Code.					
§ 354.20.			**Management Areas**					
(a)			Each Agency may define one or more management areas within a basin if the Agency has determined that creation of management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin.	N/A				No management areas have been identified for the Eastern San Joaquin Subbasin.
(b)			A basin that includes one or more management areas shall describe the following in the Plan:					
	(1)		The reason for the creation of each management area.	N/A				No management areas have been identified for the Eastern San Joaquin Subbasin.
	(2)		The minimum thresholds and measurable objectives established for each management area, and an explanation of the rationale for selecting those values, if different from the basin at large.	N/A				No management areas have been identified for the Eastern San Joaquin Subbasin.
	(3)		The level of monitoring and analysis appropriate for each management area.	N/A				No management areas have been identified for the Eastern San Joaquin Subbasin.
	(4)		An explanation of how the management area can operate under different minimum thresholds and measurable objectives without causing undesirable results outside the management area, if applicable.	N/A				No management areas have been identified for the Eastern San Joaquin Subbasin.
(c)			If a Plan includes one or more management areas, the Plan shall include descriptions, maps, and other information required by this Subarticle sufficient to describe conditions in those areas.	N/A				No management areas have been identified for the Eastern San Joaquin Subbasin.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10733.2 and 10733.4, Water Code.					
SubArticle 3.			**Sustainable Management Criteria**					
§ 354.22.			**Introduction to Sustainable Management Criteria**					
			This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.24.			**Sustainability Goal**					

Article 5.			Plan Contents for Eastern San Joaquin Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
			Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.	1-2,3-1:3-2	1.1.2, 3.1			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10727, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.26.			**Undesirable Results**					
(a)			Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.	3-3:3-5, 3-13:3-14, 3-15:3-16, 3-23, 3-23:3-25,3-28	3.3.1.1.1, 3.3.1.1.2, 3.3.2.1.1, 3.3.2.1.2, 3.3.3.1.1, 3.3.3.1.2, 3.3.4, 3.3.5.1.1, 3.3.5.1.2, 3.3.6.1.1, 3.3.6.1.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			The description of undesirable results shall include the following:					
	(1)		The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.	3-5,3-13:3-14,3-15:3-16,3-23,3-25:3-26,3-28,X-X:X-X	3.3.1.1.3, 3.3.2.1.3, 3.3.3.1.3, 3.3.4, 3.3.5.1.3, 3.3.6.1.3, Appendix 3-E			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024. Pages ___ reference to Appendix 3-E Technical Memorandum No. 4 - Water Budgets and Groundwater Storage.
	(2)		The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.	3-4:3-5, 3-13:3-14, 3-16, 3-23, 3-25, 3-28	3.3.1.1.2, 3.3.2.1.2, 3.3.3.1.2, 3.3.4, 3.3.5.1.2, 3.3.6.1.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
	(3)		Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.	3-5, 3-14, 3-16, 3-23, 3-26, 3-28:3-29	3.3.1.1.4, 3.3.2.1.4, 3.3.3.1.4, 3.3.4, 3.3.5.1.4, 3.3.6.1.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.	3-5:3-10, 3-14:3-15, 3-17:3-20, 3-23, 3-26:3-27, 3-29:3-31	3.3.1.2, 3.3.2.2, 3.3.3.2, 3.3.4, 3.3.5.2, 3.3.6.2	3-2, 3-3, 3-5, 3-6	3-1, 3-4, 3-7	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(d)			An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.	N/A				The Eastern San Joaquin GSP establishes minimum thresholds for each of the six sustainability indicators.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10721, 10723.2, 10727.2, 10733.2, and 10733.8, Water Code.					
§ 354.28.			**Minimum Thresholds**					
(a)			Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.	3-5:3-10, 3-14:3-15, 3-17:3-20, 3-23, 3-26:3-27, 3-29:3-31	3.3.1.2, 3.3.2.2, 3.3.3.2, 3.3.4, 3.3.5.2, 3.3.6.2	3-2:3-6	3-1, 3-4, 3-7	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			The description of minimum thresholds shall include the following:					
	(1)		The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.	3-5:3-10, 3-14:3-15, 3-17:3-20, 3-23, 3-26:3-27, 3-29:3-31	3.3.1.2, 3.3.2.2, 3.3.3.2, 3.3.4, 3.3.5.2, 3.3.6.2	3-2:3-6	3-1, 3-4, 3-7	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.	3-5:3-10, 3-14:3-15, 3-17:3-20, 3-23, 3-26:3-27, 3-29:3-31	3.3.1.2, 3.3.2.2, 3.3.3.2, 3.3.4.2, 3.3.5.2, 3.3.6.2	3-2:3-6	3-1, 3-4, 3-7	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(3)		How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.	3-5:3-10, 3-14:3-15, 3-17:3-20, 3-23, 3-26:3-27, 3-29:3-31	3.3.1.2, 3.2.2.2, 3.3.3.2, 3.3.4.2, 3.3.5.2, 3.3.6.2	3-2:3-6	3-1, 3-4, 3-7	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect change made in the 2024 GSP Amendment, updated November 2024.
	(4)		How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.	3-5:3-10, 3-14:3-15, 3-17:3-20, 3-23, 3-26:3-27, 3-29:3-31	3.3.1.2, 3.3.2.2, 3.3.3.2, 3.3.4.2, 3.3.5.2, 3.3.6.2	3-2:3-6	3-1, 3-4, 3-7	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect change made in the 2024 GSP Amendment, updated November 2024.
	(5)		How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.	3-5:3-10, 3-14:3-15, 3-17:3-20, 3-23, 3-26:3-27, 3-29:3-31	3.3.1.2, 3.3.2.2, 3.3.3.2, 3.3.4.2, 3.3.5.2, 3.3.6.2	3-2:3-6	3-1, 3-4, 3-7	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(6)		How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.	3-5:3-10, 3-14:3-15, 3-17:3-20, 3-23, 3-26:3-27, 3-29:3-31, 4-1:4-21	3.3.1.2, 3.3.2.2, 3.3.3.2, 3.3.4.2, 3.3.5.2, 3.3.6.2, 4.1:4.6	3-2:3-6	3-1, 3-4, 3-7, 4-1:4-8	This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			Minimum thresholds for each sustainability indicator shall be defined as follows:					
	(1)		Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:					
		(A)	The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.	2-80:2-98,2-134:2-139,2-163:2-217, 3-5:3-10,X-X:X-X,X-X:X-X	2.2.1, 2.3.1, 2.4, 3.3.1.2, Appendix 3-H:3-I, Appendix 3-C	2-42:2-43		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024. Pages __ and pages __ reference Appendix 3H Supplemental Data for Chronic Lowering of Groundwater Level Minimum Thresholds and Appendix 3-I Groundwater Level Representative Monitoring Well Historical Hydrographs.

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		(B)	Potential effects on other sustainability indicators.	3-3:3-12	3.3.1			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.	3-14:3-15, X-X:X-X	3.3.2.2, Appendix 3-E			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Seawater Intrusion. The minimum threshold for seawater intrusion shall be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results. Minimum thresholds for seawater intrusion shall be supported by the following:					
		(A)	Maps and cross-sections of the chloride concentration isocontour that defines the minimum threshold and measurable objective for each principal aquifer.	3-23, X-X:X-X	3.3.4, Appendix 3-F			Seawater intrusion is not considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin as the Subbasin is not in a coastal area and seawater intrusion is not currently present and is not reasonably expected to occur due to the active management of the 'X2' salinity barrier by the State. This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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		(B)	A description of how the seawater intrusion minimum threshold considers the effects of current and projected sea levels.	3-23, X-X:X-X	3.3.4, Appendix 3-F			Seawater intrusion is not considered an applicable sustainability indicator for the Eastern San Joaquin Subbasin as the Subbasin is not in a coastal area and seawater intrusion is not currently present and is not reasonably expected to occur due to the active management of the 'X2' salinity barrier by the State. This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		Degraded Water Quality. The minimum threshold for degraded water quality shall be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.	3-17:3-20,2-101:2-122,2-144:2-147,X-X:X-X	3.3.3.2, 2.2.4, 2.3.4, Appendix 3-F			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(5)		Land Subsidence. The minimum threshold for land subsidence shall be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. Minimum thresholds for land subsidence shall be supported by the following:					
		(A)	Identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects.	3-25:3-27	3.3.5.2	3-4:3-5		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(B)	Maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.	3-23:3-28,2-122:2-123, 2-147:2-155,X-X:X-X	3.3.5, 2.2.5, 2.3.5 Appendix 3-D	3-4		This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(6)		Depletions of Interconnected Surface Water. The minimum threshold for depletions of interconnected surface water shall be the rate or volume of surface water depletions caused by groundwater use that has adverse impacts on beneficial uses of the surface water and may lead to undesirable results. The minimum threshold established for depletions of interconnected surface water shall be supported by the following:					
		(A)	The location, quantity, and timing of depletions of interconnected surface water.	3-28:3-32, 2-123:2-126, 2-155:2-161	3.3.6, 2.2.6, 2.3.6	2-103, 2-105		This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(B)	A description of the groundwater and surface water model used to quantify surface water depletion. If a numerical groundwater and surface water model is not used to quantify surface water depletion, the Plan shall identify and describe an equally effective method, tool, or analytical model to accomplish the requirements of this Paragraph.	3-29:3-31,2-155:2-161, X-X:X-X	3.3.6.2, 2.3.6, Appendix 2-A:2-C			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024. Pages __ reference Appendix 2-A:2-C Eastern San Joaquin Water Resources Model Report (s).
(d)			An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.	3-29:3-31	3.3.6.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(e)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish minimum thresholds related to those sustainability indicators.					The Eastern San Joaquin GSP establishes minimum thresholds for each of the six sustainability indicators.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10733, 10733.2, and 10733.8, Water Code.					
§ 354.30.			**Measurable Objectives**					
(a)			Each Agency shall establish measurable objectives, including interim milestones in increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.	3-10:3-12, 3-15, 3-20:3-22,3-27:3-28, 3-31:3-32	3.3.1.3, 3.3.2.3, 3.3.3.3, 3.3.5.3, 3.3.6.3		3-2:3-3, 3-5:3-6, 3-8	This field has been updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.	3-10:3-12, 3-15, 3-20:3-22,3-27:3-28, 3-31:3-32	3.3.1.3, 3.3.2.3, 3.3.3.3, 3.3.5.3, 3.3.6.3		3-2:3-3, 3-5:3-6, 3-8	This field has been updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(c)			Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.	3-10:3-12, 3-15, 3-20:3-22,3-27:3-28, 3-31:3-32	3.3.1.3, 3.3.2.3, 3.3.3.3, 3.3.5.3, 3.3.6.3		3-2:3-3, 3-5:3-6, 3-8	This field has been updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(d)			An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.	3-10:3-12, 3-15, 3-20:3-22,3-27:3-28, 3-31:3-32	3.3.1.3, 3.3.2.3, 3.3.3.3, 3.3.5.3, 3.3.6.3			This field was updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(e)			Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.	3-10:3-12, 3-15, 3-20:3-22,3-27:3-28, 3-31:3-32	3.3.1.3, 3.3.2.3, 3.3.3.3, 3.3.5.3, 3.3.6.3		3-2:3-3, 3-5:3-6, 3-8	This field has been updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(f)			Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.	N/A				Measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 have not been included, as this is optional.
(g)			An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.	3-10:3-12, 3-15, 3-20:3-22,3-27:3-28, 3-31:3-32	3.3.1.3, 3.3.2.3, 3.3.3.3, 3.3.5.3, 3.3.6.3		3-2:3-3, 3-5:3-6, 3-8	This field has been updated to reflect changes made in the Revised GSP, updated June 2022. This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					
SubArticle 4.			**Monitoring Networks**					
§ 354.32.			**Introduction to Monitoring Networks**					
			This Subarticle describes the monitoring network that shall be developed for each basin, including monitoring objectives, monitoring protocols, and data reporting requirements. The monitoring network shall promote the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.34.			**Monitoring Network**					

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(a)			Each Agency shall develop a monitoring network capable of collecting sufficient data to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface conditions, and yield representative information about groundwater conditions as necessary to evaluate Plan implementation.	4-4:4-25	4.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			Each Plan shall include a description of the monitoring network objectives for the basin, including an explanation of how the network will be developed and implemented to monitor groundwater and related surface conditions, and the interconnection of surface water and groundwater, with sufficient temporal frequency and spatial density to evaluate the affects and effectiveness of Plan implementation. The monitoring network objectives shall be implemented to accomplish the following:					
	(1)		Demonstrate progress toward achieving measurable objectives described in the Plan.	4-4:4-21	4.1:4.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Monitor impacts to the beneficial uses or users of groundwater.	4-4:4-21	4.1:4.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds.	4-4:4-21	4.1:4.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		Quantify annual changes in water budget components.	4-4:4-21	4.1:4.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			Each monitoring network shall be designed to accomplish the following for each sustainability indicator:					
	(1)		Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:					
		(A)	A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.	4-9:4-10	4.1.4		4-2,4-3	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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		(B)	Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.	4-9	4.1.3			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.	4-10, 3-13:3-15, 2-139: 2-140	4.2, 3.3.2, 2.3.2	2-89		This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Seawater Intrusion. Monitor seawater intrusion using chloride concentrations, or other measurements convertible to chloride concentrations, so that the current and projected rate and extent of seawater intrusion for each applicable principal aquifer may be calculated.	4-14:4-15	4.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.	4-10:4-14	4.3	4-2	4-4	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(5)		Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.	4-15:4-18	4.5	4-3	4-7	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(6)		Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:					
		(A)	Flow conditions including surface water discharge, surface water head, and baseflow contribution.	4-18:4-21,4-22:4-25	4.6, 4.7.3:4.7.5			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(B)	Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.	4-18:4-21,4-22:4-25	4.6, 4.7.3:4.7.5			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
		(C)	Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.	4-18:4-21,4-22:4-25	4.6, 4.7.3:4.7.5			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(D)	Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.	4-18:4-21,4-22:4-25	4.6, 4.7.3:4.7.5			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(d)			The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.	N/A				No management areas have been identified for the Eastern San Joaquin Subbasin.
(e)			A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.	4-4:4-21	4.1:4.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(f)			The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:					
	(1)		Amount of current and projected groundwater use.	4-9:4-10, 4-14, 4-17:4-18, 4-21	4.1.4, 4.3.4, 4.5.4,4.6.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.	4-9:4-10, 4-14, 4-17:4-18, 4-21	4.1.4, 4.3.4, 4.5.4,4.6.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.	4-9:4-10, 4-14, 4-17:4-18, 4-21	4.1.4, 4.3.4, 4.5.4,4.6.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(4)		Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.	4-9:4-10, 4-14, 4-17:4-18, 4-21	4.1.4, 4.3.4, 4.5.4,4.6.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(g)			Each Plan shall describe the following information about the monitoring network:					
	(1)		Scientific rationale for the monitoring site selection process.	4-4:4-8,4-8:4-9, 4-10,4-11:4-13, 4-13:4-14, 4-14:4-15, 4-15:4-17,4-17,4-18:4-20,4-21	4.1.1, 4.1.2, 4.2, 4.3.1, 4.3.2, 4.4, 4.5.1, 4.5.2, 4.6.1, 4.6.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.	4-4:4-10, 4-10:4-14, 4-15:4-18, 4-18:4-21, 4-21:4-25	4.1, 4.3, 4.5,4.6, 4.7			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.	4-4:4-25	4.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(h)			The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.	4-4:4-10, 4-10:4-14, 4-15:4-18, 4-18:4-21, 4-21:4-25	4.1, 4.3, 4.5, 4.6, 4.7	4-1:4-4	4-1, 4-4, 4-7:4-8	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(i)			The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.	4-8:4-9, 4-13:4-14, 4-17, 4-21	4.1.2, 4.3.2, 4.5.2, 4.6.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(j)			An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.	N/A				The Eastern San Joaquin GSP establishes minimum thresholds for each of the six sustainability indicators.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10727.4, 10728, 10733, 10733.2, and 10733.8, Water Code					

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§ 354.36.			**Representative Monitoring**					
			Each Agency may designate a subset of monitoring sites as representative of conditions in the basin or an area of the basin, as follows:					
(a)			Representative monitoring sites may be designated by the Agency as the point at which sustainability indicators are monitored, and for which quantitative values for minimum thresholds, measurable objectives, and interim milestones are defined.	4-4:4-8, 4-11:4-13, 4-15:4-17, 4-18:4-20	4.1.1, 4.3.1, 4.5.1,4.6.1, 4.4	4-1:4-4	4-1, 4-4, 4-7:4-8	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			(b) Groundwater elevations may be used as a proxy for monitoring other sustainability indicators if the Agency demonstrates the following:					
	(1)		Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.	4-10	4.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Measurable objectives established for groundwater elevation shall include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.	3-14:3-15	3.3.2.2			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			The designation of a representative monitoring site shall be supported by adequate evidence demonstrating that the site reflects general conditions in the area.	4-4:4-8	4.1.1			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2 and 10733.2, Water Code					
§ 354.38.			**Assessment and Improvement of Monitoring Network**					
(a)			Each Agency shall review the monitoring network and include an evaluation in the Plan and each five-year assessment, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin.	4-21:4-25	4.7			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			Each Agency shall identify data gaps wherever the basin does not contain a sufficient number of monitoring sites, does not monitor sites at a sufficient frequency, or utilizes monitoring sites that are unreliable, including those that do not satisfy minimum standards of the monitoring network adopted by the Agency.	4-21:4-22	4.7.1:4.7.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(c)			If the monitoring network contains data gaps, the Plan shall include a description of the following:					

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	(1)		The location and reason for data gaps in the monitoring network.	4-21:4-22	4.7.1:4.7.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Local issues and circumstances that limit or prevent monitoring.	4-21:4-22	4.7.1:4.7.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(d)			Each Agency shall describe steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.	4-22:4-25	4.7.5	4-5	4-9	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(e)			Each Agency shall adjust the monitoring frequency and density of monitoring sites to provide an adequate level of detail about site-specific surface water and groundwater conditions and to assess the effectiveness of management actions under circumstances that include the following:					
	(1)		Minimum threshold exceedances.	4-4:4-25	4.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(2)		Highly variable spatial or temporal conditions.	4-4:4-25	4.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		Adverse impacts to beneficial uses and users of groundwater.	4-4:4-25	4.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		The potential to adversely affect the ability of an adjacent basin to implement its Plan or impede achievement of sustainability goals in an adjacent basin.	4-4:4-25	4.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10723.2, 10727.2, 10728.2, 10733, 10733.2, and 10733.8, Water Code					

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§ 354.40.			**Reporting Monitoring Data to the Department**					
			Monitoring data shall be stored in the data management system developed pursuant to Section 352.6. A copy of the monitoring data shall be included in the Annual Report and submitted electronically on forms provided by the Department.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10728, 10728.2, 10733.2, and 10733.8, Water Code.					
SubArticle 5.			**Projects and Management Actions**					
§ 354.42.			**Introduction to Projects and Management Actions**					
			This Subarticle describes the criteria for projects and management actions to be included in a Plan to meet the sustainability goal for the basin in a manner that can be maintained over the planning and implementation horizon.					
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Section 10733.2, Water Code.					
§ 354.44.			**Projects and Management Actions**					
(a)			Each Plan shall include a description of the projects and management actions the Agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.	6-1:6-59	6.0	6-1:6-2	6-1:6-2	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(b)			Each Plan shall include a description of the projects and management actions that include the following:					
	(1)		A list of projects and management actions proposed in the Plan with a description of the measurable objective that is expected to benefit from the project or management action. The list shall include projects and management actions that may be utilized to meet interim milestones, the exceedance of minimum thresholds, or where undesirable results have occurred or are imminent. The Plan shall include the following:					
		(A)	A description of the circumstances under which projects or management actions shall be implemented, the criteria that would trigger implementation and termination of projects or management actions, and the process by which the Agency shall determine that conditions requiring the implementation of particular projects or management actions have occurred.	6-2:6-54	6.2.2:6.2.6		6-1:6-2	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
		(B)	The process by which the Agency shall provide notice to the public and other agencies that the implementation of projects or management actions is being considered or has been implemented, including a description of the actions to be taken.	6-54	6.2.7			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

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	(2)		If overdraft conditions are identified through the analysis required by Section 354.18, the Plan shall describe projects or management actions, including a quantification of demand reduction or other methods, for the mitigation of overdraft.	6-1:6-58	6.1:6.4			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(3)		A summary of the permitting and regulatory process required for each project and management action.	6-2:6-54	6.2.2:6.2.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(4)		The status of each project and management action, including a time-table for expected initiation and completion, and the accrual of expected benefits.	6-2:6-54	6.2.2:6.2.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(5)		An explanation of the benefits that are expected to be realized from the project or management action, and how those benefits will be evaluated.	6-2:6-54	6.2.2:6.2.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(6)		An explanation of how the project or management action will be accomplished. If the projects or management actions rely on water from outside the jurisdiction of the Agency, an explanation of the source and reliability of that water shall be included.	6-2:6-54	6.2.2:6.2.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(7)		A description of the legal authority required for each project and management action, and the basis for that authority within the Agency.	6-2:6-54	6.2.2:6.2.6			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(8)		A description of the estimated cost for each project and management action and a description of how the Agency plans to meet those costs.	6-2:6-54	6.2.3:6.2.6		6-1:6-2	This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
	(9)		A description of the management of groundwater extractions and recharge to ensure that chronic lowering of groundwater levels or depletion of supply during periods of drought is offset by increases in groundwater levels or storage during other periods.	6-1:6-59	6.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.

Article 5.			Plan Contents for Eastern San Joaquin Basin	GSP Document References				
				Page Numbers of Plan	Or Section Numbers	Or Figure Numbers	Or Table Numbers	Notes
(c)			Projects and management actions shall be supported by best available information and best available science.	6-1:6-59	6.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
(d)			An Agency shall take into account the level of uncertainty associated with the basin setting when developing projects or management actions.	6-1:6-59	6.0			This field was updated to reflect changes made in the Revised GSP, updated June 2022.This field was updated again to reflect changes made in the 2024 GSP Amendment, updated November 2024.
			Note: Authority cited: Section 10733.2, Water Code.					
			Reference: Sections 10727.2, 10727.4, and 10733.2, Water Code.					

ATTACHMENT 2

APPENDIX 1-E.
COMMUNITY WATER SYSTEMS

ATTACHMENT 2

Community Water Systems		
Organization	Water System Population	Water System Connections
4N MOBILEHOME PARK	65	31
A1 WINSTONS MOBILE HOME PARK	75	30
ACAMPO WATER SYSTEM	231	70
ALMOND PARK WATER SYSTEM	60	20
ARBOR MOBILE HOME PARK WS	340	173
B&G MOBILE HOME PARK LLC WS	50	22
BEL AIR MOBILE ESTATE	325	117
BIG WHEEL MOBILE HOME PARK	120	63
CALIFORNIA WATER SERVICE - STOCKTON	175,026	44,213
CAMANCHE SOUTH SHORE-EBMUD	666	448
CARDOZA VILLA CORP	30	12
CARIBOU MOBILE PARK PWS	180	72
CASA DE AMIGOS MANUFACTURED HOUSING COMM	220	73
CCWD - JENNY LIND	9,861	3,825
CCWD - WALLACE	255	108
CENTURY MOBILE HOME PARK	50	19
CHERRY LANE TRAILER PARK	100	43
CITY OF LATHROP	35,080	9,893
CITY OF MODESTO - DEL RIO	1,327	402
CITY OF STOCKTON	183,046	50,129
CLEMENTS WATER WORKS #43	264	80
COUNTRY CLUB VISTA MUTUAL WATER CO	75	31
COUNTRY MANOR MHP	75	41
COUNTRY SQUIRE MOBILE ESTATES & WATER SY	131	49
DOUBLE L MOBILE ESTATES	320	150
EL RIO MOBILE HOME PARK	60	28
ELKHORN ESTATES WATER SYSTEM	234	71
ENCLAVE AT THE DELTA	39	15
ESCALON, CITY OF	7,362	2,521
FAIRWAY ESTATES PWS CSA-18	149	45

ATTACHMENT 2

Organization	Water System Population	Water System Connections
FARMINGTON WATER COMPANY	270	78
FINNLEES TRAILER PARK	55	26
FREMONT ONE	39	15
GALT, CITY OF	26,536	7,687
GAYLA MANOR PWS	178	54
GLENWOOD MOBILE HOME PARK	100	50
HANOT FOUNDATION INC	38	15
HAVEN ACRES RIVER CLUB INC	100	51
HAYNES BOARD & CARE HOME	41	15
IL VINETO	160	83
ISLANDER MARINA	150	75
KING ISLAND TRAILER PARK WATER SYSTEM	236	76
KNIGHTS FERRY COMM. SVC. DIST.	168	67
LINDEN COUNTY WATER DISTRICT	1,784	617
LITTLE POTATO SLOUGH MUTUAL	1,510	202
LOCKEFORD COMMUNITY SERV. DIST.	2,500	846
LOCKEFORD MOBILE HOME PARK WTR SYS	100	42
LODI HOMES	39	12
LODI LAKE MOBILE HOME PARK	104	54
LODI, CITY OF	68,272	29,421
MANTECA, CITY OF	84,625	25,967
MAPACHE TRAILER PARK	275	99
MARTINEZ APARTMENTS	26	9
MOBILE VILLAS TRAILER PARK	130	36
MOKELUMNE MOBILE SENIOR PARK	55	25
MORADA ACRES WATER SYSTEM	105	32
MORADA ESTATES N PWS #46	426	129
MORADA ESTATES PWS	290	88
MORADA MANOR WATER SYSTEM	112	34
NEW HOPE LANDING GENERAL STORE	125	44
NORTH OAKS MUTUAL WATER CO	234	78

ATTACHMENT 2

Organization	Water System Population	Water System Connections
OAKDALE, CITY OF	23,235	8,291
OAKWOOD LAKE WATER DISTRICT-SUBDIVISION	1,479	448
OID-OAKDALE RURAL WATER SYSTEM #1	1,570	473
RANCHO SAN JOAQUIN WATER SYS	172	52
RIPON, CITY OF	15,979	5,134
RIVERBANK, CITY OF	24,834	7,096
RIVERBANK, CITY OF	24,834	7,096
RIVERSIDE MOBILE HOME PARK	55	58
SAHARA MOBILE COURT	300	162
SAN JOAQUIN COUNTY - COLONIAL HEIGHTS	1,841	559
SAN JOAQUIN COUNTY - LINCOLN VILLAGE	5,990	1,815
SAN JOAQUIN COUNTY - THORNTON	964	292
SAN JOAQUIN COUNTY - WILKINSON MANOR	851	258
SAN JOAQUIN COUNTY-MOKELUMNE ACRES	3,802	1,152
SAN JOAQUIN COUNTY-RAYMUS VILLAGE	1,086	329
SAN JOAQUIN WATER WORKS #2	310	94
SAN JUAN VISTA	201	72
SHADED TERRACE PWS	238	72
SHADY REST TRAILER COURT	120	49
SPRING CREEK ESTATES PWS	119	36
STOCKTON VERDE MOBILE HOME PARK	722	293
SUNNY ROAD WATER SYSTEM	34	12
SUNNYSIDE ESTATES WATER SYSTEM	69	21
TAHAMA VILLAGE MOBILE HOME PARK	200	68
TWIN CYPRESS MOBILE HOME PARK	112	45
TWIN OAKS MOBILE PARK	238	85
V & P TRAILER COURT WATER SYSTEM	35	15
VALLEY SPRINGS PUD	900	263
VILLA CEREZOS	200	82
WALNUT ACRES	106	32
WAYSIDE MOTEL APARTMENTS WTR SYS	70	25

ATTACHMENT 2

Organization	Water System Population	Water System Connections
WILKINSON MANOR A-ZONE PWS	125	38
WINE COUNTRY APARTMENTS	40	16
WOODBRIDGE MOBILE ESTATES	110	37

APPENDIX 1-F.
RELEVANT GENERAL PLAN GOALS AND POLICIES

San Joaquin County General Plan

The abbreviations following each policy and program refer to the types of tools or actions the County can use to carry out the policies. There are eight types of tools and actions, listed below.

1. *Regulation and Development Review (RDR)*
2. *Plans, Strategies, and Programs (PSP)*
3. *Financing and Budgeting (FB)*
4. *Planning Studies and Reports (PSR)*
5. *County Services and Operations (SO)*
6. *Inter-governmental Coordination (IGC)*
7. *Joint Partnerships with the Private Sector (JP)a*
8. *Public Information (PI)*

The following San Joaquin County General Plan Land Use (LU) Element goals and policies related to groundwater use will potentially influence implementation of the GSP.

- Policy LU-1.1 Compact Growth and Development (RDR): The County shall discourage urban sprawl and promote compact development patterns, mixed-use development, and higher-development intensities that conserve agricultural land resources, protect habitat, support transit, reduce vehicle trips, improve air quality, make efficient use of existing infrastructure, encourage healthful, active living, conserve energy and water, and diversify San Joaquin County's housing stock.
- Policy LU-1.7 Farmland Preservation (RDR): The County shall consider information from the State Farmland Mapping and Monitoring Program when designating future growth areas in order to preserve prime farmland and limit the premature conversion of agricultural lands.
- Policy LU 2.2 Sustainable Building Practices (RDR): The County shall promote and, where appropriate, require sustainable building practices that incorporate a “whole system” approach to designing and constructing buildings that consume less energy, water and other resources, facilitate natural ventilation, use daylight effectively, and are healthy, safe, comfortable, and durable.
- Policy LU-2.17 Delta Primary Zone Amendments (RDR/PSP): The County shall require proposed General Plan amendment or zoning reclassification for areas in the Primary Zone of the Delta to be consistent with the Land Use and Resource Management Plan for the Primary Zone of the Delta, as required by the State Delta Protection Act of 1992 (Public Resources Code 29700 et seq.).
- Policy LU-8.1 Open Space Preservation (PSP): The County shall limit, to the extent feasible, the conversion of open space and agricultural lands to urban uses and place a high priority on preserving open space lands for recreation, habitat protection and enhancement, flood hazard management, public safety, water resource protection, and overall community benefit.

The following San Joaquin County General Plan County Areas and Communities (C) Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Policy C-1.2 Character and Quality of Life (RDR): The County shall encourage new development in Urban and Rural communities to be designed to strengthen the desirable characteristics and historical character of the communities, be supported by necessary public facilities and services, and be compatible with historical resources and nearby rural or resource uses.

- Policy C-5.2 Community Expansion Considerations (RDR/PSP): As part of any General Plan amendment to expand a community, the County shall consider the following:
  - impacts on existing neighborhoods, residents, and businesses;
  - availability of a variety of housing choices for all socio-economic segments of the community;
  - the balance between jobs and housing;
  - availability of water for all existing and planned development;
  - long-term provision of infrastructure and services for existing and planned development;
  - creation of complete streets that provide for automobiles, pedestrians, bicycles, and public transit users;
  - connections among pedestrian, bicycle, and open spaces and neighborhoods, commercial areas, and employment centers;
  - impacts on the fiscal resources of the County and nearby cities. (RDR/PSP)
- Policy C-6.18 New Urban Community Water Supply (RDR/PSP): The County shall require new Urban Communities demonstrate access to adequate water supplies to meet the ultimate buildout of the community, consistent with General Plan policies for reducing further groundwater aquifer overdraft and maintaining sufficient water supplies for agriculture. Applicants for new Urban Communities shall be required to study and guarantee, through a development agreement, that existing and future water supply needs can be met and that existing users' water supplies will not be negatively impacted.

The following San Joaquin County General Plan Economic Development (ED) Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Policy ED-3.2 Considerations for New Commercial and Industrial Development (RDR): The County shall consider the following factors when reviewing proposed non-agricultural commercial and industrial development applications, including:
  - Water – New developments must have long-term water supplies to meet the ultimate demand of the development and surrounding area and ensure the continued viability of existing and future development
- Goal ED-4: To support the continued financial growth of the agricultural sector and ag-related businesses.
- Policy ED-4.8 Protect Agricultural Infrastructure (PSP): The County shall recognize and protect agricultural infrastructure, such as farm-to-market routes, water diversion and conveyance structures, airfields, processing facilities, research and development facilities, and farmworker housing.

The following San Joaquin County General Plan Infrastructure and Services (IS) Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Goal IS-4: To ensure reliable supplies of water for unincorporated areas to meet the needs of existing and future residents and businesses, while promoting water conservation and the use of sustainable water supply sources.
- Policy IS-4.1 Interagency Cooperation (IGC): The County shall support efforts of local water agencies, special district, and water conservation districts to ensure that adequate high-quality water supplies are available to support existing and future residents and businesses.
- Policy IS-4.2 Interagency Cooperation (IGC): The County shall work with local water agencies to address existing and future water needs for the County.
- Policy IS-4.3 Water Supply Availability (RDR/PSP): The County shall consider the availability of a long-term, reliable potable water supply as a primary factor in the planning of areas for new growth and development.
- Policy IS-4.4 Water Rights Protection (IGC): The County shall support local water agencies in their efforts to protect their water rights and water supply contracts, including working with Federal and State water projects to protect local water rights.

- Policy IS-4.5 Drought Response (PSP/IGC): The County shall encourage all local water agencies to develop and maintain drought contingency and emergency services plans, emergency inter-ties, mutual aid agreements, and related measures to ensure adequate water service during drought or other emergency water shortages.

- Policy IS-4.6 Coordinate Efforts for Adequate Water Supply (PSP/IGC): The County shall support coordinated efforts to obtain adequate water supplies and develop water storage facilities to meet expected water demand.

- Policy IS-4.7 Conjunctive Use (PSP/IGC): The County shall support conjunctive use of groundwater and surface water by local water agencies to improve water supply reliability.

- Policy IS-4.8 Water Conservation Measures (RDR): The County shall require existing and new development to incorporate all feasible water conservation measures to reduce the need for water system improvements.

- Policy IS-4.9 Groundwater Management (IGC): The County shall continue to support cooperative, regional groundwater management planning by local water agencies, water users, and other affected parties to ensure a sustainable, adequate, safe, and economically viable groundwater supply for existing and future uses within the County.

- Policy IS-4.10 Groundwater Monitoring Program (PSR/IGC): The County shall continue to evaluate the quantity and quality of groundwater.

- Policy IS-4.11 Integrated Regional Water Management: The County shall support and participate in the development, implementation, and update of an integrated regional water management plan.

- Policy IS-4.12 Water Supply Planning (PSP/IGC): The County shall encourage local water agencies to develop plans for responding to droughts and the effects of global climate change, including contingency plans, water resource sharing to improve overall water supply reliability, and the allocation of water supply to priority users.

- Policy IS-4.13 Water Quality Standards (RDR): The County shall require that water supplies serving new development meet State water quality standards. If necessary, the County shall require that water be treated to meet State standards and that a water quality monitoring program be in place prior to issuance of building permits.

- Policy IS-4.14 Sufficient Water Supply Assessments (RDR): The County shall require new developments over 500 dwelling units in size to prepare a detailed water source sufficiency study and water supply analysis for use in preparing a Water Supply Assessment, consistent with any Integrated Regional Water Management Plan or similar water management plan. This shall include analyzing the effect of new development on the water supply of existing users.

- Policy IS-4.15 Test Wells (RDR/PSR): Prior to issuing building permits for new development that will rely on groundwater, the County shall require confirmation for existing wells or test wells for new wells to ensure that water quality and quantity are adequate to meet the needs of existing, proposed, and planned future development.

- Policy IS-4.16 Permit for Groundwater Export (RDR): The County shall continue to require a permit for the extraction of groundwater that is intended to be exported outside County boundaries.

- Policy IS-4.17 Advocate Against Water Exports (PSP): The County shall advocate that water should not be exported to other areas of the state unless no other areas in San Joaquin County are impacted and the current and future needs of San Joaquin County can still be met.

- Policy IS-4.19 Water Efficient Landscaping (RDR): The County shall encourage water efficient landscaping and use of native, drought-tolerant plants consistent with the Model Landscape Ordinance.

- Policy IS-4.20 Water Efficient Agricultural Practices (PSP): The County shall encourage farmers to implement irrigation practices, where feasible and practical, to conserve water.

- Goal IS-5: To maintain an adequate level of service in the water systems serving unincorporated areas to meet the needs of existing and future residents and businesses, while improving water system efficiency.

- Policy IS-5.1 Adequate Water Treatment and Distribution Facilities (RDR): The County shall ensure, through the development review process, that adequate water, treatment and distribution facilities are sufficient to serve new development and are scalable to meet capacity demands when needed. Such needs shall include capacities necessary to comply with water quality and public safety requirements.

- Policy IS-5.2 Water System Standards (RDR): The County shall require the minimum standards for water system improvements provided in Table IS-1 for the approval of tentative maps and zone reclassifications.

- Policy IS-5.3 Water Service in Antiquated Subdivisions (RDR): The County shall require water service through a public water system prior to issuance of building permits for new residences on parcels less than two acres in antiquated subdivisions. Individual wells may be allowed if public water is not available and all well and sewage requirements can be met.

- Policy IS-5.4 Water Infrastructure Fees (RDR): As a condition of approval for new developments, the County shall require verification of payment of fees imposed for water infrastructure capacity per the fee payment schedule from the appropriate local agency prior to the approval of any final subdivision map.

- Policy IS-5.5 Water System Rehabilitation (PSP): The County shall encourage the rehabilitation of irrigation systems and other water delivery systems to reduce water losses and increase the efficient use and availability of water.

- Policy IS-5.6 Consistent Fire Protection Standards for New Development (RDR/IGC): The County, in coordination with local water agencies and fire protection agencies, shall ensure consistent and adequate standards for fire flows and fire protection for new development.

The following San Joaquin County General Plan Resource Conservation and Sustainability (NCR) goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Policy NCR-3.1 Preserve Groundwater Recharge Areas (PSP): The County shall strive to ensure that substantial groundwater recharge areas are maintained as open space.

- Policy NCR-3.2 Groundwater Recharge Projects (PSP): The County shall encourage the development of groundwater recharge projects of all scales within the County and cities to increase groundwater supplies.

- Policy NCR-3.3 Multi-Jurisdictional Groundwater Management Evaluation (IGC): The County shall support multi-jurisdictional groundwater management that involves adjacent groundwater basins.

- Policy NCR-3.4 Eliminate Pollution (PSP): The County shall support efforts to eliminate sources of pollution and clean up the County's waterways and groundwater.

- Policy NCR-3.7 Septic Tank Regulation (RDR): The County shall enforce its septic tank and onsite system regulations consistent with Central Valley Regional Water Quality Control Board policy that recognizes the County as the responsible agency to protect the water quality of surface water and groundwater.

The following San Joaquin County General Plan Delta Element (D) goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Policy D-2.4 Water Rights (RDR/PSP): The County shall protect existing water rights within the Delta, including the "area of origin" laws and anti-degradation policy of the SWRCB for areas in the Delta, such that there is no deprivation of the water needed for present and future reasonable beneficial use in the areas where the water originates.

- Goal D-4: To regulate development within the Delta to ensure the long-term viability of agricultural operations, success of natural ecosystems, and continuation of Delta heritage
- Goal D-6: To protect Delta water supplies for agricultural uses and ecosystems enhancement and improve overall Delta water quality.
- Policy D-6.2 Protect Delta Water Rights: The County shall defend the existing water right priority system and legislative protections established for the Delta.
- Policy D-6.5 Water Storage Options (IGC/PSR): The County shall advocate for the study of above- and below-ground storage options as part of a statewide improved flood management and water supply system.

Calaveras County General Plan

The following Calaveras County General Plan Land Use Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Policy II-25B: Encourage the development of alternative individual waste disposal systems which minimize pollution and water usage.

The following Calaveras County General Plan Conservation Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Goal IV-1: Preserve and encourage the use of land for agriculture purposes.
- Policy IV-1A: Allow resource production lands to remain available for agriculture and rural use.
- Goal IV-2: Protect legally established agriculture from encroachment by incompatible land uses.
- Goal IV-3: Preserve and encourage the expansion of high capability timber lands for timber protection and harvest.
- Policy IV-3A: Allow lands located within high capability timberlands to remain available for timber production.
- Goal IV-4: Maintain and increase timber land productivity.
- Policy IV-4A: Encourage sustained yield timber production and harvest.
- Goal IV-9: Preserve the County's current water rights and additional water rights necessary to support the County's full development potential.
- Policy IV-9A: Support the development of water projects in the County for domestic and irrigation purposes.
- Goal IV-10: Provide for adequate domestic water supplies.
- Policy IV-10A: Encourage continued cooperation among water suppliers in meeting the water needs for the County as a whole.

The following Calaveras County General Plan Open Space Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Goal V-2: Protect streams, rivers, and lakes from excessive sedimentation due to development and grading.
- Policy V-2A: Review proposed development projects for potential effects on nearby and adjacent streams, rivers, and lakes.
- Goal V-3: Protect and preserve riparian habitat along streams and rivers in the County.

- Policy V-9A: Balance water resources development with the preservation of streams and rivers in their natural state.

Stanislaus County General Plan

The following Stanislaus County General Plan Land Use Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Goal 1: Provide for diverse land use needs by designating patterns which are responsive to the physical characteristics of the land as well as to environmental, economic, and social concerns of the residents of Stanislaus County.

- Policy 2: Land designated Agriculture shall be restricted to uses that are compatible with agricultural practices, including natural resources management, open space, outdoor recreation, and enjoyment of scenic beauty.

- Policy 4: Urban development shall be discouraged in areas with growth-limiting factors such as high water table or poor soil percolation, and prohibited in geological fault and hazard areas, flood plains, riparian areas, and airport and private airstrip hazard areas, unless measures to mitigate the problems are included as part of the application.

- Policy 7: Riparian habitat along the rivers and natural waterways of Stanislaus County shall, to the extent possible, be protected.

- Policy 14: Uses shall not be permitted to intrude into or be located adjacent to an agricultural area if they are detrimental to continued agricultural usage of the surrounding area.

- Policy 17: Agriculture, as the primary industry of the County, shall be promoted and protected.

- Policy 24: Future growth shall not exceed the capabilities/capacity of the provider of services such as sewer, water, public safety, solid waste management, road systems, schools, health care facilities, etc.

- Policy 29: Support the development of a built environment that is responsive to decreasing air and water pollution, reducing the consumption of natural resources and energy, increasing the reliability of local water supplies, and reduces vehicle miles traveled by facilitating alternative modes of transportation, and promoting active living (integration of physical activities, such as biking and walking, into everyday routines) opportunities.

- Goal 7: Provide for direct citizen participation in land use decisions involving the expansion of residential uses into agricultural and open-space areas in order to encourage compact urban form and to preserve agricultural land.

The following Stanislaus County General Plan Conservation/Open Space Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Goal 2: Conserve water resources and protect water quality in the County.

- Policy 5: Protect groundwater aquifers and recharge areas, particularly those critical for the replenishment of reservoirs and aquifers.

- Policy 6: Preserve natural vegetation to protect waterways from bank erosion and siltation.

- Policy 7: New development that does not derive domestic water from pre-existing domestic and public water supply systems shall be required to have a documented water supply that does not adversely impact Stanislaus County water resources.
- Policy 8: The County shall support efforts to develop and implement water management strategies
- Policy 9: The County will investigate additional sources of water for domestic use.

The following Stanislaus County General Plan Agricultural Element goals and policies related to groundwater use will potentially influence implementation of the GSP:

- Goal 1: Strengthen the agricultural sector of our economy.
- Policy 1.1: Efforts to promote the location of new agriculture-related business and industry in Stanislaus County shall be supported.
- Policy 1.10: The County shall protect agricultural operations from conflicts with non-agricultural uses by requiring buffers between proposed non-agricultural uses and adjacent agricultural operations.
- Goal 2: Conserve our agricultural lands for agricultural uses.
- Goal 3: Protect the natural resources that sustain our agricultural industry.
- Policy 3.4: The County shall encourage the conservation of water for both agricultural, rural domestic, and urban uses.
- Policy 3.5: The County will continue to protect the quality of water necessary for crop production and marketing.
- Policy 3.6: The County will continue to protect local groundwater for agricultural, rural domestic, and urban use in Stanislaus County.

City of Stockton General Plan

- Policy SAF-3.2: Protect the availability of clean potable water from groundwater sources.
- Policy SAF-3.2A (PFS-2.11): Continue to cooperate with San Joaquin County, SEWD, and Cal Water to monitor groundwater withdrawals and ensure that they fall within the target yield for the drinking water aquifer.
- Policy SAF-3.3: Encourage use of recycled ("gray") water for landscaping irrigation to reduce demand on potable supplies.
- Policy SAF-3.3A: Require new development to install non-potable water infrastructure for irrigation of large landscaped areas where feasible.
- Policy SAF-3.3B: Investigate and implement Code amendments to allow installation of dual plumbing and/or rainwater capture systems to enable use of recycled water and/or captured rainwater generated on-site.
- Policy SAF-3.4A: Require all new urban development to be served by an adequate wastewater collection system to avoid possible contamination of groundwater from onsite wastewater disposal systems.

City of Lodi General Plan

- Policy GM-G2: Provide infrastructure—including water, sewer, stormwater, and solid waste/recycling systems—that is designed and timed to be consistent with projected capacity requirements and development phasing.
- Policy GM-G3: Promote conservation of resources in order to reduce the load on existing and planned infrastructure capacity, and to preserve existing environmental resources.
- Policy GM-P8: Ensure that public facilities and infrastructure—including water supply, sewer, and stormwater facilities—are designed to meet projected capacity requirements to avoid the need for future replacement and upsizing, pursuant to the General Plan and relevant master planning.
- Policy GM-P12: Require water conservation in both City operations and private development to minimize the need for the development of new water sources and facilities. To the extent practicable, promote water conservation and reduced water demand by:

- Requiring the installation of non-potable water (recycled or gray water) infrastructure for irrigation of landscaped areas over one acre of new landscape acreage, where feasible. Conditions of approval shall require connection and use of nonpotable water supplies when available at the site.

- Encouraging water-conserving landscaping, including the use of drought-tolerant and native plants, xeriscaping, use of evapotranspiration water systems, and other conservation measures.

- Encouraging retrofitting of existing development with water-efficient plumbing fixtures, such as ultra low-flow toilets, waterless urinals, low-flow sinks and showerheads, and water efficient dishwashers and washing machines.

- <u>Policy C-P7 Agricultural Soil Resources:</u> Adopt an agricultural conservation program (ACP) establishing a mitigation fee to protect and conserve agricultural lands. The ACP shall include the collection of an agricultural mitigation fee for acreage converted from agricultural to urban use, taking into consideration all fees collected for agricultural loss (i.e., AB1600). The mitigation fee collected shall fund agricultural conservation easements, fee title acquisition, and research; the funding of agricultural education and local marketing programs; other capital improvement projects that clearly benefit agriculture (e.g., groundwater recharge projects); and administrative fees through an appropriate entity ("Administrative Entity") pursuant to an administrative agreement. Goal CO-2: Prevent the creation of new groundwater contamination or the spread of existing contamination.

- <u>Policy C-P13 Biological Resources</u>: Support the protection, restoration, expansion, and management of wetland and riparian plant communities along the Mokelumne River for passive recreation, groundwater recharge, and wildlife habitat.

- <u>Policy C-P27 Hydrology and Water Quality</u>: Monitor the water quality of the Mokelumne River and Lodi Lake, in coordination with San Joaquin County, to determine when the coliform bacterial standard for contact recreation and the maximum concentration levels of priority pollutants, established by the California Department of Health Services, are exceeded. Monitor the presence of pollutants and variables that could cause harm to fish, wildlife, and plant species in the Mokelumne River and Lodi Lake. Post signs at areas used by water recreationists warning users of health risks whenever the coliform bacteria standard for contact recreation is exceeded. Require new industrial development to not adversely affect water quality in the Mokelumne River or in the area's groundwater basin. Control use of potential water contaminants through inventorying hazardous materials used in City and industrial operations.

- <u>Policy C-P34 Hydrology and Water Quality</u>: Protect groundwater resources by working with the county to prevent septic systems in unincorporated portions of the county that are in the General Plan Land Use Diagram on parcels less than two acres.

- <u>Policy GM-P17 Potable Water Supply</u>: Cooperate with Northeastern San Joaquin County Groundwater Banking Authority, other member water agencies, and the WID to retain surface water rights and groundwater supply.

City of Manteca General Plan

- <u>Policy PF-P-5 Public Facilities and Services Element</u>: The City will continue to rely principally on groundwater resources for its municipal water in the near term and will participate in the regional improvements to deliver surface water to augment the City's groundwater supply.

- <u>Policy PF-P-15 Public Facilities and Services Element</u>: The City shall monitor water quality regularly and take necessary measures to prevent contamination.

- <u>Policy PF-P-16 Public Facilities and Services Element</u>: The City shall include a groundwater analysis as a technical analysis of water system capacity in the update of the Public Facilities Implementation Plan (PFIP) and shall prepare an environmental analysis in the PFIP that addresses the quality and availability of groundwater.

- <u>Policy PF-P-17 Public Facilities and Services Element</u>: The City shall consider incremental increases in the demands on groundwater supply and water quality when reviewing development applications.

- Policy RC-P-3 Resource Conservation Element – Water Conservation: The City shall protect the quantity of Manteca's groundwater.
- Policy RC-P-4 Resource Conservation Element – Water Conservation: The City shall require water conservation in both City operations and private development to minimize the need for the development of new water sources.
- Policy RC-P-5 Resource Conservation Element – Water Conservation: Development of private water wells within the city limits shall be allowed only where the City makes a finding that municipal water service is not readily and feasibly available, and such private well systems shall only be allowed to be used until such time as City water service becomes available.
- Policy RC-1.10: Where feasible, encourage and support multipurpose detention basins that provide water quality protection, storm water detention, groundwater recharge, open space amenities, and recreational amenities.
- Goal RC02: Groundwater: Manage and enhance groundwater as a valuable and limited shared resource on a sustainable yield basis that can provide water purveyors and individual users with reliable, high quality groundwater to serve existing and planned land uses during prolonged drought periods.
- Policy RC-P-14 Resource Conservation Element – Water Conservation: Encourage participation by the County and surrounding communities in a basin-wide groundwater management study.
- Policy S-P-1 Safety Element: The City shall require preparation of geological reports and/or geological engineering reports for proposed new development located in areas of potentially significant geological hazards, including potential subsidence (collapsible surface soils) due to groundwater extraction.

City of Escalon General Plan

- Policy 2.4 (2) Public Safety Standard: It is the policy of the City to require that water supply systems be related to the size and configuration of land developments. Standards as set forth in the current subdivision ordinance shall be maintained and improved as necessary.
- Objective 3.1 (A) Natural Resources: Protect natural resources including groundwater, soils, and air quality to meet the needs of present and future generations.
- Policy 3.1 (1) Natural Resources: Expand programs that enhance groundwater recharge in order to maintain the groundwater supply, including the installation of retention ponds in new growth areas.
- Policy 3.1 (3) Natural Resources: Policy 3.1 (1) Natural Resources: Expand programs that enhance groundwater recharge in order to maintain the groundwater supply, including the installation of retention ponds in new growth areas.
- Policy 7.1 (1) Public and Institutional Land Use: Update the water, wastewater and storm drainage master plans, and any other specific or master plans related to infrastructure development on a periodic basis.
- Policy 9.1 (12) Public Facility Improvement: To encourage groundwater recharge, ponding basins shall be designed as retention basins. However, pumping facilities shall be included in such facilities to handle peak flows and to provide for disposal of stormwater into irrigation ditches when necessary. Stormwater inflow into irrigation district canals and pipelines shall be subject to existing or future agreements by and between the City and the irrigation districts specifying maximum inflow, maximum service area boundary, and any other limitation thereto.
- Policy 9.1 (14) Public Facility Improvement: New municipal water well sites should be planned which include pump, storage, pressure filtration, and/or treatment equipment. These new wells should be located so that they will not conflict with planned residential neighborhoods. They should have design, screening, landscaping, and architectural improvements which make them compatible with adjacent land uses.

City of Ripon General Plan

- Goal D: To reduce the impact of urban development on surrounding agricultural and riparian habitat as much as possible, consistent with the policies of the general plan.
- Policy D5: The City shall implement the Groundwater Management Plan adopted by the City Council. This program includes but is not necessarily limited to: the ongoing collection and analysis of well quantity and quality data; the identification of recharge areas within the Planning Area; inter-agency coordination and planning to protect and enhance recharge areas; establishment of a well head protection program to ensure well and aquifer testing for new city wells; and the installation of monitoring wells, as required.
- Policy D6. The City shall review design and operation parameters for storm water detention facilities and make feasible adjustments to these plans, which would promote recharge of storm water to the groundwater system. For example, siting detention facilities in areas of maximum infiltration capacity; increasing detention time for where necessary storage capacity is not compromised, and adjustment of area/depth ratios to maximize infiltration.
- Goal F: Groundwater management pursuant to the City's Urban Water Management Plans to avoid overdraft and maintain drinking water quality.
- Policy F1. Expand City's existing system to regularly monitor and evaluate the physical condition and quality of the groundwater system underlying Ripon, and to identify the need for supplemental water as required.
- Policy F2. Identify and secure available sources of supplemental surface water for replacement or recharge of groundwater as required.
- Policy F3. Manage land use and sewage disposal as required to maintain adequate groundwater quality.
- Goal G: Efficient use of water resources throughout the community pursuant to the City's Groundwater Management and Preservation Plan.
- Policy G1. Promote water conservation through public dissemination of groundwater and municipal water use information.
- Policy G2. Develop a plan, financing mechanism, and target date for installation of water meters on un-metered portions of the water system.
- Policy G3. Promote reclamation and reuse of municipal and industrial wastewaters for irrigation, recharge, or other beneficial uses.
- Policy D5. The City shall implement the Groundwater Management Plan adopted by the City Council. This program includes, but is not necessarily limited to: the ongoing collection and analysis of well quantity and quality data; the identification of recharge areas within the Planning Area; inter-agency coordination and planning to protect and enhance recharge areas; establishment of a well head protection program to ensure well and aquifer testing for new city wells; and the installation of monitoring wells, as required.
- Policy D6. The City shall review design and operation parameters for stormwater detention facilities and make feasible adjustments to these plans, which would promote recharge of stormwater to the groundwater system. For example, siting detention facilities in areas of maximum infiltration capacity, increasing detention time for where necessary storage capacity is not compromised, and adjustment of area/depth ratios to maximize infiltration.

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APPENDIX 1-G.
FRESHWATER SPECIES IN ESJ SUBBASIN

Freshwater Species in the Eastern San Joaquin Subbasin

Source: The following information was compiled by The Nature Conservancy and included with comments submitted May 31, 2019.

Methodology: ArcGIS was used to select features within the California Freshwater Species Database version 2.0.9 within the GSA's boundary. This database contains information on ~4,000 vertebrates, macroinvertebrates and vascular plants that depend on fresh water for at least one stage of their life cycle. The methods used to compile the California Freshwater Species Database can be found in Howard et al. 2015[1]. The spatial database contains locality observations and/or distribution information from ~400 data sources. The database is housed in the California Department of Fish and Wildlife's BIOS[2] as well as on The Nature Conservancy's science website[3]."

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
BIRDS				
Actitis macularius	Spotted Sandpiper			
Aechmophorus clarkii	Clark's Grebe			
Aechmophorus occidentalis	Western Grebe			
Agelaius tricolor	Tricolored Blackbird	Bird of Conservation Concern	Special Concern	BSSC - First priority
Aix sponsa	Wood Duck			
Anas acuta	Northern Pintail			
Anas americana	American Wigeon			
Anas clypeata	Northern Shoveler			
Anas crecca	Green-winged Teal			
Anas cyanoptera	Cinnamon Teal			
Anas discors	Blue-winged Teal			
Anas platyrhynchos	Mallard			
Anas strepera	Gadwall			
Anser albifrons	Greater White-fronted Goose			
Ardea alba	Great Egret			
Ardea herodias	Great Blue Heron			

[1] Howard, J.K. et al. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLoSONE, 11(7). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710
[2] California Department of Fish and Wildlife BIOS: https://www.wildlife.ca.gov/data/BIOS
[3] Science for Conservation: https://www.scienceforconservation.org/products/california-freshwater-species- database

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Aythya affinis	Lesser Scaup			
Aythya americana	Redhead		Special Concern	BSSC - Third priority
Aythya collaris	Ring-necked Duck			
Aythya marila	Greater Scaup			
Aythya valisineria	Canvasback		Special	
Botaurus lentiginosus	American Bittern			
Bucephala albeola	Bufflehead			
Bucephala clangula	Common Goldeneye			
Butorides virescens	Green Heron			
Calidris alpina	Dunlin			
Calidris mauri	Western Sandpiper			
Calidris minutilla	Least Sandpiper			
Chen caerulescens	Snow Goose			
Chen rossii	Ross's Goose			
Chlidonias niger	Black Tern		Special Concern	BSSC - Second priority
Chroicocephalus philadelphia	Bonaparte's Gull			
Cinclus mexicanus	American Dipper			
Cistothorus palustris palustris	Marsh Wren			
Cygnus buccinator	Trumpeter Swan			
Cygnus columbianus	Tundra Swan			
Cypseloides niger	Black Swift	Bird of Conservation Concern	Special Concern	BSSC - Third priority
Egretta thula	Snowy Egret			
Empidonax traillii	Willow Flycatcher	Bird of Conservation Concern	Endangered	
Fulica americana	American Coot			
Gallinago delicata	Wilson's Snipe			
Gallinula chloropus	Common Moorhen			
Geothlypis trichas trichas	Common Yellowthroat			

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Grus canadensis	Sandhill Crane			
Grus canadensis canadensis	Lesser Sandhill Crane		Special Concern	BSSC - Third priority
Haliaeetus leucocephalus	Bald Eagle	Bird of Conservation Concern	Endangered	
Himantopus mexicanus	Black-necked Stilt			
Icteria virens	Yellow-breasted Chat		Special Concern	BSSC - Third priority
Laterallus jamaicensis coturniculus	California Black Rail	Bird of Conservation Concern	Threatened	
Limnodromus scolopaceus	Long-billed Dowitcher			
Lophodytes cucullatus	Hooded Merganser			
Megaceryle alcyon	Belted Kingfisher			
Mergus merganser	Common Merganser			
Mergus serrator	Red-breasted Merganser			
Numenius americanus	Long-billed Curlew			
Numenius phaeopus	Whimbrel			
Nycticorax nycticorax	Black-crowned Night-Heron			
Oreothlypis luciae	Lucy's Warbler		Special Concern	BSSC - Third priority
Oxyura jamaicensis	Ruddy Duck			
Pelecanus erythrorhynchos	American White Pelican		Special Concern	BSSC - First priority
Phalacrocorax auritus	Double-crested Cormorant			
Phalaropus tricolor	Wilson's Phalarope			
Piranga rubra	Summer Tanager		Special Concern	BSSC - First priority
Plegadis chihi	White-faced Ibis		Watch list	
Pluvialis squatarola	Black-bellied Plover			
Podiceps nigricollis	Eared Grebe			
Podilymbus podiceps	Pied-billed Grebe			
Porzana carolina	Sora			

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Rallus limicola	Virginia Rail			
Recurvirostra americana	American Avocet			
Riparia riparia	Bank Swallow		Threatened	
Setophaga petechia	Yellow Warbler			BSSC - Second priority
Tachycineta bicolor	Tree Swallow			
Tringa melanoleuca	Greater Yellowlegs			
Tringa semipalmata	Willet			
Tringa solitaria	Solitary Sandpiper			
Vireo bellii pusillus	Least Bell's Vireo	Endangered	Endangered	
Xanthocephalus xanthocephalus	Yellow-headed Blackbird		Special Concern	BSSC - Third priority
CRUSTACEANS				
Branchinecta lynchi	Vernal Pool Fairy Shrimp	Threatened	Special	IUCN - Vulnerable
Branchinecta mesovallensis	Midvalley Fairy Shrimp		Special	
Cambaridae fam.	Cambaridae fam.			
Crangonyx spp.	Crangonyx spp.			
Gnorimosphaeroma insulare	An Isopod			
Hyalella spp.	Hyalella spp.			
Lepidurus packardi	Vernal Pool Tadpole Shrimp	Endangered	Special	IUCN - Endangered
Linderiella occidentalis	California Fairy Shrimp		Special	IUCN - Near Threatened
FISH				
Acipenser medirostris ssp. 1	Southern green sturgeon	Threatened	Special Concern	Endangered - Moyle 2013
Mylopharodon conocephalus	Hardhead		Special Concern	Near-Threatened - Moyle 2013
Oncorhynchus mykiss - CV	Central Valley steelhead	Threatened	Special	Vulnerable - Moyle 2013
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Pogonichthys macrolepidotus	Sacramento splittail		Special Concern	Vulnerable - Moyle 2013
Spirinchus thaleichthys	Longfin smelt	Candidate	Threatened	Vulnerable - Moyle 2013
Acipenser medirostris ssp. 1	Southern green sturgeon	Threatened	Special Concern	Endangered - Moyle 2013
Acipenser transmontanus	White sturgeon		Special	Vulnerable - Moyle 2013
Catostomus occidentalis occidentalis	Sacramento sucker			Least Concern - Moyle 2013
Cottus asper ssp. 1	Prickly sculpin			Least Concern - Moyle 2013
Cottus gulosus	Riffle sculpin		Special	Near-Threatened - Moyle 2013
Entosphenus tridentata ssp. 1	Pacific lamprey		Special	Near-Threatened - Moyle 2013
Gasterosteus aculeatus microcephalus	Inland threespine stickleback		Special	Least Concern - Moyle 2013
Hypomesus pacificus	Delta smelt	Threatened	Endangered	Endangered - Moyle 2013
Hysterocarpus traskii traskii	Sacramento tule perch		Special	Near-Threatened - Moyle 2013
Lampetra ayersi	River lamprey		Special Concern	Near-Threatened - Moyle 2013
Lampetra richardsoni	Western brook lamprey			Near-Threatened - Moyle 2013
Lavinia exilicauda exilicauda	Sacramento hitch		Special	Near-Threatened - Moyle 2013
Lavinia symmetricus symmetricus	Central California roach		Special Concern	Near-Threatened - Moyle 2013
Mylopharodon conocephalus	Hardhead		Special Concern	Near-Threatened - Moyle 2013

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Oncorhynchus gorbuscha	Pink salmon		Special Concern	Endangered - Moyle 2013
Oncorhynchus mykiss - CV	Central Valley steelhead	Threatened	Special	Vulnerable - Moyle 2013
Oncorhynchus mykiss irideus	Coastal rainbow trout			Least Concern - Moyle 2013
Oncorhynchus tshawytscha - CV fall	Central Valley fall Chinook salmon	Species of Special Concern	Special Concern	Vulnerable - Moyle 2013
Oncorhynchus tshawytscha - CV late fall	Central Valley late fall Chinook salmon	Species of Special Concern		Endangered - Moyle 2013
Oncorhynchus tshawytscha - CV spring	Central Valley spring Chinook salmon	Threatened	Threatened	Vulnerable - Moyle 2013
Orthodon microlepidotus	Sacramento blackfish			Least Concern - Moyle 2013
Pogonichthys macrolepidotus	Sacramento splittail		Special Concern	Vulnerable - Moyle 2013
Ptychocheilus grandis	Sacramento pikeminnow			Least Concern - Moyle 2013
Rhinichthys osculus ssp. 1	Sacramento speckled dace			Least Concern - Moyle 2013
Spirinchus thaleichthys	Longfin smelt	Candidate	Threatened	Vulnerable - Moyle 2013
HERPS				
Actinemys marmorata marmorata	Western Pond Turtle		Special Concern	ARSSC
Ambystoma californiense californiense	California Tiger Salamander	Threatened	Threatened	ARSSC
Anaxyrus boreas boreas	Boreal Toad			
Anaxyrus boreas halophilus	California Toad			ARSSC
Rana boylii	Foothill Yellow-legged Frog	Under Review in the Candidate or Petition Process	Special Concern	ARSSC
Rana draytonii	California Red-legged Frog	Threatened	Special Concern	ARSSC
Spea hammondii	Western Spadefoot	Under Review in the Candidate or Petition Process	Special Concern	ARSSC

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Taricha torosa	Coast Range Newt		Special Concern	ARSSC
Thamnophis couchii	Sierra Gartersnake			
Thamnophis elegans elegans	Mountain Gartersnake			Not on any status lists
Thamnophis elegans terrestris	Coast Gartersnake			Not on any status lists
Thamnophis gigas	Giant Gartersnake	Threatened	Threatened	
Thamnophis sirtalis fitchi	Valley Gartersnake			Not on any status lists
Thamnophis sirtalis sirtalis	Common Gartersnake			
INSECTS & OTHER INVERTEBRATES				
Ablabesmyia annulata				Not on any status lists
Ablabesmyia spp.	Ablabesmyia spp.			
Aeshna spp.	Aeshna spp.			
Anax junius	Common Green Darner			
Apedilum spp.	Apedilum spp.			
Caenis latipennis	A Mayfly			
Centroptilum album	A Mayfly			
Centroptilum spp.	Centroptilum spp.			
Chironomidae fam.	Chironomidae fam.			
Chironomus spp.	Chironomus spp.			
Cladopelma spp.	Cladopelma spp.			
Cladotanytarsus spp.	Cladotanytarsus spp.			
Coenagrionidae fam.	Coenagrionidae fam.			
Corisella spp.	Corisella spp.			
Corixidae fam.	Corixidae fam.			
Cricotopus annulator				Not on any status lists
Cricotopus spp.	Cricotopus spp.			
Cryptochironomus curryi				Not on any status lists
Cryptochironomus spp.	Cryptochironomus spp.			
Cryptotendipes spp.	Cryptotendipes spp.			

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Dicrotendipes spp.	Dicrotendipes spp.			
Enallagma carunculatum	Tule Bluet			
Enallagma civile	Familiar Bluet			
Endotribelos spp.	Endotribelos spp.			
Fallceon quilleri	A Mayfly			
Fallceon spp.	Fallceon spp.			
Glyptotendipes spp.	Glyptotendipes spp.			
Gomphus spp.	Gomphus spp.			
Hydrophilidae fam.	Hydrophilidae fam.			
Hydropsyche spp.	Hydropsyche spp.			
Hydropsychidae fam.	Hydropsychidae fam.			
Hydroptila spp.	Hydroptila spp.			
Hydroptilidae fam.	Hydroptilidae fam.			
Ischnura cervula	Pacific Forktail			
Ischnura spp.	Ischnura spp.			
Liodessus obscurellus				Not on any status lists
Micrasema arizonica				Not on any status lists
Micrasema spp.	Micrasema spp.			
Microchironomus nigrovittatus				Not on any status lists
Microchironomus spp.	Microchironomus spp.			
Micropsectra spp.	Micropsectra spp.			
Mideopsis spp.	Mideopsis spp.			
Nanocladius spp.	Nanocladius spp.			
Nectopsyche spp.	Nectopsyche spp.			
Oxyethira aculea				Not on any status lists
Oxyethira spp.	Oxyethira spp.			
Pachydiplax longipennis	Blue Dasher			
Pantala flavescens	Wandering Glider			
Pantala hymenaea	Spot-winged Glider			

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Paracladopelma alphaeus				Not on any status lists
Paracladopelma spp.	Paracladopelma spp.			
Parakiefferiella spp.	Parakiefferiella spp.			
Paratanytarsus grimmii				Not on any status lists
Paratanytarsus spp.	Paratanytarsus spp.			
Peltodytes callosus				Not on any status lists
Peltodytes spp.	Peltodytes spp.			
Pentaneura spp.	Pentaneura spp.			
Phaenopsectra spp.	Phaenopsectra spp.			
Plathemis lydia	Common Whitetail			
Polypedilum albicorne				Not on any status lists
Polypedilum spp.	Polypedilum spp.			
Procladius spp.	Procladius spp.			
Psectrocladius spp.	Psectrocladius spp.			
Pseudosmittia spp.	Pseudosmittia spp.			
Rheotanytarsus spp.	Rheotanytarsus spp.			
Rhionaeschna multicolor	Blue-eyed Darner			
Robackia demeijeri				Not on any status lists
Sigara alternata				Not on any status lists
Sigara mckinstryi	A Water Boatman			Not on any status lists
Sigara spp.	Sigara spp.			
Simulium anduzei				Not on any status lists
Simulium spp.	Simulium spp.			
Sperchon spp.	Sperchon spp.			
Sympetrum corruptum	Variegated Meadowhawk			
Tanypus spp.	Tanypus spp.			

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Tanytarsus angulatus				Not on any status lists
Tanytarsus spp.	Tanytarsus spp.			
Tramea lacerata	Black Saddlebags			
Trichocorixa calva				Not on any status lists
Tricorythodes spp.	Tricorythodes spp.			
MAMMALS				
Castor canadensis	American Beaver			Not on any status lists
Lontra canadensis canadensis	North American River Otter			Not on any status lists
Neovison vison	American Mink			Not on any status lists
Ondatra zibethicus	Common Muskrat			Not on any status lists
MOLLUSKS				
Anodonta californiensis	California Floater		Special	
Ferrissia spp.	Ferrissia spp.			
Galba spp.	Galba spp.			
Gonidea angulata	Western Ridged Mussel		Special	
Gyraulus spp.	Gyraulus spp.			
Helisoma spp.	Helisoma spp.			
Lymnaea spp.	Lymnaea spp.			
Margaritifera falcata	Western Pearlshell		Special	
Menetus opercularis	Button Sprite			CS
Menetus spp.	Menetus spp.			
Physa acuta	Pewter Physa			Not on any status lists
Physa spp.	Physa spp.			
Pisidium spp.	Pisidium spp.			
Planorbidae fam.	Planorbidae fam.			
Sphaeriidae fam.	Sphaeriidae fam.			
Sphaerium occidentale				Not on any

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
				status lists
Sphaerium spp.	Sphaerium spp.			
PLANTS				
Alnus rhombifolia	White Alder			
Alopecurus saccatus	Pacific Foxtail			
Ammannia coccinea	Scarlet Ammannia			
Ammannia robusta	Grand Redstem			
Anemopsis californica	Yerba Mansa			
Arundo donax	NA			
Azolla filiculoides	NA			
Baccharis salicina				Not on any status lists
Bacopa eisenii	Gila River Water-hyssop			
Bergia texana	Texas Bergia			
Bidens laevis	Smooth Bur-marigold			
Bidens tripartita	NA			
Blennosperma bakeri	Baker's Blennosperma	Endangered	Endangered	CRPR - 1B.1
Boehmeria cylindrica	NA			Not on any status lists
Brodiaea nana				Not on any status lists
Brodiaea pallida	Chinese Camp Brodiaea	Threatened	Endangered	CRPR - 1B.1
Callitriche heterophylla bolanderi	Large Water-starwort			
Callitriche heterophylla heterophylla	Northern Water-starwort			
Callitriche longipedunculata	Longstock Water-starwort			
Callitriche marginata	Winged Water-starwort			
Carex comosa	Bristly Sedge		Special	CRPR - 2B.1
Carex densa	Dense Sedge			
Carex feta	Green-sheath Sedge			
Carex lenticularis	Shore Sedge			
Carex nudata	Torrent Sedge			

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Carex senta	Western Rough Sedge			
Castilleja campestris succulenta	Fleshy Owl's-clover	Threatened	Endangered	CRPR - 1B.2
Cephalanthus occidentalis	Common Buttonbush			
Ceratophyllum demersum	Common Hornwort			
Cicendia quadrangularis	Oregon Microcala			
Cirsium crassicaule	Slough Thistle		Special	CRPR - 1B.1
Cotula coronopifolia	NA			
Crassula aquatica	Water Pygmyweed			
Crypsis vaginiflora	NA			
Cyperus acuminatus	Short-point Flatsedge			
Cyperus erythrorhizos	Red-root Flatsedge			
Cyperus fuscus	NA			
Cyperus squarrosus	Awned Cyperus			
Damasonium californicum				Not on any status lists
Datisca glomerata	Durango Root			
Downingia bella	Hoover's Downingia			
Downingia bicornuta	NA			
Downingia cuspidata	Toothed Calicoflower			
Downingia elegans	NA			
Downingia insignis	Parti-color Downingia			
Downingia ornatissima	NA			
Downingia pulchella	Flat-face Downingia			
Downingia pusilla	Dwarf Downingia		Special	CRPR - 2B.2
Elatine brachysperma	Shortseed Waterwort			
Elatine californica	California Waterwort			
Elatine rubella	Southwestern Waterwort			
Eleocharis acicularis acicularis	Least Spikerush			
Eleocharis bella	Delicate Spikerush			
Eleocharis bolanderi	Bolander's Spikerush			
Eleocharis engelmannii	Engelmann's Spikerush			Not on any

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
engelmannii				status lists
Eleocharis flavescens flavescens	Pale Spikerush			
Eleocharis macrostachya	Creeping Spikerush			
Eleocharis obtusa	Blunt Spikerush			
Eleocharis parishii	Parish's Spikerush			
Elodea canadensis	Broad Waterweed			
Epilobium campestre	NA			Not on any status lists
Epilobium cleistogamum	Cleistogamous Spike-primrose			
Eragrostis hypnoides	Teal Lovegrass			
Eryngium aristulatum aristulatum	California Eryngo			
Eryngium castrense	Great Valley Eryngo			
Eryngium pinnatisectum	Tuolumne Coyote-thistle		Special	CRPR - 1B.2
Eryngium racemosum	Delta Coyote-thistle		Endangered	CRPR - 1B.1
Eryngium vaseyi vallicola				Not on any status lists
Eryngium vaseyi vaseyi	Vasey's Coyote-thistle			Not on any status lists
Euphorbia hooveri	NA			Not on any status lists
Euthamia occidentalis	Western Fragrant Goldenrod			
Galium trifidum	Small Bedstraw			
Gratiola ebracteate	Bractless Hedge-hyssop			
Gratiola heterosepala	Boggs Lake Hedge-hyssop		Endangered	CRPR - 1B.2
Gratiola neglecta	Clammy Hedge-hyssop			
Helenium bigelovii	Bigelow's Sneezeweed			
Helenium puberulum	Rosilla			
Hibiscus lasiocarpos occidentalis			Special	CRPR - 1B.2
Hippuris vulgaris	Common Mare's-tail			
Hosackia oblongifolia	NA			1.B.3

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Hydrocotyle ranunculoides	Floating Marsh-pennywort			
Hydrocotyle verticillata verticillata	Whorled Marsh-pennywort			
Isoetes nuttallii	NA			
Isoetes orcuttii	NA			
Isolepis cernua	Low Bulrush			
Juncus acuminatus	Sharp-fruit Rush			
Juncus effusus effusus	NA			
Juncus effusus pacificus				
Juncus phaeocephalus paniculatus	Brownhead Rush			
Juncus uncialis	Inch-high Rush			
Lasthenia ferrisiae	Ferris' Goldfields		Special	CRPR - 4.2
Lasthenia fremontii	Fremont's Goldfields			
Leersia oryzoides	Rice Cutgrass			
Legenere limosa	False Venus'-looking-glass		Special	CRPR - 1B.1
Lemna gibba	Inflated Duckweed			
Lemna minor	Lesser Duckweed			
Lemna minuta	Least Duckweed			
Lemna turionifera	Turion Duckweed			
Lepidium oxycarpum	Sharp-pod Pepper-grass			
Lilaeopsis masonii	Mason's Lilaeopsis		Special	CRPR - 1B.1
Limnanthes alba alba	White Meadowfoam			
Limnanthes alba versicolor	White Meadowfoam			
Limnanthes douglasii douglasii	Douglas' Meadowfoam			
Limnanthes douglasii rosea	Douglas' Meadowfoam			
Limosella acaulis	Southern Mudwort			
Limosella aquatica	Northern Mudwort			
Limosella australis	NA		Special	CRPR - 2B.1
Lindernia dubia	Yellowseed False Pimpernel			
Lipocarpha micrantha	Dwarf Bulrush			

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Ludwigia grandiflora	NA			
Ludwigia peploides montevidensis	NA			Not on any status lists
Ludwigia peploides peploides	NA			Not on any status lists
Lycopus americanus	American Bugleweed			
Lythrum californicum	California Loosestrife			
Lythrum portula	NA			
Marsilea vestita vestita	NA			Not on any status lists
Mimulus cardinalis	Scarlet Monkeyflower			
Mimulus guttatus	Common Large Monkeyflower			
Mimulus latidens	Broad-tooth Monkeyflower			
Mimulus tricolor	Tricolor Monkeyflower			
Myosurus minimus	NA			
Myosurus sessilis	Sessile Mousetail			
Myriophyllum aquaticum	NA			
Najas guadalupensis guadalupensis	Southern Naiad			
Navarretia intertexta	Needleleaf Navarretia			
Navarretia leucocephala leucocephala	White-flower Navarretia			
Navarretia leucocephala minima	Least Navarretia			
Navarretia myersii myersii	Pincushion Navarretia		Special	CRPR - 1B.1
Neostapfia colusana	Colusa Grass	Threatened	Endangered	CRPR - 1B.1
Oenanthe sarmentosa	Water-parsley			
Orcuttia inaequalis	San Joaquin Valley Orcutt Grass	Threatened	Endangered	CRPR - 1B.1
Orcuttia pilosa	Hairy Orcutt Grass	Endangered	Endangered	CRPR - 1B.1
Orcuttia tenuis	Slender Orcutt Grass	Threatened	Endangered	CRPR - 1B.1
Orcuttia viscida	Sacramento Orcutt Grass	Endangered	Endangered	CRPR - 1B.1
Panicum acuminatum acuminatum				Not on any status lists

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Panicum dichotomiflorum	NA			
Paspalum distichum	Joint Paspalum			
Perideridia bacigalupii	Bacigalupi's Perideridia		Special	CRPR - 4.2
Perideridia bolanderi bolanderi	Bolander's Yampah			
Perideridia bolanderi involucrata	Bolander's Yampah			
Perideridia kelloggii	Kellogg's Yampah			
Perideridia lemmonii	Lemmon's Yampah			
Persicaria amphibia				Not on any status lists
Persicaria hydropiper	NA			Not on any status lists
Persicaria hydropiperoides				Not on any status lists
Persicaria lapathifolia				Not on any status lists
Persicaria maculosa	NA			Not on any status lists
Persicaria pensylvanica	NA			Not on any status lists
Persicaria punctata	NA			Not on any status lists
Phacelia distans	NA			
Phyla lanceolata	Fog-fruit			
Phyla nodiflora	Common Frog-fruit			
Pilularia americana	NA			
Plagiobothrys acanthocarpus	Adobe Popcorn-flower			
Plagiobothrys austiniae	Austin's Popcorn-flower			
Plagiobothrys distantiflorus	California Popcorn-flower			
Plagiobothrys greenei	Greene's Popcorn-flower			
Plagiobothrys humistratus	Dwarf Popcorn-flower			
Plagiobothrys leptocladus	Alkali Popcorn-flower			
Plagiobothrys reticulatus				Not on any

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
reticulatus				status lists
Plagiobothrys undulatus	NA			Not on any status lists
Plantago elongata elongata	Slender Plantain			
Platanus racemosa	California Sycamore			
Pleuropogon californicus californicus				Not on any status lists
Pluchea odorata odorata	Scented Conyza			
Pogogyne douglasii	NA			
Pogogyne zizyphoroides				Not on any status lists
Potamogeton diversifolius	Water-thread Pondweed			
Potamogeton foliosus foliosus	Leafy Pondweed			
Potamogeton illinoensis	Illinois Pondweed			
Potamogeton nodosus	Longleaf Pondweed			
Primula subalpina				Not on any status lists
Psilocarphus brevissimus brevissimus	Dwarf Woolly-heads			
Psilocarphus brevissimus multiflorus	Delta Woolly Marbles		Special	CRPR - 4.2
Psilocarphus oregonus	Oregon Woolly-heads			
Psilocarphus tenellus	NA			
Ranunculus aquatilis aquatilis	White Water Buttercup			
Ranunculus bonariensis	NA			
Ranunculus hystriculus				Not on any status lists
Ranunculus lobbii	Lobb's Water Buttercup		Special	CRPR - 4.2
Ranunculus pusillus pusillus	Pursh's Buttercup			
Rorippa curvisiliqua curvisiliqua	Curve-pod Yellowcress			
Rorippa palustris palustris	Bog Yellowcress			
Rotala ramosior	Toothcup			

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Rumex conglomeratus	NA			
Rumex occidentalis				Not on any status lists
Rumex salicifolius salicifolius	Willow Dock			
Sagittaria latifolia latifolia	Broadleaf Arrowhead			
Sagittaria montevidensis calycina				Not on any status lists
Sagittaria sanfordii	Sanford's Arrowhead		Special	CRPR - 1B.2
Salix exigua exigua	Narrowleaf Willow			
Salix exigua hindsiana				Not on any status lists
Salix gooddingii	Goodding's Willow			
Salix laevigata	Polished Willow			
Salix lasiolepis lasiolepis	Arroyo Willow			
Salix melanopsis	Dusky Willow			
Schoenoplectus acutus occidentalis	Hardstem Bulrush			
Schoenoplectus californicus	California Bulrush			
Scirpus microcarpus	Small-fruit Bulrush			
Sidalcea calycosa calycosa	Annual Checker-mallow			
Sidalcea hirsuta	Hairy Checker-mallow			
Sium suave	Hemlock Water-parsnip			
Spirodela polyrhiza	NA			
Stachys ajugoides	Bugle Hedge-nettle			
Stachys albens	White-stem Hedge-nettle			
Stachys pycnantha	Short-spike Hedge-nettle			
Stachys stricta	Sonoma Hedge-nettle			
Symphyotrichum lentum	Suisun Marsh Aster		Special	CRPR - 1B.2
Taxus brevifolia				
Toxicoscordion venenosum venenosum				Not on any status lists

Scientific Name	Common Name	Legal Protected Status		
		Federal	State	Other
Tuctoria greenei	Green's Awnless Orcutt Grass	Endangered	Rare	CRPR - 1B.1
Typha domingensis	Southern Cattail			
Typha latifolia	Broadleaf Cattail			
Utricularia gibba	Humped Bladderwort			
Veronica americana	American Speedwell			
Veronica anagallis-aquatica	NA			
Wolffia globosa	Asian Watermeal			
Wolffiella lingulata	Tongue Bogmat			

APPENDIX 1-H.
2024 EASTERN SAN JOAQUIN SUBBASIN COMMUNICATION AND ENGAGEMENT PLAN UPDATE

ATTACHMENT 2

PLACEHOLDER

APPENDIX 1-I.
PUBLIC COMMENTS RECEIVED

From: info@esjgroundwater.org [PW] <info@esjgroundwater.org>
Sent: Thursday, October 31, 2024 2:38 PM
To: Brandon Nakagawa <brandon.nakagawa@ssjid.gov>; Katie Cole <kcole@woodardcurran.com>
Subject: FW: Comments on ESJ Public Draft of the ESJ 2024 Groundwater Sustainability Plan Amendment

You don't often get email from info@esjgroundwater.org. Learn why this is important

From: Brent Barton <brent@bartonranch.com>
Sent: Thursday, October 3, 2024 11:24 AM
To: info@esjgroundwater.org [PW] <info@esjgroundwater.org>
Subject: Comments on ESJ Public Draft of the ESJ 2024 Groundwater Sustainability Plan Amendment

Thank you for all the hard work you've put into the GSP to this point.

Most of our properties are in the San Joaquin County GSA, some is in the CSJWCD GSA…

My comments are:

A-1

Let's get to sustainability by increasing our water supply (i.e., bring additional surface water into the GWA areas). Let's not allow ourselves to be forced into sustainability via mandated groundwater pumping restrictions. That would be disastrous.

We need to get the San Joaquin County GAS and the Central San Joaquin Water Conservation District GSA to be more proactive by submitting plans for increasing water supply.

Let us know if we can help.

Thank you again,

Brent Barton
Barton Ranch, Inc.
Escalon, CA
209-838-8930 farm office
209-404-0394 cell

ATTACHMENT 2

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
North Central Region
1701 Nimbus Road
Rancho Cordova, CA 95670
www.wildlife.ca.gov

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

October 30, 2024

Fritz Buchman
Eastern San Joaquin Subbasin Plan Manager
San Joaquin County Public Works Department
1810 E. Hazelton Ave
Stockton, CA 95205
info@esjgroundwater.org

Subject: CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE COMMENTS ON THE EASTERN SAN JOAQUIN BASIN AMENDED GROUNDWATER SUSTAINABILITY PLAN

Dear Fritz Buchman:

The California Department of Fish and Wildlife (Department) is providing comments on the 2024 Eastern San Joaquin Groundwater Sustainability Plan Amendment (Amended GSP) made available to the public on October 1, 2024 and prepared pursuant to the Sustainable Groundwater Management Act (SGMA). The Basin is designated as Critically Over Drafted under SGMA.

The Department is writing to support ecosystem preservation and enhancement in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems, species, and public trust resources depend on groundwater and interconnected surface water (ISW), including groundwater dependent ecosystems (GDEs). In the context of SGMA statutes and regulations, and Public Trust Doctrine considerations, groundwater planning should carefully consider and protect environmental beneficial uses and users of groundwater, including fish and wildlife and their habitats, GDEs, and ISW. The Department has enclosed, for reference, a summary of GSP requirements and GSA obligations with respect to the protection of fish and wildlife and public trust resources (Attachment A).

COMMENTS AND RECOMMENDATIONS

The Department reviewed the Eastern San Joaquin Amended GSP and believes that it fails to adequately address the following two Recommended Corrective Actions identified in the Department of Water Resources (DWR) Approval Determination:

<u>DWR Recommended Corrective Action 1b</u>: The GSP should include a more thorough evaluation of the impacts to environmental uses and users related to the groundwater level minimum thresholds, or, at minimum, describe a plan to perform this evaluation in the future when additional data becomes available.

Amended GSP: A response to Recommended Corrective Action 1 is provided in Appendix 3-C of the Amended GSP. Through use of the same GDE mapping methodology included in the 2020 GSP, a count of GDE polygons was generated for the subbasin. For each representative monitoring well for the Chronic Lowering of Groundwater Levels Sustainable Management Criteria (SMC), an "impact zone" within a 3-mile radius of the well was delineated. The Amended GSP modeled groundwater levels at Minimum Thresholds, assessed which impact zones would experience groundwater levels more than 30 feet below the ground surface, and computed what percentage of GDEs within the subbasin would lose access to groundwater resources.

Department Response and Recommendation: The Department appreciates the effort to more thoroughly consider impacts to GDEs that may occur at the identified SMC for Chronic Lowering of Groundwater Levels. After reviewing the Amended GSP, the Department provides the following responses and recommendations:

a. Appendix 3-C Figures 6, 7, and 8 show examples of the GDE impact zone assessment. The inset map in each figure shows an overlay of the groundwater level monitoring network, the impact zone of each well, and the location of GDEs within the subbasin. It appears that a high proportion of GDEs within the subbasin are not located sufficiently close to a monitoring well to be within an analyzed impact zone, particularly in the northwestern portion of the subbasin and along the western boundary. It is therefore unclear to what extent, if any, the groundwater levels underlying these GDEs have been modeled or considered in the impact analysis presented in the Amended GSP. Without an associated monitoring well that can be used to assess whether or not groundwater levels in these areas would decline below the root zone of GDEs, the analysis and statistics presented in the Amended GSP stating that only a small percentage of GDEs would be impacted during a subbasin Undesirable Result scenario is insufficient and risks underestimating impacts to GDEs. The Department recommends the Amended GSP clearly identify the lack of monitoring wells sufficiently close to identified GDEs as a data gap and propose an actionable path to resolve the data gap. While the Amended GSP describes vague plans to install additional shallow monitoring wells in the future, the plan should provide a specific timeline for addressing this data gap.

B-1

b. The Amended GSP acknowledges that the GDE analysis completed was a desktop review, and field identification and verification of vegetated and wetland GDEs and associated wildlife is warranted. This data gap and need was also identified in the 2020 GSP, however no timeline or specific project or management action associated with GDE field verification was readily apparent in the Amended GSP. The Department recommends including GDE field identification and verification as a project and management action, with an associated timeline for implementation.

B-2

c. Appendix 3-C of the Amended GSP, when describing the GDEs located within impact zones shown in Figures 6, 7, and 8, states that if a potential GDE is proximate to irrigated agriculture or surface water sources that may provide some level of water supply to the potential GDE, that ecosystem may not be considered a GDE. This perpetuates a false dichotomy and incorrect assumption that GDEs must rely solely on groundwater in order to be considered groundwater dependent; instead, GDEs may rely on groundwater for *a portion* of their water needs and may rely on groundwater to varying degrees depending on water year type and relative water availability from surface or groundwater sources. The Department recommends that this language be updated accordingly or removed from the Amended GSP.

B-3

DWR Recommended Corrective Action 6: The following items related to Depletions of Interconnected Surface Water by the first periodic evaluation:

1. *Establish undesirable results, minimum thresholds, and measurable objectives consistent with GSP regulations. Quantify the location, quantity, and timing of depletions of interconnected surface water due to groundwater extraction.*

2. *Continue to fill data gaps, collect additional monitoring data, and implement the current strategy to manage depletions of interconnected surface water and define segments of interconnectivity and timing. The monitoring network should be updated to reflect any corresponding changes and approaches.*

3. *Prioritize collaborating and coordinating with local, state, and federal regulatory agencies as well as interested parties to better understand the full suite of beneficial uses and users that may be impacted by pumping induced surface water depletion within the GSA's jurisdictional area.*

Amended GSP: A response to Recommended Corrective Action 6 is provided in Appendix 3-G of the Amended GSP. The Amended GSP methodology identifies ISW by comparing modeled monthly groundwater conditions from the historic calibration scenario to streambed elevations. ISW are defined as surface water bodies in which groundwater levels are at or above the streambed elevation at least 75% of the time. The Amended GSP sets ISW SMC at the same levels as the SMC for Chronic Lowering of Groundwater Levels and provides figures that compare the spatial extent of ISW connectivity, annual gains and losses, and seasonal gains and losses for both 2015 and an increased pumping, minimum threshold scenario as justification that the selected thresholds are protective.

Department Response and Recommendation: The Department appreciates the additional analysis and information provided for ISW in the Amended GSP. After reviewing the Amended GSP, the Department provides the following responses and recommendations:

a. The Amended GSP does not provide context nor justification for requiring streams to be connected to groundwater at least 75% of the time to be considered ISW, as connectivity can vary seasonally and by water year type. The Department recommends that the Amended GSP revise this connectivity threshold and include surface waters that may be connected only seasonally, or in wetter water year types, as ISW and include them in the subsequent analysis. Discounting streams connected less than 75% of the time as ISW risks failure to characterize and protect ISW GDEs with corresponding Minimum Thresholds that may be critical to aquatic and riparian species.

B-4

The Amended GSP also states that many smaller creeks and streams are used for the conveyance of irrigation water and are therefore not considered in the analysis of depletions. The Amended GSP does not provide specifics or rationale for this decision. The use of streams and creeks as conveyance does not preclude them from being ISW, particularly outside of the typical irrigation season when depletions may have relatively higher impacts to flows and instream temperatures. The Department recommends the Amended GSP identify what thresholds for irrigation conveyance were used to remove streams and creeks from the analysis, identify where they are located, and identify them as a data gap for improved ISW analysis in the future.

B-5

b. In DWR's 2023 Determination Letter for the Resubmitted Eastern San Joaquin GSP, DWR stated that the Resubmitted GSP did not quantify what would be considered an undesirable result in terms of stream depletion. Rather than defining groundwater level thresholds that could cause undesirable results, the GSP suggests that the Chronic Lowering of Groundwater Levels SMC would preemptively protect against stream depletion undesirable results.

The Department does not believe that the Amended GSP adequately addresses and corrects this deficiency identified by DWR. Though the Amended GSP updates the ISW analysis to compare depletions estimated in 2015 to projected conditions at the minimum thresholds, the Amended GSP does not ever independently describe what would constitute an undesirable result for depletions of ISW. Instead, it presents metrics showing the relative change in depletions between the two scenarios, and though some segments experience increases in depletions beyond 2015 conditions, the changes are considered too small to constitute an undesirable result, though that undesirable result has not been otherwise defined. Additionally, the statistics presented are on a seasonal basis rather than a monthly basis, and the depletion values are aggregated for the entire length of each river through the subbasin which is too coarse a geography to meaningfully evaluate potential adverse impacts to ISW.

ATTACHMENT 2

B-6

The Department recommends that the Amended GSP be updated with a definition of what would constitute an undesirable result for depletions of ISW that is independent of modeled changes based on the groundwater level SMC. The undesirable result definition should describe the rate, timing, and volume of depletions of ISW.

B-7

Additionally, a table presenting the baseline and projected scenario accretions and depletions by month, rather than in a figure showing quarterly values, would provide a higher resolution of information for review that is necessary for evaluating undesirable results to environmental beneficial users. As noted in the Amended GSP, some ISW within the subbasin experience markedly different depletion and accretion conditions in their upper vs lower reaches. Aggregating gains and losses across an entire river, rather than in more discrete segments, can mask localized adverse impacts to ISW in which specific segments may experience a significant increase in the rate of depletions, or decrease in the rate of accretions, that are not immediately evident when added together. The Department recommends separating ISW such as the Mokelumne River, Stanislaus River, Dry Creek, and the San Joaquin River into multiple segments and reporting modeled monthly depletion volumes for each.

B-7, cont

c. The Amended GSP states that no undesirable results for ISW were occurring in 2015 in the subbasin because minimum instream flow requirements and agreements were met, and Chinook salmon populations were recovering after a decline in the late 2000s. Neither of these claims is evidence that demonstrates a lack of undesirable results due to depletions occurring in the subbasin.

Stream gauge compliance points located both upstream and downstream of the subbasin are used to inform surface water releases and allowable diversions to ensure that instream flow requirements and agreements are met. If significant depletions were occurring within the subbasin, additional surface water would be released, or diverters would bypass flow, to continue to maintain the required instream flows and offset the depletions.

Further, population dynamics of Chinook salmon are complex, variable, and not dependent solely on streamflow depletions. Streamflow, timing of pulse or attractant flows, water quality and temperature, habitat availability, and management actions all play a role in population numbers that are expected to vary from year to year. Presenting a single year of population data, which does not consider survival rates or spawning success, as evidence that depletions were not affecting aquatic users of ISW is overly simplistic and inappropriate.

B-8

The Department recommends the statements referenced above be removed from the Amended GSP. The Amended GSP should determine what *rates,* *timing, and volumes* of depletion of ISW would be considered an undesirable result (see above comment on defining ISW undesirable results).

d. The Department appreciates the work involved in installing 6 new monitoring wells within the subbasin that are now included as part of the ISW monitoring network. The Amended GSP states that due to the lack of historic groundwater level data, there are not yet any SMC thresholds identified for these six ISW wells. At least 4 years of data will need to be collected before SMC can be determined, but additional years of data collection may be required if one wet and one dry/critically dry year to not occur within those first 4 years.

The Department acknowledges the challenges associated with the lack of measured groundwater level data at these 6 wells. However, the Amended GSP identifies only 12 wells as part of the ISW monitoring well network; for at least 4 more years, 6 of the 12, or half of the monitoring network, will not have any SMC defined. Should the required wet and dry hydrology not occur in those 4 years, the lack of SMC could stretch even further. Given the need to reach sustainability by 2040, this level of delay in determining SMC for half of the ISW monitoring network is not acceptable and would prevent identification of undesirable results for ISW should they occur. The northern portion of the subbasin, where 5 of the 6 new wells are located, would be particularly susceptible to having unidentified undesirable results occur due to the lack of SMC. The Department recommends the Amended GSP include an *interim* methodology for establishing SMC at the 6 new monitoring wells included in the ISW network, that will be refined with additional years of data collection.

B-9

e. The Department acknowledges that additional guidance from DWR on techniques for estimating depletions of ISW was not available prior to development of the Amended GSP. The Draft DWR guidance is now available for public review, and it encourages the use of numerical modeling to determine the depletion of ISW that is specifically attributable to groundwater pumping. The Amended GSP states that comparing modeled pumping and no-pumping scenarios using the most updated model for the Eastern San Joaquin subbasin was attempted, but it resulted in an inconclusive understanding and was therefore not incorporated into this Amended GSP.

B-10

The Department recommends the Amended GSP include specific, time-based plans to develop numerical model scenarios in accordance with DWR resources, define the ISW undesirable result, and develop protective SMC.

ATTACHMENT 2

CONCLUSION

In conclusion, the Department appreciates the updated analyses included in the Amended GSP, but the plan still needs improvement in its consideration of GDEs, ISW, and environmental beneficial uses and users of groundwater including fish and wildlife and their habitats. The Department's comments further indicate that the Amended GSP fails to sufficiently address deficiencies previously identified by DWR, and thus may still include deficiencies in the following areas:

1. The assumptions, criteria, findings, and objectives, including the sustainability goal, undesirable results, minimum thresholds, measurable objectives, and interim milestones are not reasonable and/or not supported by the best available information and best available science [Cal. Code Regs., tit. 23, § 355.4, subd. (b)(1)];

2. The GSP does not identify reasonable measures and schedules to eliminate data gaps [Cal. Code Regs., tit. 23, § 355.4, subd. (b)(2)];

3. The interests of the beneficial uses and users of groundwater in the basin, and the land uses and property interests potentially affected by the use of groundwater in the basin, have not been considered [Cal. Code Regs., tit. 23, § 355.4, subd. (b)(4)].

The Department has included a summary of GSP regulatory requirements pertaining to the protection of fish and wildlife (Attachment A) and has also included prior Department comments (Attachments B, C, and D) for your reference.

The Department appreciates the opportunity to provide comments on the Eastern San Joaquin Basin Updated GSP. If you have any further questions or would like to discuss the Department's comments, please contact R2Water@wildlife.ca.gov.

Sincerely,

DocuSigned by:
Morgan Kilgour
C3A86764C0AD4F6...

Morgan Kilgour
Regional Manager, North Central Region

Enclosures (Attachments A, B, C, D)

ATTACHMENT 2

ec: California Department of Fish and Wildlife

Brooke Jacobs, Branch Chief
Water Branch
Brooke.Jacobs@wildlife.ca.gov

Robert Holmes, Environmental Program Manager
Statewide Water Planning Program
Robert.Holmes@wildlife.ca.gov

Adam Weinberg, Statewide SGMA Coordinator
Groundwater Program
Adam.Weinberg@wildlife.ca.gov

Briana Seapy, Water Program Supervisor
North Central Region
Briana.Seapy@wildlife.ca.gov

Jennifer Garcia, Environmental Program Manager
North Central Region
Jennifer.Garcia@wildlife.ca.gov

Bridget Gibbons, Regional SGMA Coordinator
North Central Region
Bridget.Gibbons@wildlife.ca.gov

California Department of Water Resources

Chelsea Spier, Eastern San Joaquin SGMA Point of Contact
North Central Region Office
Chelsea.Spier@water.ca.gov

National Marine Fisheries Service

Rick Rogers, Fish Biologist
West Coast Region
Rick.Rogers@noaa.gov

State Water Resources Control Board

Natalie Stork, Assistant Director
Office of Sustainable Groundwater Management
Natalie.Stork@waterboards.ca.gov

ATTACHMENT 2

Attachment A

Summary of GSP Requirements and GSA Obligations with Respect to the Protection of Fish and Wildlife and Public Trust Resources

As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & G. Code, §§ 711.7 and 1802). SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to GSPs:

- GSPs must **consider impacts to GDEs** (Water Code, § 10727.4, subd. (l); see also Cal. Code Regs., tit. 23, § 354.16, subd. (g));
- GSPs must consider the interests of all beneficial uses and users of groundwater, including environmental users of groundwater (Water Code, § 10723.2) and GSPs must **identify and consider potential effects on all beneficial uses and users of groundwater** (Cal. Code Regs., tit. 23, §§ 354.10, subd. (a), 354.26, subd. (b)(3), 354.28, subd. (b)(4), 354.34, subds. (b)(2), & (f)(3));
- GSPs must **establish sustainable management criteria that avoid undesirable results** within 20 years of the applicable statutory deadline, including **depletions of ISW that have significant and unreasonable adverse impacts on beneficial uses of the surface water** (Cal. Code Regs., tit. 23, § 354.22 *et seq*. and Water Code §§ 10721, subd. (x)(6) and 10727.2, subd. (b)) and describe monitoring networks that can identify adverse impacts to beneficial uses of ISW (Cal. Code Regs., tit. 23, § 354.34, subd. (c)(6)(D)); and
- GSPs must **account for groundwater extraction for all water use sectors,** including managed wetlands, managed recharge, and native vegetation (Cal. Code Regs., tit. 23, §§ 351, subds. (a) & (l) and 354.18, subd. (b)(3)).

Furthermore, the Public Trust Doctrine imposes a related but distinct obligation to consider how groundwater management affects public trust resources, including navigable surface waters and fisheries. Groundwater hydrologically connected to surface waters is also subject to the Public Trust Doctrine to the extent that groundwater extractions or diversions affect or may affect public trust uses. (*Environmental Law Foundation v. State Water Resources Control Board* (2018), 26 Cal. App. 5th 844; *National Audubon Society v. Superior Court* (1983), 33 Cal. 3d 419.) The GSA has "an affirmative duty to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever feasible." (*National Audubon Society*, *supra*, 33 Cal. 3d at 446.) Accordingly, groundwater plans should consider potential impacts to and appropriate protections for ISW and their tributaries, and ISW that support fisheries, including the level of groundwater contribution to those waters.

ATTACHMENT 2

Attachment B

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE COMMENTS ON THE EASTERN SAN JOAQUIN ***REVISED*** *GROUNDWATER SUSTAINABILITY PLAN*

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
North Central Region
1701 Nimbus Road
Rancho Cordova, CA 95670
www.wildlife.ca.gov

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

September 29, 2022

Via Electronic Mail and Online Submission

Monica Reis, Supervising Water Resources Engineer
California Department of Water Resources
715 P Street, 8th Floor
Sacramento, CA 95814

Email: Monica.Reis@water.ca.gov
Portal Submission: https://sgma.water.ca.gov/portal/#gsp

Fritz Buchman, C.E, T.E., CFM
Eastern San Joaquin Groundwater Authority
1810 E. Hazelton Avenue
Stockton, CA 95210
Email: fbuchman@sjgov.org

Dear Monica Reis and Fritz Buchman:

Subject: CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE COMMENTS ON THE EASTERN SAN JOAQUIN SUBBASIN REVISED GROUNDWATER SUSTAINABILITY PLAN

The California Department of Fish and Wildlife (Department) is providing comments on the Eastern San Joaquin Subbasin Revised Groundwater Sustainability Plan (Revised GSP) prepared by the Eastern San Joaquin Groundwater Authority (ESJGA)[1] pursuant to the Sustainable Groundwater Management Act (SGMA) and submitted to the California Department of Water Resources (DWR) on January 28, 2022. The Subbasin is designated as a Critically Overdrafted, High Priority subbasin under SGMA. In response to the Department of Water Resources (DWR) Incomplete Determination, the GSA must submit the Revised GSP and other required information and materials to DWR by July 27, 2022.

[1] The Eastern San Joaquin Groundwater Authority comprises 17 Groundwater Sustainability Agencies (GSAs): Calaveras County Water District / Stanislaus County, California Water Service Company, Central Delta Water Agency, Central San Joaquin Water Conservation District, City of Lathrop, City of Lodi, City of Manteca, City of Stockton, Linden County Water District, Lockeford Community Services District, North San Joaquin Water Conservation District, Oakdale Irrigation District, San Joaquin County, South Delta Water Agency, South San Joaquin Groundwater Sustainability Agency, Stockton East Water District, and Woodbridge Irrigation District GSA.

ATTACHMENT 2

The Department is writing to support ecosystem preservation and enhancement in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science. As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & Game Code §§ 711.7 and 1802).

Development and implementation of GSPs under SGMA represents a new era of California groundwater management. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems, species, and public trust resources depend on groundwater and interconnected surface water (ISW). SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to GSPs:

- GSPs must **consider impacts to groundwater dependent ecosystems** (GDEs) (Water Code § 10727.4(l); see also 23 CCR § 354.16(g));
- GSPs must consider the interests of all beneficial uses and users of groundwater, including environmental users of groundwater (Water Code § 10723.2) and GSPs must **identify and consider potential effects on all beneficial uses and users of groundwater** (23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3));
- GSPs must **establish sustainable management criteria that avoid undesirable results** within 20 years of the applicable statutory deadline, including **depletions of ISW that have significant and unreasonable adverse impacts on beneficial uses of the surface water** (23 CCR § 354.22 *et seq*. and Water Code §§ 10721(x)(6) and 10727.2(b)) and describe monitoring networks that can identify adverse impacts to beneficial uses of ISW (23 CCR § 354.34(c)(6)(D)); and
- GSPs must **account for groundwater extraction for all water use sectors,** including managed wetlands, managed recharge, and native vegetation (23 CCR §§ 351(al) and 354.18(b)(3)).

In the context of SGMA statutes and regulations, and Public Trust Doctrine considerations, groundwater planning should carefully consider and protect environmental beneficial uses and users of groundwater, including fish and wildlife and their habitats, GDEs, and ISW.

Furthermore, the Public Trust Doctrine imposes a related but distinct obligation to consider how groundwater management affects public trust resources, including navigable surface waters and fisheries. Groundwater hydrologically connected to surface waters is also subject to the Public Trust Doctrine to the extent that groundwater extractions or diversions affect or may affect public trust uses. (*Environmental Law*

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Foundation v. State Water Resources Control Board (2018), 26 Cal. App. 5th 844; *National Audubon Society v. Superior Court* (1983), 33 Cal. 3d 419.) The GSA has "an affirmative duty to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever feasible." (*National Audubon Society*, *supra*, 33 Cal. 3d at 446.) Accordingly, groundwater plans should consider potential impacts to and appropriate protections for ISW and their tributaries, and ISW that support fisheries, including the level of groundwater contribution to those waters.

The Department is providing comments and recommendations on the Eastern San Joaquin Subbasin Revised GSP (Attachment A). The comments in Attachment A only reflect those issues that DWR directed the GSA to address in its Incomplete Determination, and do not encompass all previous Department comments, many of which remain unresolved. For additional background, the Department is providing prior comments on the Final GSP as Attachment B, and prior comments on the Draft GSP as Attachment C.

As detailed in Attachment A, **the Department believes that the Revised GSP does not address all the deficiencies identified by DWR in its Incomplete Determination**. The Revised GSP does not adequately consider environmental users of groundwater or ISW. Accordingly, the Department continues to recommend ESJGA characterize impacts to environmental users and subsequently reselect minimum thresholds and measurable objectives that will avoid undesirable results for environmental users.

The Department appreciates the opportunity to provide comments on the Eastern San Joaquin Subbasin Revised GSP. If you have any further questions, please contact Tiffanee Hutton by email at Tiffanee.Hutton@wildlife.ca.gov.

Sincerely,

DocuSigned by:
Kevin Thomas
A2A0A9C574C3445...

Kevin Thomas
Regional Manager, North Central Region

Enclosures (Attachments A, B)

ec: California Department of Fish and Wildlife

Brooke Jacobs, Acting Branch Chief

Water Branch
Brooke.Jacobs@wildlife.ca.gov

Robert Holmes, Environmental Program Manager
Statewide Water Planning Program
Robert.Holmes@wildlife.ca.gov

Angela Murvine, Statewide SGMA Coordinator
Groundwater Program
Angela.Murvine@wildlife.ca.gov

Jennifer Garcia, Environmental Program Manager
North Central Region
Jennifer.Garcia@wildlife.ca.gov

Briana Seapy, Water Program Supervisor
North Central Region
Briana.Seapy@wildlife.ca.gov

Tiffanee Hutton, Regional SGMA Coordinator
North Central Region
Tiffanee.Hutton@wildlife.ca.gov

California Department of Water Resources

Paul Wells, Eastern San Joaquin Subbasin SGMA Point of Contact
North Central Region Office
Paul.Wells@water.ca.gov

National Marine Fisheries Service

Rick Rogers, Fish Biologist
West Coast Region
Rick.Rogers@noaa.gov

State Water Resources Control Board

Natalie Stork, Chief
Groundwater Management Program
Natalie.Stork@waterboards.ca.gov

ATTACHMENT 2

Attachment A

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE COMMENTS ON THE EASTERN SAN JOAQUIN SUBBASIN REVISED GROUNDWATER SUSTAINABILITY PLAN

COMMENTS AND RECOMMENDATIONS

DWR's January 28, 2022 Incomplete Determination of the 2020 Eastern San Joaquin Groundwater Sustainability Plan (Incomplete Determination) identified two deficiencies and a total of nine associated corrective actions that needed to be addressed by the ESJGA prior to DWR determining the plan to be complete. The Department reviewed the Revised GSP and believes that the revision fails to adequately address the following portions of Deficiency 1 and Corrective Action 1d (Incomplete Determination):

> Deficiency 1: The GSP also lacks sufficient explanation for its minimum thresholds and undesirable results for chronic lowering of groundwater levels.
>
> Corrective Action 1d: The GSAs should also explain how other factors they identified as "potential undesirable results" (e.g., adverse impacts to environmental uses and users) were considered when developing and selecting minimum thresholds and describe anticipated effects of the thresholds on beneficial uses and users of groundwater.

Revised GSP Response to Corrective Action 1d: The Department reviewed sections 3.3.2 Sustainable Management Criteria; Chronic Lowering of Groundwater Levels and 3.3.6 Sustainable Management Criteria; Depletions of Interconnected Surface Water in the Revised GSP, looking for additional rationale that would demonstrate the minimum thresholds selected for chronic lowering of groundwater levels, and by proxy, the depletion of interconnected surface water, were developed with a consideration of environmental beneficial users and were determined to be protective against adverse impacts. No changes were made in the primary text of the Revised GSP in either section that relate to environmental users of groundwater; the Revised GSP instead states that additional explanations related to Corrective Action 1d can be found in Appendix 3-D, which contains Technical Memorandum No. 2 – Drinking Water and Shallow Wells.

Department Response and Recommendation: Upon review of the information provided in Appendix 3-D, the Department believes that the rationale provided in the Revised GSP remains insufficient in its consideration of environmental users of groundwater. In the subsection of Appendix 3-D that purportedly provides a response to the sentence of Corrective Action 1d outlined above, the appendix makes no mention of environmental users of groundwater, including groundwater dependent ecosystems or interconnected surface water, as specifically recommended by DWR in its Incomplete Determination. Appendix 3-D largely restates the rationale provided in the main text of the GSP, in which the identification of minimum thresholds and measurable objectives relies on the unsubstantiated assertion that groundwater levels within the subbasin can continue to decline without environmental users of groundwater experiencing significant and unreasonable undesirable results, a statement which is incongruous with DWR's identification of the subbasin as critically overdrafted.

Low flows and increased water temperatures in the lower San Joaquin River have been documented to negatively impact Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) (Hallock 1970, Marston 2012). The Department believes historical declines in terrestrial and aquatic groundwater dependent ecosystem viability, exacerbated by recent drought years, are evidence of undesirable results and further groundwater decline will undoubtedly lead to significant and unreasonable effects on fish and wildlife beneficial uses and users of groundwater and interconnected surface waters under the proposed sustainable management criteria.

As previously stated in the Department's comments on both the Final (Attachment B) and Draft (Attachment C) GSPs, the Department recommends that the ESJGA complete a thorough assessment of the potential adverse impacts to environmental beneficial users and reselect minimum thresholds and measurable objectives that would be protective of environmental beneficial users of groundwater and interconnected surface water.

CONCLUSION

In conclusion, the Department believes the Revised GSP warrants a determination of inadequacy because deficiencies identified by DWR have not been corrected prior to the applicable statutory deadline (23 CCR § 355.2(e) and 355.4(a)). The Revised GSP neither presents a rationale that explains how environmental users were considered in the methodology for determining sustainability criteria, nor does it include analysis that demonstrates that environmental users would be protected from undesirable results by the identified minimum thresholds and measurable objectives. As described above, the Department's comments indicate that the Revised GSP fails to sufficiently address the following:

1. The assumptions, criteria, findings, and objectives, including the sustainability goal, undesirable results, minimum thresholds, measurable objectives, and interim milestones are not reasonable and/or not supported by the best available information and best available science. [23 CCR § 355.4(b)(1)]

2. The sustainable management criteria and projects and management actions are not commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the GSP. [23 CCR § 355.4(b)(3)]

3. The interests of the beneficial uses and users of groundwater in the basin, and the land uses and property interests potentially affected by the use of groundwater in the basin, have not been considered. [23 CCR § 355.4(b)(4)]

ATTACHMENT 2

Attachment B

COMMENTS ON THE FINAL EASTERN SAN JOAQUIN SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
North Central Region
1701 Nimbus Road,
Rancho Cordova, CA 95670
www.wildlife.ca.gov

ATTACHMENT 2

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

May 13, 2020

Via Electronic Mail and Online Submission

Craig Altare
Supervising Engineering Geologist
California Department of Water Resources
901 P Street, Room 213
Sacramento, CA 94236

Email: Craig.Altare@water.ca.gov
Portal Submission: https://sgma.water.ca.gov/portal/#gsp

Dear Mr. Altare:

Subject: COMMENTS ON THE FINAL EASTERN SAN JOAQUIN SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

The California Department of Fish and Wildlife (Department) North Central Region is providing comments on the Final Eastern San Joaquin Subbasin Groundwater Sustainability Plan (GSP) prepared by the Eastern San Joaquin Groundwater Authority (ESJGA)[1] pursuant to the Sustainable Groundwater Management Act (SGMA). As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & Game Code §§ 711.7 and 1802).

Development and implementation of GSPs under SGMA represents a new era of California groundwater management. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems and species depend on groundwater and interconnected surface waters, including ecosystems on Department-owned and -managed lands within SGMA-regulated basins. SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to Groundwater Sustainability Plans:

---

[1] The Eastern San Joaquin Groundwater Authority comprises 17 Groundwater Sustainability Agencies (GSAs): Calaveras County Water District / Stanislaus County, California Water Service Company, Central Delta Water Agency, Central San Joaquin Water Conservation District, City of Lathrop, City of Lodi, City of Manteca, City of Stockton, Linden County Water District, Lockeford Community Services District, North San Joaquin Water Conservation District, Oakdale Irrigation District, San Joaquin County, South Delta Water Agency, South San Joaquin Groundwater Sustainability Agency, Stockton East Water District, and Woodbridge Irrigation District GSA.

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- Groundwater Sustainability Plans must **identify and consider impacts to groundwater dependent ecosystems (GDEs)** [23 CCR § 354.16(g) and Water Code § 10727.4(l)];
- Groundwater Sustainability Agencies must **consider all beneficial uses and users of groundwater**, including environmental users of groundwater [Water Code §10723.2 (e)]; and Groundwater Sustainability Plans must **identify and consider potential effects on all beneficial uses and users of groundwater** [23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3)];
- Groundwater Sustainability Plans must **establish sustainable management criteria that avoid undesirable results** within 20 years of the applicable statutory deadline, including **depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water** [23 CCR § 354.22 *et seq*. and Water Code §§ 10721(x)(6) and 10727.2(b)] and **describe monitoring networks** that can identify adverse impacts to beneficial uses of interconnected surface waters [23 CCR § 354.34(c)(6)(D)]; and
- Groundwater Sustainability Plans must **account for groundwater extraction for all water use sectors** including managed wetlands, managed recharge, and native vegetation [23 CCR §§ 351(al) and 354.18(b)(3)].

Furthermore, the Public Trust Doctrine imposes a related but distinct obligation to consider how groundwater management affects public trust resources, including navigable surface waters and fisheries. Groundwater hydrologically connected to navigable surface waters or surface waters supporting fisheries, and surface waters tributary to navigable surface waters or surface waters supporting fisheries, are also subject to the Public Trust Doctrine to the extent that groundwater extractions or diversions affect or may affect public trust uses (*Environmental Law Foundation v. State Water Resources Control Board* (2018), 26 Cal. App. 5th 844; *National Audubon Society v. Superior Court* (1983), 33 Cal. 3d 419). Accordingly, groundwater plans should consider potential impacts to and appropriate protections for interconnected surface waters and their tributaries, and interconnected surface waters that support fisheries, including the level of groundwater contribution to those waters.

In the context of SGMA statutes and regulations, and Public Trust Doctrine considerations, the Department values groundwater planning that carefully considers and protects environmental beneficial uses and users of groundwater including fish and wildlife and their habitats: groundwater dependent ecosystems and interconnected surface waters.

COMMENT OVERVIEW

The Department supports ecosystem preservation and enhancement in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science. Consistent with comments previously submitted to the GSA on August 23, 2019, the Department recommends the GSP provide additional information and analysis that considers all environmental beneficial uses and users of groundwater and that better characterizes surface water-groundwater connectivity. The Department appreciates ESJGA's consideration and integration of many of the Department's original comments. Where the Department's initial comments have not been addressed, they are restated in this letter with updated page citations. Where ESJGA has since responded to the Department's comments, the Department has updated the comments and provided additional context in *italicized text*.

COMMENTS AND RECOMMENDATIONS

The Department comments are as follows:

1. **Comment #1** (Basin Setting, 2.2.6 **Interconnected Surface Water Systems**, starting page 2-104): The narrative describing the basin's interconnected surface water (ISW) conditions lacks specifics.
   a. *Issue*:
      i. The interconnected surface water conditions narrative lacks estimations of the quantity and timing of streamflow depletions as required by 23 CCR § 354.16(f).
   b. *Recommendation*:
      i. Identify the estimated quantity and timing of streamflow depletions in the ESJ Subbasin. If this information is not available, delineate a specific and expeditious path to estimating these values.

   GSA Response to Comments: "*See Master Response 2 - ISW" (Appendix 1-J, PDF page 899).*
   Department Response: *In response to ISW comments, ESJGA identified ISW as a data gap, specified the need for near-stream monitoring wells additional analysis/iterative modeling, clarified gaining/losing stream language and figures, and removed stream nodes with poor model calibration (among other responses). The Department appreciates these responsive GSP updates and the clear acknowledgement of ISW as a data gap. Though the above comment identifies an unmet GSP regulatory expectation, the Department understands data scarcity challenges and recommends ESJGA clearly identify how they will succeed in meeting this regulatory standard during GSP implementation.*

2. **Comment #2** (Basin Setting, 2.2.7 **Groundwater-Dependent Ecosystems**, starting page 2-108): GDE identification, required by 23 CCR § 354.16(g), is incomplete.

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a. *Issues*: Use of the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset to identify GDEs is incomplete.
   i. Incomplete GDE Description: The GSP notes, "GDEs exist where vegetation accesses shallow groundwater for survival. This Plan identifies GDEs within the Eastern San Joaquin Subbasin based on determining the areas where vegetation is dependent on groundwater" (2-108). This cursory summation of GDEs excludes aquatic GDEs that rely on groundwater recharge to instream flow. Further, the GDE methods section states, "The NCCAG database was then further refined to identify communities without access to alternate water supplies, as those communities would not be dependent on groundwater" (2-110). Presumably the word 'not' is included in error.
   ii. GDE Identification Data Gap: In response to GDE comments on the Draft GSP, ESJGA identified several GDE assessments as data gaps rather than remove the potential GDEs from the dataset, which was the previous approach. These data gaps include potential GDEs where the depth to groundwater exceeds 30 feet (using a 2015 baseline) and potential GDEs with access to alternate water supplies (2-111). The GSP intends to refine these categories of potential GDEs via future analysis (2-110, 2-111), but the plan does not specify how. The Department reiterates its original concern for exclusion of GDEs based on a snapshot of groundwater elevation during a historical drought or based on the assumption that ecosystem water reliance is static, rather than fluid and able to tap into surface water *and* groundwater, condition-dependent.

b. *Recommendations*:
   i. Incomplete GDE Description: Include aquatic GDEs (i.e., ISW) in the narrative description of GDEs and confirm that ecological communities without access to surface water are groundwater dependent.
   ii. GDE Data Gap Identification: Specify how ESJGA will refine GDE identification and resolve data gaps to comply with GSP regulations during GSP implementation.

GSA Response to Comments: "*See Master Response 1 - GDEs" (Appendix 1-J, PDF page 898).*

Department Response: *In response to GDE comments, ESJGA updated GDE identification methods, adding language identifying NCCAG areas previously removed as data gaps that require further refinement. The Department appreciates these responsive GSP updates and the clear acknowledgement of GDE identification data gaps. The Department has updated the above comment accordingly, and though the above comment identifies an unmet GSP regulatory expectation, the Department understands data scarcity challenges and recommends the ESJGA clearly identify how* *they will succeed in meeting this regulatory standard during GSP implementation.*

3. **Comment #3** (Basin Setting, 2.3.5.3 **Projected Water Budget**, starting page 2-138): Projected water budget assumptions may risk overestimating surface water availability and sustainable yield by not relying on best available information [23 CCR § 354.18(e)].
   a. *Issue*: Projected surface water budget assumptions may risk overestimating water availability. Overestimation of water availability can result in the overallocation of both surface and groundwater water resources, jeopardizing environmental beneficial users. Two water budget assumptions that do not rely on best available information and that underscore current sustainable yield estimations are as follows: 1) the climate change analysis predicting a net depletion of aquifer storage is not reflected in the projected water budget or estimated sustainable yield, rather it is presented as a separate analysis; and 2) projected surface water deliveries do not reflect new regulatory reductions of surface water deliveries such as those that may be codified in the State Water Resources Control Board Water Quality Control Plan for the Bay Delta: San Joaquin River Flows and Southern Delta Water Quality.
   b. *Recommendation*: Amend the water budget and sustainable yield: 1) apply climate change estimates to the projected water budget and scale the sustainable yield accordingly; and 2) adjust surface water delivery estimates to reflect any new regulatory compliance.

GSA Response to Comments: "*1) Consistent with regulations, the 2070 climate change sensitivity analysis on the projected conditions scenario was used to better understand trends and inform planning. Due to the uncertainty around climate projections in the 2070 timeframe, the ESJGWA Board determined the projected conditions scenario was most appropriate for analyzing sustainable yield in the GSP implementation time period beginning in 2040. Therefore, the sustainable yield analysis did not include climate change. Comment noted for follow up in next round of model refinements and updates to analyses. 2) Added text to Section 2.3.5 (Water Budget Estimates) clarifying that climate change was a separate scenario: "Hydrology under climate change projections was evaluated in a separate ESJWRM scenario and results are discussed separately in Section 2.3.7.4." 3) Added text to Section 2.3.6 (Sustainable Yield Estimate) clarifying that climate change was not part of the analysis: "The sustainable conditions scenario, building off the projected conditions scenario, does not include climate change discussed in*

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Section 2.3.7. Due to the uncertainty around DWR's climate projections for a 2070 timeframe, the ESJGWA Board determined the projected conditions scenario was most appropriate for analyzing sustainable yield in the GSP implementation time period beginning in 2040." 4) The SWRCB did adopt the water quality control plan for the Bay-Delta, which has an impact on the Subbasin and will be addressed in future updates to the GSP. Given the timeframe of the GSP being adopted, it was not possible to include the new regulations in the analysis in this GSP and they will be included in future iterations" (Appendix 1-J, PDF page 903).

Department Response: *The Department appreciates the clarifying language and explanations provided in ESJGA's above response. The Department believes the above comment remains relevant, particularly for future GSP updates and successful, realistic long-term GSP implementation.*

4. **Comment #4** (**Sustainable Management Criteria**, 3.2.1 Chronic Lowering of Groundwater Levels and 3.2.6 Depletions of Interconnected Surface Water, starting page 3-3): Groundwater Level and Interconnected Surface Water sustainable management criteria do not protect against undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface waters.
   a. *Issues*:
      i. Proxy Metric: Before addressing the individual sustainability criteria for both Groundwater Levels and Depletions of Interconnected Surface Water, the Department challenges the use of groundwater elevations as a proxy metric for Depletions of Interconnected Surface Water. The GSP does not provide evidence that a "significant correlation exists between groundwater elevations" and Depletions of Interconnected Surface Water [23 CCR § 354.36(b)(1)]. Instead, the GSP backs into the proxy metric by associating the proposed Groundwater Level minimum thresholds with the absence of significant and unreasonable surface water depletions, claiming that historical depletions of interconnected surface water had no associated undesirable results (page 3-22). The GSP offers few details to substantiate this claim that historical surface water depletions did not lead to undesirable results, and the summarized modeling exercise used to determine the insignificance of historical surface water depletions is based on a model with significant data gaps around surface water depletion functions (see Comment #1). Provided the status of surface water allocations and aquatic ecosystems on rivers in the ESJ basin, the

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Department contests that any surface water depletions attributable to groundwater pumping are likely to be significant and unreasonable, particularly in the benchmark year of 2015 when groundwater pumping and surface water temperatures were critically high. Depleted flows in the lower San Joaquin River, many reaches of which are identified as interconnected in the GSP, contribute to increased in-river water temperatures. Groundwater extraction from interconnected aquifers contributes to depletion of instream flow (Barlow and Leake, 2012). Low flows and increased water temperatures in the lower San Joaquin River have been documented to negatively impact Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) (Hallock 1970, Marston 2012). Acknowledging that fish and wildlife beneficial uses and users of groundwater likely experienced undesirable results during historical pumping regimes, especially during critically dry years, the GSP cannot rely on groundwater elevation as a proxy metric for Depletions of Interconnected Surface Water. If a significant correlation is lacking between groundwater elevations and Depletions of Interconnected Surface Water, particularly at the representative monitoring well locations used to track groundwater elevations in the ESJ Subbasin, then groundwater elevations used as a proxy for surface water depletions may misinform groundwater management activities and poorly predict instream habitat conditions for fish and wildlife species. Accordingly, the application of Groundwater Level sustainable management criteria to Depletions of Interconnected Surface Water is inappropriate, as it is not grounded in a quantifiable and site-specific understanding of surface water-groundwater connectivity as required by 23 CCR § 354.28 (c)(6)(A).

ii. <u>Undesirable Results</u>**:** Groundwater Level 'undesirable results' and 'effects of undesirable results' do not specify impacts to environmental beneficial users such as terrestrial GDEs (pages 3-3, 3-4). Additionally, the method used to identify undesirable results for Groundwater Levels (i.e., minimum threshold exceedances in groundwater elevation) is applied to the identification of undesirable results for the Depletions of Interconnected Surface Water without a reasonable justification. The indicator of undesirable results for Groundwater Levels is the measure of 25% of monitoring wells falling below their minimum thresholds for two consecutive (non-dry) years, yet the GSP does not prove a relationship between the Groundwater Level identification of undesirable results and the presence of undesirable results for Depletions of Interconnected Surface Water (see Comment #4.a.i). Effectively, the GSP does not connect identification of undesirable results for Depletions of Interconnected Surface Water to effects on interconnected surface water beneficial users per 23 CCR § 354.26 (b)(3). Finally, the GSP notes that groundwater levels that fall below the minimum threshold during hydrologically dry or critically dry years are not considered to be an indicator of undesirable results (page 3-3). This means proposed indicators of undesirable results for Groundwater Levels and Depletions of Interconnected Surface Water do not exist for dry water years. This absence of undesirable results indicators for certain water years means beneficial users of groundwater and interconnected surface water may experience significant and unreasonable effects throughout the duration of dry or critical water years before the undesirable results are 'identified' and managed. Accordingly, there is no groundwater management accountability during the most challenging of years for water resource managers and fish and wildlife beneficial users alike.

iii. Minimum Thresholds and Measurable Objectives: Minimum thresholds and measurable objectives for Groundwater Levels, and by proxy, for Depletions of Interconnected Surface Water, are not protective of environmental beneficial uses and users of groundwater and interconnected surface water. Minimum thresholds allow for a decrease of groundwater elevation from 2015, or a comparable historic low, for all representative monitoring sites (page 3-8); and measurable objectives are set at historically low groundwater elevations (page 3-8). These sustainability criteria suggest that groundwater elevations at all representative wells in the ESJ Subbasin can continue to decrease for the next 20 years, dropping further from historically low groundwater elevations during drought years, without witnessing undesirable results.

The ESJ Subbasin is characterized by DWR as 'Critically Overdrafted,' meaning "continuation of present water management practices [in the subbasin] would probably result in significant adverse overdraft-related environmental, social, or economic impacts" (CDWR). However, according to the GSP, there are no areas within the basin that are considered to have 'significant and unreasonable existing issues' (page 3-4), therefore minimum thresholds allow for continued groundwater depletions. Conceptually, there is a disconnect between the ESJ's 'Critically Overdrafted' designation and the GSP's claim that the basin has not experienced undesirable results, nor will it if groundwater levels continue to decrease. More specifically, the Department believes historical declines in terrestrial and aquatic groundwater dependent ecosystem viability, exacerbated by recent drought years, are evidence of undesirable results and further groundwater decline will undoubtedly lead to significant and unreasonable effects on fish and wildlife beneficial uses and users of groundwater and interconnected surface waters under the proposed sustainable management criteria. For example, further streamflow depletion attributable to groundwater pumping that lowers groundwater levels to meet minimum thresholds or even measurable objective may further compromise in-stream temperature targets in the lower San Joaquin River, adversely impacting in-stream species (see Comment #4.a.i). Accordingly, the Department does not believe groundwater levels above the proposed minimum thresholds and below the proposed measurable objectives (in the margin of operational flexibility) will allow the basin to achieve sustainability, particularly with respect to avoiding undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface water.

b. *Recommendations*:
   i. <u>Proxy Metrics</u>: To justify use of groundwater elevations as a proxy metric for Depletions of Interconnected Surface Water, the GSP should either specify how groundwater elevations are significantly correlated to surface water depletions; or define an expeditious path to identifying the location, quantity, and timing of surface water depletions caused by groundwater use, per 23 CCR § 354.28(c)(6)(A), to better inform sustainability criteria for Depletions of Interconnected Surface Water.
   ii. <u>Undesirable Results</u>**:** Specify Groundwater Level 'undesirable results' and 'effects of undesirable results' for environmental beneficial users of groundwater and interconnected surface water. Specify undesirable result indicators for Depletions of Interconnected Surface Water that are relevant to beneficial users

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of surface waters. Identify undesirable results indicators for dry and critically dry water years for all sustainability indicators.

iii. <u>Minimum Thresholds and Measurable Objectives</u>: Reconsider minimum thresholds and measurable objectives, accounting for undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface water. Design sustainable management criteria that reflect a 'Critically Overdrafted' subbasin designation by seeking to improve current groundwater conditions rather than allowing for continued aquifer depletions over the next two decades. Consider how historical groundwater pumping has impacted stream interconnectivity (Figure 2-7, page 2-106), likely increasing streamflow depletion and reducing baseflows in ESJ Subbasin tributaries. Reduced groundwater baseflow exacerbates high water temperatures in the lower San Joaquin River, and high water temperatures negatively impact listed species such as the Chinook Salmon. Minimum thresholds and measurable objectives should reflect an effort to prevent further degradation to interconnected surface waters and to avoid undesirable results, rather than risk magnifying historical undesirable results through lowered groundwater elevations.

<u>GSA Response to Comments</u>: "*See Master Response 2 - ISW" (Appendix 1-J, PDF page 899).*
<u>Department Response</u>: *The above comment remains relevant.*

5. **Comment #5** (**Monitoring Networks,** starting page 4-1): Number, distribution, and frequency of data collection of shallow groundwater monitoring wells are insufficient for analysis of ISW.
   a. *Issue*: The current monitoring network lacks a sufficient number, representative distribution, and frequency of monitoring of shallow groundwater monitoring wells to monitor impacts to environmental beneficial uses and users of groundwater and interconnected surface waters [23 CCR § 354.34(2)]. Few wells are near interconnected surface waters or concentrations of GDEs; therefore, there are few data points on shallow groundwater level trends. These data are critical to understanding groundwater management impacts on fish and wildlife beneficial uses and users of groundwater, including GDEs and interconnected surface water habitats, which are impacted disproportionately by shallow groundwater trends.

b. *Recommendation*: Install additional shallow groundwater monitoring wells near GDEs and interconnected surface waters, potentially pairing multiple-completion wells with streamflow gauges for improved understanding of surface water-groundwater interconnectivity. Monitor wells monthly to capture seasonal trends important to GDEs.

GSA Response to Comments: "*Data gaps are discussed in Section 4.7 (Data Gaps) and include identified gaps in the monitoring and analysis of interconnected surface waters and GDEs. The GSP includes a plan for the drilling of up to 12 proposed wells to help resolve identified gaps and enhance future analysis of interconnected surface waters and GDEs. These proposed wells would all measure for both groundwater quality and groundwater levels and include 2 deep, nested wells funded under the TSS application and up to 10 shallow wells drilled by the ESJGWA. If a need for more detail is recognized, the monitoring network will be reevaluated as updates to the GSP occur. Frequency of groundwater level monitoring is cited in the Draft Monitoring Networks and Identification of Data Gaps Best Management Practice. While semi-annual monitoring is required for groundwater levels, DWR guidance recommends monthly sampling of groundwater levels for the Subbasin based on aquifer type, volume of long-term aquifer withdrawals, and recharge potential. The ESJGWA Board determined semi-annual sampling was appropriate as it will capture seasonal highs and lows and that additional monitoring would not necessarily provide additional information on trends" (Appendix 1-J, PDF page 905).*

Department Response: *The anticipated monitoring network expansion will vastly improve data collection and monitoring. Until such time as the new system is in place, the Department maintains the above concern for insufficient monitoring. The Department will also continue to recommend monthly monitoring of shallow groundwater to better understand the relationships between shallow groundwater trends and fish and wildlife beneficial uses and users of groundwater.*

6. **Comment #6** (**Project and Management Actions**; 6.1 Projects, Management Actions, and Adaptive Management Strategies; starting page 6-1): Demand reduction management actions lack emphasis and specificity critical to ESJ Subbasin sustainability goal achievement.
   a. *Issue*: The GSP project and management actions focus on supply augmentation, with only three projects intended to conserve groundwater through metering and systems optimization. Though the GSP reserves the

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flexibility to implement demand-side management in the future (page 6-1), there are no specifics as to how the ESJGA or subbasin GSAs would implement demand management. This lack of specificity on how demand will be managed may lead to deprioritization or delayed implementation of demand management actions, which can undermine a basin's ability to achieve sustainability goals. Considering the ESJ Subbasins' current unsustainable rate of groundwater consumption as a 'Critically Overdrafted Basin' and considering the cost and timing challenges associated with supply augmentation projects, a balanced portfolio approach to achieve groundwater sustainability should include demand-management strategies.

b. *Recommendation*: Add specific measures for initiating demand reduction on an earlier timeline in the ESJ Subbasin to account for groundwater pumping lag impacts, supply-augmentation project implementation challenges, and a scaled ramping-down of groundwater use that is a necessary component of San Joaquin Valley long-term groundwater sustainability. Be specific about triggers, timing, and expected outcomes of demand-management actions.

GSA Response to Comments: "*See Master Response 5 – Projects" (Appendix 1-J, PDF page 902)*
Department Response: *Master Response 5 includes the addition of new language in the GSP that promises to convene a working group if projects are not effective in achieving their target recharge or offset targets. The Department remains concerned that this action, in concert with the minimal demand-management actions, may be insufficient to achieve long term sustainability. Therefore, the above comment remains relevant.*

CONCLUSION

In conclusion, the Final Eastern San Joaquin Basin GSP has improved GSP transparency by acknowledging several key data gaps. After thorough review, the Department deems the GSP insufficient in its consideration of environmental beneficial uses and users of groundwater, including fish and wildlife and their habitats: GDEs and ISW. The Department recommends that ESJGA address the Departments concerns before the California Department of Water Resources approves the final GSP.

The Department appreciates the opportunity to provide comments on the Final Eastern San Joaquin Basin GSP. If you have any further questions, please contact Briana Seapy by email at Briana.Seapy@wildlife.ca.gov or at (916) 508-3345.

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Sincerely,

kevin.thomas@wildlife.ca.gov

Digitally signed by kevin.thomas@wildlife.ca.gov
DN: CN=kevin.thomas@wildlife.ca.gov
Reason: I am the author of this document
Location: your signing location here
Date: 2020-05-13 11:09:14
Foxit PhantomPDF Version: 9.6.0

Kevin Thomas
Regional Manager, North Central Region

ec: Joshua Grover, Joshua.Grover@wildlife.ca.gov
Robert Holmes, Robert.Holmes@wildlife.ca.gov
Jeff Drongesen, Jeff.Drongesen@wildlife.ca.gov
Briana Seapy, Briana.Seapy@wildlife.ca.gov
California Department of Fish and Wildlife

ec's: Continued on page 14

Paul Wells, Paul.Wells@water.ca.gov
California Department of Water Resources

Brandon Nakagawa, ESJgroundwater@sjgov.org
Groundwater Sustainability Agency

Rick Rogers, Rick.Rogers@noaa.gov
Erin Strange, Erin.Strange@noaa.gov
National Marine Fisheries Service

Natalie Stork, Natalie.Stork@waterboards.ca.gov
State Water Resources Control Board

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Attachment C

COMMENTS ON THE DRAFT EASTERN SAN JOAQUIN SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
North Central Region
1701 Nimbus Road,
Rancho Cordova, CA 95670
www.wildlife.ca.gov

ATTACHMENT 2
GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

August 23, 2019

Brandon Nakagawa
Eastern San Joaquin Groundwater Sustainability Plan Manager
Eastern San Joaquin Groundwater Authority
1810 E. Hazelton Avenue
P.O. Box 1810
Stockton, CA 95201
Email: ESJgroundwater@sjgov.org

Subject: COMMENTS ON THE EASTERN SAN JOAQUIN SUBBASIN DRAFT GROUNDWATER SUSTAINABILITY PLAN

Dear Mr. Nakagawa:

The California Department of Fish and Wildlife (Department) North Central Region is providing comments on the Eastern San Joaquin (ESJ) Subbasin Draft Groundwater Sustainability Plan (GSP) prepared by the Eastern San Joaquin Groundwater Authority (ESJGA)[1] pursuant to the Sustainable Groundwater Management Act (SGMA). As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & Game Code §§ 711.7 and 1802).

Development and implementation of GSPs under SGMA represents a new era of California groundwater management. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems and species depend on groundwater and interconnected surface waters, including ecosystems on Department-owned and -managed lands within SGMA-regulated basins. SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to Groundwater Sustainability Plans:

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[1] The Eastern San Joaquin Groundwater Authority comprises 17 Groundwater Sustainability Agencies (GSAs): Calaveras County Water District / Stanislaus County, California Water Service Company, Central Delta Water Agency, Central San Joaquin Water Conservation District, City of Lathrop, City of Lodi, City of Manteca, City of Stockton, Linden County Water District, Lockeford Community Services District, North San Joaquin Water Conservation District, Oakdale Irrigation District, San Joaquin County, South Delta Water Agency, South San Joaquin Groundwater Sustainability Agency, Stockton East Water District, Woodbridge Irrigation District GSA.

- Groundwater Sustainability Plans must **identify and consider impacts to groundwater dependent ecosystems** [23 CCR § 354.16(g) and Water Code § 10727.4(l)];
- Groundwater Sustainability Agencies must **consider all beneficial uses and users of groundwater**, including environmental users of groundwater [Water Code §10723.2 (e)]; and Groundwater Sustainability Plans must **identify and consider potential effects on all beneficial uses and users of groundwater** [23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3)];
- Groundwater Sustainability Plans must **establish sustainable management criteria that avoid undesirable results** within 20 years of the applicable statutory deadline, including depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water [23 CCR § 354.22 *et seq.* and Water Code §§ 10721(x)(6) and 10727.2(b)] and describe monitoring networks that can identify adverse impacts to beneficial uses of interconnected surface waters [23 CCR § 354.34(c)(6)(D)]; and
- Groundwater Sustainability Plans must **account for groundwater extraction for all Water Use Sectors** including managed wetlands, managed recharge, and native vegetation [23 CCR §§ 351(al) and 354.18(b)(3)].

Accordingly, the Department values SGMA groundwater planning that carefully considers and protects groundwater dependent ecosystems (GDE), fish and wildlife beneficial uses, and users of groundwater and interconnected surface waters.

COMMENT OVERVIEW

The Department is writing to support ecosystem preservation in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science.

The Department believes the GSP does not adequately demonstrate consideration of environmental beneficial uses and users of groundwater in its sustainability management criteria nor does it adequately characterize or consider surface water-groundwater connectivity. Accordingly, the Department recommends that ESJGA address these deficiencies before submitting the GSP to the Department of Water Resources (DWR).

COMMENTS AND RECOMMENDATIONS

The Department comments are as follows:

1. **Comment #1** (Plan Area, 1.2.1.1 Summary of Jurisdictional Areas and Other Features, pp. 1-18): Department lands are excluded from 'Summary of Jurisdictional Areas' narrative as well as from Figure 1-11, which maps other federal and state lands.

   a. *Issue*: The GSP does not identify the jurisdictional boundaries of Department-owned and -managed lands as required by 23 CCR § 354.8(a)(3).
   b. *Recommendation*: Include in Figure 1-11 and the accompanying narrative White Slough Wildlife Area, Woodbridge Ecological Reserve, and Vernalis Ecological Reserve Department lands.
2. **Comment #2** (Basin Setting, 2.2.6 Interconnected Surface Water Systems, starting pp 2-97): The narrative describing the basin's interconnected surface water conditions lacks specifics and contains inconsistencies in mapped surface water-groundwater interconnectivity.
   a. *Issue*:
      i. The interconnected surface water conditions narrative lacks estimations of the quantity and timing of streamflow depletions as specified in 23 CCR § 354.16(f).
      ii. Figure 2-65 portrays modeled 'losing,' 'gaining,' and 'mixed' stream reaches, and Figure 2-66 portrays modeled 'interconnected and 'disconnected' streams. Figure 2-66 shows modeled stream reaches as 'disconnected,' whereas Figure 2-65 identifies those same reaches as switching between 'losing,' 'gaining,' and 'mixed.' Accompanying narrative suggests that streams are only mapped as 'interconnected' in Figure 2-66 when they are interconnected at least 75% of the time. This 75% threshold for displaying interconnected surface waters excludes reaches of stream that are intermittently connected to groundwater and that may depend on groundwater contributions to meet the needs of instream or riparian beneficial uses and users of interconnected surface waters.
   b. *Recommendation*:
      i. Identify the estimated quality and timing of streamflow depletions in the ESJ Subbasin. If this information is not available, identify an expeditious path to estimating these values.
      ii. Update Figure 2-66 to show all interconnected stream reaches, even if they are interconnected less than 25% of the time.
3. **Comment #3** (Basin Setting, 2.2.7 Groundwater-Dependent Ecosystems, starting pp 2-100): GDE identification, required by 23 CCR § 354.16(g), is based on methods that risk exclusion of ecosystems that may depend on groundwater.
   a. *Issue*: Methods applied to the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset to eliminate potential GDEs are fallible.

i. Depth to Groundwater: The removal of potential GDEs with a depth to groundwater greater than 30 feet during (an unspecified season) of 2015 relies on a single-point-in-time baseline hydrology. Specifically, this 2015 baseline falls several years into a historic drought when groundwater levels throughout the San Joaquin Valley were trending dramatically lower than usual due to reduced surface water availability. Exclusion of potential GDEs based on a snapshot of groundwater elevations during a historic drought is invalid; because this approach does not consider representative climate conditions or account for GDEs that can survive a finite period of time without groundwater access (Naumburg 2005), but that rely on groundwater table recovery for long term survival.

ii. Adjacent to Alternate Water Supplies: The GSP notes that "to be dependent on groundwater there must not be other available water supplies" (GSP pp 2-104). This statement disregard's a GDE's adaptability and opportunistic approach to accessing water in which vegetation may vary reliance on surface water and groundwater between seasons and water years.[2] Therefore, the removal of potential GDEs that are within 50 feet of irrigated lands, 150 feet of managed wetlands, and 150 feet of perennial surface water does not consider the potential for GDEs shifting reliance between surface and groundwater. Additionally, vegetation near *interconnected* perennial surface waters may depend on sustained groundwater elevations to stabilize the gradient or rate of loss of surface water; meaning ecosystems near interconnected surface waters likely depend on sustainable groundwater elevations and constitute GDEs. Therefore, it is possible that any of these potential GDEs proximate to 'alternate water supplies' rely on groundwater during specific seasons or water years.

b. *Recommendations*:

i. Depth to Groundwater: Develop a hydrologically robust baseline from which to remove 'areas with a depth to groundwater greater than 30 feet' that relies on multiple, climatically representative years of groundwater elevation and that accounts for the inter-seasonal and inter-annual variability of GDE water demand.

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[2] The Department assumes that potential GDEs removed under this step overlie shallow groundwater, otherwise they would have already been removed during the step of excluding potential GDEs that overlie a depth to groundwater of 30+ feet.

ii. Adjacent to Alternate Water Supplies: Reevaluate potential GDEs previously removed due to proximity to irrigated lands, managed wetlands, and perennial surface waters. Err on the side of inclusivity until there is evidence that the overlying ecosystem has no significant dependence on groundwater across seasons and water year types. Ensure that riparian GDE beneficial users of groundwater and interconnected surface water are carefully considered in the analysis of undesirable results and minimum thresholds for depletions of interconnected surface waters.

4. **Comment #4** (Basin Setting, 2.3.5.4 Projected Water Budget, starting pp 2-130): Projected water budget assumptions may risk overestimating surface water availability and sustainable yield by not relying on best available information [23 CCR § 354.18(e)].
   a. *Issue*: Projected surface water budget assumptions may risk overestimating water availability. Overestimation of water availability can result in the overallocation of both surface and groundwater water resources, unnecessarily jeopardizing environmental beneficial users. Two water budget assumptions that do not rely on best available information and that underscore current sustainable yield estimations are as follows: 1) the climate change analysis predicting a net depletion of aquifer storage is not reflected in the projected water budget or estimated sustainable yield, rather it is presented as a separate analysis; and 2) projected surface water deliveries need to be updated to reflect any new regulatory reductions of surface water deliveries such as those that may be codified in the State Water Resources Control Board Water Quality Control Plan for the Bay Delta: San Joaquin River Flows and Southern Delta Water Quality.
   b. *Recommendation*: Amend the water budget and sustainable yield: 1) apply climate change estimates to the projected water budget and scale the sustainable yield accordingly; and 2) adjust surface water delivery estimates to reflect any new regulatory compliance.
5. **Comment #5** (Sustainable Management Criteria, 3.2.1 Groundwater Levels and 3.2.6 Depletions of Interconnected Surface Water, starting pp 3-1): Groundwater Level and Interconnected Surface Water sustainable management criteria do not protect against undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface waters.
   a. *Issues*:
      i. Proxy Metric: Before addressing the individual sustainability criteria for both Groundwater Levels and Depletions of Interconnected

Surface Water, the Department challenges the use of groundwater elevations as a proxy metric for Depletions of Interconnected Surface Water. The GSP does not provide evidence that a "significant correlation exists between groundwater elevations" and Depletions of Interconnected Surface Water [23 CCR § 354.36(b)(1)]. Instead, the GSP backs into the proxy metric by associating the proposed Groundwater Level minimum thresholds with the absence of significant and unreasonable surface water depletions, claiming that historical depletions of interconnected surface water had no associated undesirable results (GSP pp 3-19). The GSP offers few details to substantiate this claim that historical surface water depletions did not lead to undesirable results, and the GSP does not specify the modeling exercise used to determine the insignificance of historical surface water depletions. Provided the status of surface water allocations and aquatic ecosystems on rivers in the ESJ basin, the Department contests that any surface water depletions attributable to groundwater pumping are likely to be significant and unreasonable, particularly in the benchmark year of 2015 when groundwater pumping and surface water temperatures were critically high. Depleted flows in the lower San Joaquin River, many reaches of which are identified as interconnected in the GSP, contribute to increased in-river water temperatures. Groundwater extraction from interconnected aquifers contributes to depletion of instream flow (Barlow and Leake, 2012). Low flows and increased water temperatures in the lower San Joaquin River have been documented to negatively impact Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) (Hallock 1970, Marston 2012). Acknowledging that fish and wildlife beneficial uses and users of groundwater likely experienced undesirable results during historical pumping regimes, especially during critically dry years, the GSP cannot rely on groundwater elevation as a proxy metric for Depletions of Interconnected Surface Water. If a significant correlation is lacking between groundwater elevations and Depletions of Interconnected Surface Water, particularly at the representative monitoring well locations used to track groundwater elevations in the ESJ Subbasin, then groundwater elevations used as a proxy for surface water depletions may misinform groundwater management activities and poorly predict instream habitat conditions for fish and wildlife species. Accordingly, the application of Groundwater Level sustainable management criteria to Depletions of Interconnected Surface Water is inappropriate, as it is not grounded in a quantifiable and site-specific understanding of surface water-groundwater connectivity as required by 23 CCR § 354.28 (c)(6)(A).

ii. Undesirable Results: Groundwater Level 'undesirable results' and 'effects of undesirable results' do not specify impacts to environmental beneficial users such as terrestrial GDEs (GSP pp 3-3, 3-4). Additionally, the method used to identify undesirable results for Groundwater Levels (i.e., minimum threshold exceedances in groundwater elevation) is applied to the identification of undesirable results for the Depletions of Interconnected Surface Water without a reasonable justification. The indicator of undesirable results for Groundwater Levels is the measure of 25% of monitoring wells falling below their minimum thresholds for two consecutive (non-dry) years, yet the GSP does not prove a relationship between the Groundwater Level identification of undesirable results and the presence of undesirable results for Depletions of Interconnected Surface Water (see Comment #5.a.i). Effectively, the GSP does not connect identification of undesirable results for Depletions of Interconnected Surface Water to effects on interconnected surface water beneficial users per 23 CCR § 354.26 (b)(3). Finally, the GSP notes that groundwater levels that fall below the minimum threshold during hydrologically dry or critically dry years are not considered to be an indicator of undesirable results (GSP pp 3-3). This means proposed indicators of undesirable results for Groundwater Levels and Depletions of Interconnected Surface Water do not exist for dry water years. This absence of undesirable results indicators for certain water years means beneficial users of groundwater and interconnected surface water may experience significant and unreasonable effects throughout the duration of dry or critical water years before the undesirable results are 'identified' and managed. Accordingly, there is no groundwater management accountability during the most challenging of years for water resource managers and fish and wildlife beneficial users alike.

iii. Minimum Thresholds and Measurable Objectives: Minimum thresholds and measurable objectives for Groundwater Levels, and by proxy, for Depletions of Interconnected Surface Water, are not protective of environmental beneficial uses and users of groundwater and interconnected surface water. Minimum thresholds allow for a decrease of groundwater elevation from 2015, or a comparable historic low, for all representative monitoring sites (3-7); and measurable objectives are set at historically low groundwater elevations (GSP 3-8). These sustainability criteria suggest that groundwater elevations at all representative wells in the ESJ Subbasin can continue to decrease for the next 20 years, dropping further from historically low groundwater elevations during drought years, without witnessing undesirable results.

The ESJ Subbasin is characterized by DWR as 'Critically Overdrafted,' meaning "continuation of present water management practices [in the basin] would probably result in significant adverse overdraft-related environmental, social, or economic impacts" ("Critically"). However, according to the GSP, there are no areas within the basin that are considered to have 'significant and unreasonable existing issues' (GSP pp 3-4), therefore minimum thresholds allow for continued groundwater depletions.

Conceptually, there is a disconnect between the ESJ's 'Critically Overdrafted' designation and the GSP's claim that the basin has not experienced undesirable results, nor will it if groundwater levels continue to decrease. More specifically, the Department believes historical declines in terrestrial and aquatic groundwater dependent ecosystem viability, exacerbated by recent drought years, are evidence of undesirable results and further groundwater decline will undoubtedly lead to significant and unreasonable effects on fish and wildlife beneficial uses and users of groundwater and interconnected surface waters under the proposed sustainable management criteria. For example, further streamflow depletion attributable to groundwater pumping that lowers groundwater levels to meet minimum thresholds or even measurable objective may further compromise in-stream temperature targets in the lower San Joaquin River, adversely impacting in-stream species (see Comment #5.a.i). Accordingly, the Department does not believe groundwater levels above the proposed minimum thresholds and below the proposed measurable objectives (in the margin of operational flexibility) will allow the basin to achieve sustainability, particularly with respect to avoiding undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface water.

b. *Recommendation*:

   i. Proxy Metrics: To justify use of groundwater elevations as a proxy metric for Depletions of Interconnected Surface Water, the GSP should either specify how groundwater elevations are significantly correlated to surface water depletions; or define an expeditious path to identifying the location, quantity, and timing of surface water depletions caused by groundwater use, per 23 CCR § 354.28(c)(6)(A), to better inform sustainability criteria for Depletions of Interconnected Surface Water.

   ii. Undesirable Results: Specify Groundwater Level 'undesirable results' and 'effects of undesirable results' for environmental beneficial users of groundwater and interconnected surface water. Specify undesirable result indicators for Depletions of Interconnected Surface Water that are relevant to beneficial users of surface waters. Identify undesirable results indicators for dry and critically dry water years for all sustainability indicators.

   iii. Minimum Thresholds and Measurable Objectives: Reconsider minimum thresholds and measurable objectives, accounting for undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface water. Design sustainable management criteria that reflect a 'Critically Overdrafted' subbasin designation by seeking to improve current groundwater conditions rather than allowing for continued aquifer depletions over the next two decades. For example, historical groundwater pumping has likely contributed to stream disconnection illustrated in figure 2-66 (GSP 2-99); resulting in depleted stream flows and reduced baseflows in ESJ Subbasin tributaries, and exacerbated high water temperatures in the lower San Joaquin River that negatively impact listed species such as the Chinook Salmon. Minimum thresholds and measurable objectives should reflect an effort to prevent further degradation to interconnected surface waters and to avoid undesirable results, rather than risk magnifying historical undesirable results through lowered groundwater elevations.

6. **Comment #6** (Sustainable Management Criteria, 3.6 Degraded Water Quality, starting pp 3-10): The GSP wrongly abdicates responsibility for specific constituents by implying there is no nexus between specific groundwater contaminants and groundwater pumping (GSP pp 3-11).

a. *Issue*: The GSP identifies two primary water quality constituents of concern in the ESJ Subbasin: salinity and arsenic (GSP pp 2-76). The GSP only specifies sustainability management criteria for salinity. The GSP explains that other constituents, including arsenic, are managed through other regulatory programs, and suggests that because GSAs do not have land use authority, they lack an ability to manage for such constituents as arsenic (GSP pp 3-11). Science suggests that over-pumping of aquifers can cause clay layers to compress and release dissolved arsenic, resulting in an increase of arsenic in extracted water ("Groundwater"). Thus, groundwater pumping actions can affect the presence, movement, and concentration of naturally occurring arsenic in groundwater, potentially increasing anthropogenic and ecosystem exposure to arsenic contamination. According to SGMA statue, GSAs have the authority to establish groundwater extraction allocations, among other relevant authorities [WC § 10726.4]. Because arsenic contamination can be impacted by groundwater pumping, and because GSAs have the authority to manage groundwater pumping, the ESJGA has a viable management lever over arsenic contamination in the ESJ Subbasin.
b. *Recommendation*: Draft a plan to investigate the relationship between groundwater pumping and the presence, movement, and concentration of arsenic in the ESJ Subbasin and include the plan in the GSP submitted to DWR by January 2020. Develop sustainability criteria for arsenic accordingly and in partnership with existing regulatory programs by the first 5-year GSP update due in January 2025.

7. **Comment #7** (Monitoring Networks, starting pp 4-1): Number and distribution of groundwater monitoring wells are insufficient for analysis.
    a. *Issue*: The current monitoring network lacks a sufficient number and representative distribution of shallow groundwater monitoring wells to monitor impacts to environmental beneficial uses and users of groundwater and interconnected surface waters [23 CCR § 354.34(2)]. Few wells are near interconnected surface waters or concentrations of GDEs; and therefore, there are few data points on shallow groundwater level trends. These data are critical to understanding groundwater management impacts on fish and wildlife beneficial uses and users of groundwater, including GDEs and interconnected surface water habitats, that are impacted disproportionately by shallow groundwater trends.
    b. *Recommendation*: Install additional shallow groundwater monitoring wells near GDEs and interconnected surface waters, potentially pairing multiple-

completion wells with streamflow gauges for improved understanding of surface water-groundwater interconnectivity.

8. **Comment #8** (Project and Management Actions; 6.1 Projects, Management Actions, and Adaptive Management Strategies; starting pp 6-1): Demand reduction management actions lack emphasis and specificity critical to ESJ Subbasin sustainability goal achievement.
    a. *Issue*: The GSP project and management actions focus on supply augmentation, with only three projects intended to conserve groundwater through metering and systems optimization. Though the GSP reserves the flexibility to implement demand-side management in the future (GSP pp 6-1), there are no specifics as to how the ESJGA would implement demand management. This lack of specificity on how demand will be managed may lead to deprioritization or delayed implementation of demand management actions, which can undermine a basin's ability to achieve sustainability goals. Considering the ESJ Subbasins' current unsustainable rate of groundwater consumption and considering the cost and timing challenges associated with supply augmentation projects, a balanced portfolio approach to achieve groundwater sustainability should include demand-management strategies.
    b. *Recommendation*: Add specific measures for initiating demand reduction on an earlier timeline in the ESJ Subbasin to account for groundwater pumping lag impacts, supply-augmentation project implementation challenges, and a scaled ramping-down of groundwater use that is a necessary ingredient in San Joaquin Valley long-term groundwater sustainability. Be specific about triggers, timing, and expected outcomes of demand-management actions.

CONCLUSION

In conclusion, the ESJ Subbasin Draft GSP does not comply with all aspects of SGMA statutes and regulations. The Department deems the GSP insufficient in its consideration of fish and wildlife beneficial uses and users of groundwater and interconnected surface waters. The Department recommends that ESJGA address the above comments before GSP submission to DWR. If these comments are not integrated, the Department may recommend to DWR an 'incomplete' or 'inadequate' plan determination based on the following regulatory criteria for plan evaluations:

1. The assumptions, criteria, findings, and objectives, including the sustainability goal, undesirable results, minimum thresholds, measurable objectives, and interim milestones are not reasonable and/or not supported by the best available information and best available science. [23 CCR § 355.4(b)(1)] (See Comment #2, 3, 4, 5, 7)

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2. The GSP does not identify reasonable measures and schedules to eliminate data gaps. [23 CCR § 355.4(b)(2)] (See Comment #7)
3. The sustainable management criteria and projects and management actions are not commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the GSP. [23 CCR § 355.4(b)(3)] (See Comment #5, 6, 8)
4. The interests of the beneficial uses and users of groundwater in the basin, and the land uses and property interests potentially affected by the use of groundwater in the basin, have not been considered. [23 CCR § 355.4(b)(4)] (See Comment #1, 2, 3, 4, 5, 7)
5. The projects and management actions are not feasible and/or not likely to prevent undesirable results and ensure that the basin is operated within its sustainable yield. [23 CCR § 355.4(b)(5)] (See Comment #8)
6. The GSP does not include a reasonable assessment of overdraft conditions and/or does not include reasonable means to mitigate overdraft, if present. [23 CCR § 355.4(b)(6)] (See Comment #4, 8)

The Department appreciates the opportunity to provide comments on the ESJ Subbasin Draft GSP. Please contact Lauren Mulloy by email at Lauren.Mulloy@wildlife.ca.gov with any questions.

Sincerely,

Kevin Thomas
Regional Manager, North Central Region

Enclosures (Literature Cited)

ec: *California Department of Fish and Wildlife*

Joshua Grover, Branch Chief
Water Branch
Joshua.Grover@wildlife.ca.gov

Robert Holmes, Environmental Program Manager
Statewide Water Planning Program
Robert.Holmes@wildlife.ca.gov

Briana Seapy, Statewide SGMA Coordinator
Groundwater Program
Briana.Seapy@wildlife.ca.gov

ATTACHMENT 2

MaryLisa Cornell, Water Unit Supervisor
North Central Region
MaryLisa.Cornell@wildlife.ca.gov

Lauren Mulloy, Environmental Scientist
North Central Region
Lauren.Mulloy@wildlife.ca.gov

California Department of Water Resources

Craig Altare, Supervising Engineering Geologist
Sustainable Groundwater Management Program
Craig.Altare@water.ca.gov

Paul Wells, Eastern San Joaquin Subbasin SGMA Point of Contact
North Central Region Office
Paul.Wells@water.ca.gov

National Marine Fisheries Service

Rick Rogers, Fish Biologist
West Coast Region
Rick.Rogers@noaa.gov

Erin Strange, San Joaquin River Branch Lead
West Coast Region
Erin.Strange@noaa.gov

State Water Resources Control Board

James Nachbaur, Director
Office of Research, Planning & Performance
James.Nachbaur@waterboards.ca.gov

ATTACHMENT 2

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Attachment D

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CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE COMMENTS ON THE EASTERN SAN JOAQUIN ***FINAL*** *GROUNDWATER SUSTAINABILITY PLAN*

Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
North Central Region
1701 Nimbus Road,
Rancho Cordova, CA 95670
www.wildlife.ca.gov

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

May 13, 2020

Via Electronic Mail and Online Submission

Craig Altare
Supervising Engineering Geologist
California Department of Water Resources
901 P Street, Room 213
Sacramento, CA 94236

Email: Craig.Altare@water.ca.gov
Portal Submission: https://sgma.water.ca.gov/portal/#gsp

Dear Mr. Altare:

Subject: COMMENTS ON THE FINAL EASTERN SAN JOAQUIN SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

The California Department of Fish and Wildlife (Department) North Central Region is providing comments on the Final Eastern San Joaquin Subbasin Groundwater Sustainability Plan (GSP) prepared by the Eastern San Joaquin Groundwater Authority (ESJGA)[1] pursuant to the Sustainable Groundwater Management Act (SGMA). As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & Game Code §§ 711.7 and 1802).

Development and implementation of GSPs under SGMA represents a new era of California groundwater management. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems and species depend on groundwater and interconnected surface waters, including ecosystems on Department-owned and -managed lands within SGMA-regulated basins. SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to Groundwater Sustainability Plans:

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[1] The Eastern San Joaquin Groundwater Authority comprises 17 Groundwater Sustainability Agencies (GSAs): Calaveras County Water District / Stanislaus County, California Water Service Company, Central Delta Water Agency, Central San Joaquin Water Conservation District, City of Lathrop, City of Lodi, City of Manteca, City of Stockton, Linden County Water District, Lockeford Community Services District, North San Joaquin Water Conservation District, Oakdale Irrigation District, San Joaquin County, South Delta Water Agency, South San Joaquin Groundwater Sustainability Agency, Stockton East Water District, and Woodbridge Irrigation District GSA.

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- Groundwater Sustainability Plans must **identify and consider impacts to groundwater dependent ecosystems (GDEs)** [23 CCR § 354.16(g) and Water Code § 10727.4(l)];
- Groundwater Sustainability Agencies must **consider all beneficial uses and users of groundwater**, including environmental users of groundwater [Water Code §10723.2 (e)]; and Groundwater Sustainability Plans must **identify and consider potential effects on all beneficial uses and users of groundwater** [23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3)];
- Groundwater Sustainability Plans must **establish sustainable management criteria that avoid undesirable results** within 20 years of the applicable statutory deadline, including **depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water** [23 CCR § 354.22 *et seq*. and Water Code §§ 10721(x)(6) and 10727.2(b)] and **describe monitoring networks** that can identify adverse impacts to beneficial uses of interconnected surface waters [23 CCR § 354.34(c)(6)(D)]; and
- Groundwater Sustainability Plans must **account for groundwater extraction for all water use sectors** including managed wetlands, managed recharge, and native vegetation [23 CCR §§ 351(al) and 354.18(b)(3)].

Furthermore, the Public Trust Doctrine imposes a related but distinct obligation to consider how groundwater management affects public trust resources, including navigable surface waters and fisheries. Groundwater hydrologically connected to navigable surface waters or surface waters supporting fisheries, and surface waters tributary to navigable surface waters or surface waters supporting fisheries, are also subject to the Public Trust Doctrine to the extent that groundwater extractions or diversions affect or may affect public trust uses (*Environmental Law Foundation v. State Water Resources Control Board* (2018), 26 Cal. App. 5th 844; *National Audubon Society v. Superior Court* (1983), 33 Cal. 3d 419). Accordingly, groundwater plans should consider potential impacts to and appropriate protections for interconnected surface waters and their tributaries, and interconnected surface waters that support fisheries, including the level of groundwater contribution to those waters.

In the context of SGMA statutes and regulations, and Public Trust Doctrine considerations, the Department values groundwater planning that carefully considers and protects environmental beneficial uses and users of groundwater including fish and wildlife and their habitats: groundwater dependent ecosystems and interconnected surface waters.

COMMENT OVERVIEW

The Department supports ecosystem preservation and enhancement in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science. Consistent with comments previously submitted to the GSA on August 23, 2019, the Department recommends the GSP provide additional information and analysis that considers all environmental beneficial uses and users of groundwater and that better characterizes surface water-groundwater connectivity. The Department appreciates ESJGA's consideration and integration of many of the Department's original comments. Where the Department's initial comments have not been addressed, they are restated in this letter with updated page citations. Where ESJGA has since responded to the Department's comments, the Department has updated the comments and provided additional context in *italicized text*.

COMMENTS AND RECOMMENDATIONS

The Department comments are as follows:

1. **Comment #1** (Basin Setting, 2.2.6 **Interconnected Surface Water Systems**, starting page 2-104): The narrative describing the basin's interconnected surface water (ISW) conditions lacks specifics.
   a. *Issue*:
      i. The interconnected surface water conditions narrative lacks estimations of the quantity and timing of streamflow depletions as required by 23 CCR § 354.16(f).
   b. *Recommendation*:
      i. Identify the estimated quantity and timing of streamflow depletions in the ESJ Subbasin. If this information is not available, delineate a specific and expeditious path to estimating these values.

   <u>GSA Response to Comments</u>: "*See Master Response 2 - ISW" (Appendix 1-J, PDF page 899).*
   <u>Department Response</u>: *In response to ISW comments, ESJGA identified ISW as a data gap, specified the need for near-stream monitoring wells additional analysis/iterative modeling, clarified gaining/losing stream language and figures, and removed stream nodes with poor model calibration (among other responses). The Department appreciates these responsive GSP updates and the clear acknowledgement of ISW as a data gap. Though the above comment identifies an unmet GSP regulatory expectation, the Department understands data scarcity challenges and recommends ESJGA clearly identify how they will succeed in meeting this regulatory standard during GSP implementation.*

2. **Comment #2** (Basin Setting, 2.2.7 **Groundwater-Dependent Ecosystems**, starting page 2-108): GDE identification, required by 23 CCR § 354.16(g), is incomplete.

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a. *Issues*: Use of the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset to identify GDEs is incomplete.
    i. Incomplete GDE Description: The GSP notes, "GDEs exist where vegetation accesses shallow groundwater for survival. This Plan identifies GDEs within the Eastern San Joaquin Subbasin based on determining the areas where vegetation is dependent on groundwater" (2-108). This cursory summation of GDEs excludes aquatic GDEs that rely on groundwater recharge to instream flow. Further, the GDE methods section states, "The NCCAG database was then further refined to identify communities without access to alternate water supplies, as those communities would not be dependent on groundwater" (2-110). Presumably the word 'not' is included in error.
    ii. GDE Identification Data Gap: In response to GDE comments on the Draft GSP, ESJGA identified several GDE assessments as data gaps rather than remove the potential GDEs from the dataset, which was the previous approach. These data gaps include potential GDEs where the depth to groundwater exceeds 30 feet (using a 2015 baseline) and potential GDEs with access to alternate water supplies (2-111). The GSP intends to refine these categories of potential GDEs via future analysis (2-110, 2-111), but the plan does not specify how. The Department reiterates its original concern for exclusion of GDEs based on a snapshot of groundwater elevation during a historical drought or based on the assumption that ecosystem water reliance is static, rather than fluid and able to tap into surface water *and* groundwater, condition-dependent.

b. *Recommendations*:
    i. Incomplete GDE Description: Include aquatic GDEs (i.e., ISW) in the narrative description of GDEs and confirm that ecological communities without access to surface water are groundwater dependent.
    ii. GDE Data Gap Identification: Specify how ESJGA will refine GDE identification and resolve data gaps to comply with GSP regulations during GSP implementation.

GSA Response to Comments: *"See Master Response 1 - GDEs" (Appendix 1-J, PDF page 898).*
Department Response: *In response to GDE comments, ESJGA updated GDE identification methods, adding language identifying NCCAG areas previously removed as data gaps that require further refinement. The Department appreciates these responsive GSP updates and the clear acknowledgement of GDE identification data gaps. The Department has updated the above comment accordingly, and though the above comment identifies an unmet GSP regulatory expectation, the Department understands data scarcity challenges and recommends the ESJGA clearly identify how*

they will succeed in meeting this regulatory standard during GSP implementation.

3. **Comment #3** (Basin Setting, 2.3.5.3 **Projected Water Budget**, starting page 2-138): Projected water budget assumptions may risk overestimating surface water availability and sustainable yield by not relying on best available information [23 CCR § 354.18(e)].
   a. *Issue*: Projected surface water budget assumptions may risk overestimating water availability. Overestimation of water availability can result in the overallocation of both surface and groundwater water resources, jeopardizing environmental beneficial users. Two water budget assumptions that do not rely on best available information and that underscore current sustainable yield estimations are as follows: 1) the climate change analysis predicting a net depletion of aquifer storage is not reflected in the projected water budget or estimated sustainable yield, rather it is presented as a separate analysis; and 2) projected surface water deliveries do not reflect new regulatory reductions of surface water deliveries such as those that may be codified in the State Water Resources Control Board Water Quality Control Plan for the Bay Delta: San Joaquin River Flows and Southern Delta Water Quality.
   b. *Recommendation*: Amend the water budget and sustainable yield: 1) apply climate change estimates to the projected water budget and scale the sustainable yield accordingly; and 2) adjust surface water delivery estimates to reflect any new regulatory compliance.

<u>GSA Response to Comments:</u> "*1) Consistent with regulations, the 2070 climate change sensitivity analysis on the projected conditions scenario was used to better understand trends and inform planning. Due to the uncertainty around climate projections in the 2070 timeframe, the ESJGWA Board determined the projected conditions scenario was most appropriate for analyzing sustainable yield in the GSP implementation time period beginning in 2040. Therefore, the sustainable yield analysis did not include climate change. Comment noted for follow up in next round of model refinements and updates to analyses. 2) Added text to Section 2.3.5 (Water Budget Estimates) clarifying that climate change was a separate scenario: "Hydrology under climate change projections was evaluated in a separate ESJWRM scenario and results are discussed separately in Section 2.3.7.4." 3) Added text to Section 2.3.6 (Sustainable Yield Estimate) clarifying that climate change was not part of the analysis: "The sustainable conditions scenario, building off the projected conditions scenario, does not include climate change discussed in*

Section 2.3.7. Due to the uncertainty around DWR's climate projections for a 2070 timeframe, the ESJGWA Board determined the projected conditions scenario was most appropriate for analyzing sustainable yield in the GSP implementation time period beginning in 2040." 4) The SWRCB did adopt the water quality control plan for the Bay-Delta, which has an impact on the Subbasin and will be addressed in future updates to the GSP. Given the timeframe of the GSP being adopted, it was not possible to include the new regulations in the analysis in this GSP and they will be included in future iterations" (Appendix 1-J, PDF page 903).

Department Response: *The Department appreciates the clarifying language and explanations provided in ESJGA's above response. The Department believes the above comment remains relevant, particularly for future GSP updates and successful, realistic long-term GSP implementation.*

4. **Comment #4** (**Sustainable Management Criteria**, 3.2.1 Chronic Lowering of Groundwater Levels and 3.2.6 Depletions of Interconnected Surface Water, starting page 3-3): Groundwater Level and Interconnected Surface Water sustainable management criteria do not protect against undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface waters.
    a. *Issues*:
        i. Proxy Metric: Before addressing the individual sustainability criteria for both Groundwater Levels and Depletions of Interconnected Surface Water, the Department challenges the use of groundwater elevations as a proxy metric for Depletions of Interconnected Surface Water. The GSP does not provide evidence that a "significant correlation exists between groundwater elevations" and Depletions of Interconnected Surface Water [23 CCR § 354.36(b)(1)]. Instead, the GSP backs into the proxy metric by associating the proposed Groundwater Level minimum thresholds with the absence of significant and unreasonable surface water depletions, claiming that historical depletions of interconnected surface water had no associated undesirable results (page 3-22). The GSP offers few details to substantiate this claim that historical surface water depletions did not lead to undesirable results, and the summarized modeling exercise used to determine the insignificance of historical surface water depletions is based on a model with significant data gaps around surface water depletion functions (see Comment #1). Provided the status of surface water allocations and aquatic ecosystems on rivers in the ESJ basin, the

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Department contests that any surface water depletions attributable to groundwater pumping are likely to be significant and unreasonable, particularly in the benchmark year of 2015 when groundwater pumping and surface water temperatures were critically high. Depleted flows in the lower San Joaquin River, many reaches of which are identified as interconnected in the GSP, contribute to increased in-river water temperatures. Groundwater extraction from interconnected aquifers contributes to depletion of instream flow (Barlow and Leake, 2012). Low flows and increased water temperatures in the lower San Joaquin River have been documented to negatively impact Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) (Hallock 1970, Marston 2012). Acknowledging that fish and wildlife beneficial uses and users of groundwater likely experienced undesirable results during historical pumping regimes, especially during critically dry years, the GSP cannot rely on groundwater elevation as a proxy metric for Depletions of Interconnected Surface Water. If a significant correlation is lacking between groundwater elevations and Depletions of Interconnected Surface Water, particularly at the representative monitoring well locations used to track groundwater elevations in the ESJ Subbasin, then groundwater elevations used as a proxy for surface water depletions may misinform groundwater management activities and poorly predict instream habitat conditions for fish and wildlife species. Accordingly, the application of Groundwater Level sustainable management criteria to Depletions of Interconnected Surface Water is inappropriate, as it is not grounded in a quantifiable and site-specific understanding of surface water-groundwater connectivity as required by 23 CCR § 354.28 (c)(6)(A).

ii. <u>Undesirable Results</u>**:** Groundwater Level 'undesirable results' and 'effects of undesirable results' do not specify impacts to environmental beneficial users such as terrestrial GDEs (pages 3-3, 3-4). Additionally, the method used to identify undesirable results for Groundwater Levels (i.e., minimum threshold exceedances in groundwater elevation) is applied to the identification of undesirable results for the Depletions of Interconnected Surface Water without a reasonable justification. The indicator of undesirable results for Groundwater Levels is the measure of 25% of monitoring wells falling below their minimum thresholds for two consecutive (non-

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dry) years, yet the GSP does not prove a relationship between the Groundwater Level identification of undesirable results and the presence of undesirable results for Depletions of Interconnected Surface Water (see Comment #4.a.i). Effectively, the GSP does not connect identification of undesirable results for Depletions of Interconnected Surface Water to effects on interconnected surface water beneficial users per 23 CCR § 354.26 (b)(3). Finally, the GSP notes that groundwater levels that fall below the minimum threshold during hydrologically dry or critically dry years are not considered to be an indicator of undesirable results (page 3-3). This means proposed indicators of undesirable results for Groundwater Levels and Depletions of Interconnected Surface Water do not exist for dry water years. This absence of undesirable results indicators for certain water years means beneficial users of groundwater and interconnected surface water may experience significant and unreasonable effects throughout the duration of dry or critical water years before the undesirable results are 'identified' and managed. Accordingly, there is no groundwater management accountability during the most challenging of years for water resource managers and fish and wildlife beneficial users alike.

iii. Minimum Thresholds and Measurable Objectives: Minimum thresholds and measurable objectives for Groundwater Levels, and by proxy, for Depletions of Interconnected Surface Water, are not protective of environmental beneficial uses and users of groundwater and interconnected surface water. Minimum thresholds allow for a decrease of groundwater elevation from 2015, or a comparable historic low, for all representative monitoring sites (page 3-8); and measurable objectives are set at historically low groundwater elevations (page 3-8). These sustainability criteria suggest that groundwater elevations at all representative wells in the ESJ Subbasin can continue to decrease for the next 20 years, dropping further from historically low groundwater elevations during drought years, without witnessing undesirable results.

The ESJ Subbasin is characterized by DWR as 'Critically Overdrafted,' meaning "continuation of present water management practices [in the subbasin] would probably result in significant adverse overdraft-related environmental, social, or economic impacts" (CDWR). However, according to the GSP, there are no areas within the basin that are considered to have 'significant and unreasonable existing issues' (page 3-4), therefore minimum thresholds allow for continued groundwater depletions. Conceptually, there is a disconnect between the ESJ's 'Critically Overdrafted' designation and the GSP's claim that the basin has not experienced undesirable results, nor will it if groundwater levels continue to decrease. More specifically, the Department believes historical declines in terrestrial and aquatic groundwater dependent ecosystem viability, exacerbated by recent drought years, are evidence of undesirable results and further groundwater decline will undoubtedly lead to significant and unreasonable effects on fish and wildlife beneficial uses and users of groundwater and interconnected surface waters under the proposed sustainable management criteria. For example, further streamflow depletion attributable to groundwater pumping that lowers groundwater levels to meet minimum thresholds or even measurable objective may further compromise in-stream temperature targets in the lower San Joaquin River, adversely impacting in-stream species (see Comment #4.a.i). Accordingly, the Department does not believe groundwater levels above the proposed minimum thresholds and below the proposed measurable objectives (in the margin of operational flexibility) will allow the basin to achieve sustainability, particularly with respect to avoiding undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface water.

b. *Recommendations*:

   i. Proxy Metrics: To justify use of groundwater elevations as a proxy metric for Depletions of Interconnected Surface Water, the GSP should either specify how groundwater elevations are significantly correlated to surface water depletions; or define an expeditious path to identifying the location, quantity, and timing of surface water depletions caused by groundwater use, per 23 CCR § 354.28(c)(6)(A), to better inform sustainability criteria for Depletions of Interconnected Surface Water.

   ii. Undesirable Results**:** Specify Groundwater Level 'undesirable results' and 'effects of undesirable results' for environmental beneficial users of groundwater and interconnected surface water. Specify undesirable result indicators for Depletions of Interconnected Surface Water that are relevant to beneficial users of surface waters. Identify undesirable results indicators for dry and critically dry water years for all sustainability indicators.

iii. <u>Minimum Thresholds and Measurable Objectives</u>: Reconsider minimum thresholds and measurable objectives, accounting for undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface water. Design sustainable management criteria that reflect a 'Critically Overdrafted' subbasin designation by seeking to improve current groundwater conditions rather than allowing for continued aquifer depletions over the next two decades. Consider how historical groundwater pumping has impacted stream interconnectivity (Figure 2-7, page 2-106), likely increasing streamflow depletion and reducing baseflows in ESJ Subbasin tributaries. Reduced groundwater baseflow exacerbates high water temperatures in the lower San Joaquin River, and high water temperatures negatively impact listed species such as the Chinook Salmon. Minimum thresholds and measurable objectives should reflect an effort to prevent further degradation to interconnected surface waters and to avoid undesirable results, rather than risk magnifying historical undesirable results through lowered groundwater elevations.

<u>GSA Response to Comments</u>: "*See Master Response 2 - ISW" (Appendix 1-J, PDF page 899).*
<u>Department Response</u>: *The above comment remains relevant.*

5. **Comment #5** (**Monitoring Networks,** starting page 4-1): Number, distribution, and frequency of data collection of shallow groundwater monitoring wells are insufficient for analysis of ISW.
   a. *Issue*: The current monitoring network lacks a sufficient number, representative distribution, and frequency of monitoring of shallow groundwater monitoring wells to monitor impacts to environmental beneficial uses and users of groundwater and interconnected surface waters [23 CCR § 354.34(2)]. Few wells are near interconnected surface waters or concentrations of GDEs; therefore, there are few data points on shallow groundwater level trends. These data are critical to understanding groundwater management impacts on fish and wildlife beneficial uses and users of groundwater, including GDEs and interconnected surface water habitats, which are impacted disproportionately by shallow groundwater trends.

b. *Recommendation*: Install additional shallow groundwater monitoring wells near GDEs and interconnected surface waters, potentially pairing multiple-completion wells with streamflow gauges for improved understanding of surface water-groundwater interconnectivity. Monitor wells monthly to capture seasonal trends important to GDEs.

GSA Response to Comments: "*Data gaps are discussed in Section 4.7 (Data Gaps) and include identified gaps in the monitoring and analysis of interconnected surface waters and GDEs. The GSP includes a plan for the drilling of up to 12 proposed wells to help resolve identified gaps and enhance future analysis of interconnected surface waters and GDEs. These proposed wells would all measure for both groundwater quality and groundwater levels and include 2 deep, nested wells funded under the TSS application and up to 10 shallow wells drilled by the ESJGWA. If a need for more detail is recognized, the monitoring network will be reevaluated as updates to the GSP occur. Frequency of groundwater level monitoring is cited in the Draft Monitoring Networks and Identification of Data Gaps Best Management Practice. While semi-annual monitoring is required for groundwater levels, DWR guidance recommends monthly sampling of groundwater levels for the Subbasin based on aquifer type, volume of long-term aquifer withdrawals, and recharge potential. The ESJGWA Board determined semi-annual sampling was appropriate as it will capture seasonal highs and lows and that additional monitoring would not necessarily provide additional information on trends" (Appendix 1-J, PDF page 905).*

Department Response: *The anticipated monitoring network expansion will vastly improve data collection and monitoring. Until such time as the new system is in place, the Department maintains the above concern for insufficient monitoring. The Department will also continue to recommend monthly monitoring of shallow groundwater to better understand the relationships between shallow groundwater trends and fish and wildlife beneficial uses and users of groundwater.*

6. **Comment #6** (**Project and Management Actions**; 6.1 Projects, Management Actions, and Adaptive Management Strategies; starting page 6-1): Demand reduction management actions lack emphasis and specificity critical to ESJ Subbasin sustainability goal achievement.
   a. *Issue*: The GSP project and management actions focus on supply augmentation, with only three projects intended to conserve groundwater through metering and systems optimization. Though the GSP reserves the

flexibility to implement demand-side management in the future (page 6-1), there are no specifics as to how the ESJGA or subbasin GSAs would implement demand management. This lack of specificity on how demand will be managed may lead to deprioritization or delayed implementation of demand management actions, which can undermine a basin's ability to achieve sustainability goals. Considering the ESJ Subbasins' current unsustainable rate of groundwater consumption as a 'Critically Overdrafted Basin' and considering the cost and timing challenges associated with supply augmentation projects, a balanced portfolio approach to achieve groundwater sustainability should include demand-management strategies.

b. *Recommendation*: Add specific measures for initiating demand reduction on an earlier timeline in the ESJ Subbasin to account for groundwater pumping lag impacts, supply-augmentation project implementation challenges, and a scaled ramping-down of groundwater use that is a necessary component of San Joaquin Valley long-term groundwater sustainability. Be specific about triggers, timing, and expected outcomes of demand-management actions.

GSA Response to Comments: "*See Master Response 5 – Projects" (Appendix 1-J, PDF page 902)*
Department Response: *Master Response 5 includes the addition of new language in the GSP that promises to convene a working group if projects are not effective in achieving their target recharge or offset targets. The Department remains concerned that this action, in concert with the minimal demand-management actions, may be insufficient to achieve long term sustainability. Therefore, the above comment remains relevant.*

CONCLUSION

In conclusion, the Final Eastern San Joaquin Basin GSP has improved GSP transparency by acknowledging several key data gaps. After thorough review, the Department deems the GSP insufficient in its consideration of environmental beneficial uses and users of groundwater, including fish and wildlife and their habitats: GDEs and ISW. The Department recommends that ESJGA address the Departments concerns before the California Department of Water Resources approves the final GSP.

The Department appreciates the opportunity to provide comments on the Final Eastern San Joaquin Basin GSP. If you have any further questions, please contact Briana Seapy by email at Briana.Seapy@wildlife.ca.gov or at (916) 508-3345.

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Sincerely,

Kevin Thomas
Regional Manager, North Central Region

ec: Joshua Grover, Joshua.Grover@wildlife.ca.gov
Robert Holmes, Robert.Holmes@wildlife.ca.gov
Jeff Drongesen, Jeff.Drongesen@wildlife.ca.gov
Briana Seapy, Briana.Seapy@wildlife.ca.gov
California Department of Fish and Wildlife

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Paul Wells, Paul.Wells@water.ca.gov
California Department of Water Resources

Brandon Nakagawa, ESJgroundwater@sjgov.org
Groundwater Sustainability Agency

Rick Rogers, Rick.Rogers@noaa.gov
Erin Strange, Erin.Strange@noaa.gov
National Marine Fisheries Service

Natalie Stork, Natalie.Stork@waterboards.ca.gov
State Water Resources Control Board

Literature Cited

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Attachment D

*CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE COMMENTS ON THE EASTERN SAN JOAQUIN **DRAFT** GROUNDWATER SUSTAINABILITY PLAN*

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
North Central Region
1701 Nimbus Road,
Rancho Cordova, CA 95670
www.wildlife.ca.gov

ATTACHMENT 2

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

August 23, 2019

Brandon Nakagawa
Eastern San Joaquin Groundwater Sustainability Plan Manager
Eastern San Joaquin Groundwater Authority
1810 E. Hazelton Avenue
P.O. Box 1810
Stockton, CA 95201
Email: ESJgroundwater@sjgov.org

Subject: COMMENTS ON THE EASTERN SAN JOAQUIN SUBBASIN DRAFT GROUNDWATER SUSTAINABILITY PLAN

Dear Mr. Nakagawa:

The California Department of Fish and Wildlife (Department) North Central Region is providing comments on the Eastern San Joaquin (ESJ) Subbasin Draft Groundwater Sustainability Plan (GSP) prepared by the Eastern San Joaquin Groundwater Authority (ESJGA)[1] pursuant to the Sustainable Groundwater Management Act (SGMA). As trustee agency for the State's fish and wildlife resources, the Department has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary for biologically sustainable populations of such species (Fish & Game Code §§ 711.7 and 1802).

Development and implementation of GSPs under SGMA represents a new era of California groundwater management. The Department has an interest in the sustainable management of groundwater, as many sensitive ecosystems and species depend on groundwater and interconnected surface waters, including ecosystems on Department-owned and -managed lands within SGMA-regulated basins. SGMA and its implementing regulations afford ecosystems and species specific statutory and regulatory consideration, including the following as pertinent to Groundwater Sustainability Plans:

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[1] The Eastern San Joaquin Groundwater Authority comprises 17 Groundwater Sustainability Agencies (GSAs): Calaveras County Water District / Stanislaus County, California Water Service Company, Central Delta Water Agency, Central San Joaquin Water Conservation District, City of Lathrop, City of Lodi, City of Manteca, City of Stockton, Linden County Water District, Lockeford Community Services District, North San Joaquin Water Conservation District, Oakdale Irrigation District, San Joaquin County, South Delta Water Agency, South San Joaquin Groundwater Sustainability Agency, Stockton East Water District, Woodbridge Irrigation District GSA.

Conserving California's Wildlife Since 1870

- Groundwater Sustainability Plans must **identify and consider impacts to groundwater dependent ecosystems** [23 CCR § 354.16(g) and Water Code § 10727.4(l)];
- Groundwater Sustainability Agencies must **consider all beneficial uses and users of groundwater**, including environmental users of groundwater [Water Code §10723.2 (e)]; and Groundwater Sustainability Plans must **identify and consider potential effects on all beneficial uses and users of groundwater** [23 CCR §§ 354.10(a), 354.26(b)(3), 354.28(b)(4), 354.34(b)(2), and 354.34(f)(3)];
- Groundwater Sustainability Plans must **establish sustainable management criteria that avoid undesirable results** within 20 years of the applicable statutory deadline, including depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water [23 CCR § 354.22 *et seq.* and Water Code §§ 10721(x)(6) and 10727.2(b)] and describe monitoring networks that can identify adverse impacts to beneficial uses of interconnected surface waters [23 CCR § 354.34(c)(6)(D)]; and
- Groundwater Sustainability Plans must **account for groundwater extraction for all Water Use Sectors** including managed wetlands, managed recharge, and native vegetation [23 CCR §§ 351(al) and 354.18(b)(3)].

Accordingly, the Department values SGMA groundwater planning that carefully considers and protects groundwater dependent ecosystems (GDE), fish and wildlife beneficial uses, and users of groundwater and interconnected surface waters.

COMMENT OVERVIEW
The Department is writing to support ecosystem preservation in compliance with SGMA and its implementing regulations based on Department expertise and best available information and science.

The Department believes the GSP does not adequately demonstrate consideration of environmental beneficial uses and users of groundwater in its sustainability management criteria nor does it adequately characterize or consider surface water-groundwater connectivity. Accordingly, the Department recommends that ESJGA address these deficiencies before submitting the GSP to the Department of Water Resources (DWR).

COMMENTS AND RECOMMENDATIONS
The Department comments are as follows:

1. **Comment #1** (Plan Area, 1.2.1.1 Summary of Jurisdictional Areas and Other Features, pp. 1-18): Department lands are excluded from 'Summary of Jurisdictional Areas' narrative as well as from Figure 1-11, which maps other federal and state lands.

   a. *Issue*: The GSP does not identify the jurisdictional boundaries of Department-owned and -managed lands as required by 23 CCR § 354.8(a)(3).
   b. *Recommendation*: Include in Figure 1-11 and the accompanying narrative White Slough Wildlife Area, Woodbridge Ecological Reserve, and Vernalis Ecological Reserve Department lands.

2. **Comment #2** (Basin Setting, 2.2.6 Interconnected Surface Water Systems, starting pp 2-97): The narrative describing the basin's interconnected surface water conditions lacks specifics and contains inconsistencies in mapped surface water-groundwater interconnectivity.
   a. *Issue*:
      i. The interconnected surface water conditions narrative lacks estimations of the quantity and timing of streamflow depletions as specified in 23 CCR § 354.16(f).
      ii. Figure 2-65 portrays modeled 'losing,' 'gaining,' and 'mixed' stream reaches, and Figure 2-66 portrays modeled 'interconnected and 'disconnected' streams. Figure 2-66 shows modeled stream reaches as 'disconnected,' whereas Figure 2-65 identifies those same reaches as switching between 'losing,' 'gaining,' and 'mixed.' Accompanying narrative suggests that streams are only mapped as 'interconnected' in Figure 2-66 when they are interconnected at least 75% of the time. This 75% threshold for displaying interconnected surface waters excludes reaches of stream that are intermittently connected to groundwater and that may depend on groundwater contributions to meet the needs of instream or riparian beneficial uses and users of interconnected surface waters.
   b. *Recommendation*:
      i. Identify the estimated quality and timing of streamflow depletions in the ESJ Subbasin. If this information is not available, identify an expeditious path to estimating these values.
      ii. Update Figure 2-66 to show all interconnected stream reaches, even if they are interconnected less than 25% of the time.

3. **Comment #3** (Basin Setting, 2.2.7 Groundwater-Dependent Ecosystems, starting pp 2-100): GDE identification, required by 23 CCR § 354.16(g), is based on methods that risk exclusion of ecosystems that may depend on groundwater.
   a. *Issue*: Methods applied to the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset to eliminate potential GDEs are fallible.

i. Depth to Groundwater: The removal of potential GDEs with a depth to groundwater greater than 30 feet during (an unspecified season) of 2015 relies on a single-point-in-time baseline hydrology. Specifically, this 2015 baseline falls several years into a historic drought when groundwater levels throughout the San Joaquin Valley were trending dramatically lower than usual due to reduced surface water availability. Exclusion of potential GDEs based on a snapshot of groundwater elevations during a historic drought is invalid; because this approach does not consider representative climate conditions or account for GDEs that can survive a finite period of time without groundwater access (Naumburg 2005), but that rely on groundwater table recovery for long term survival.

ii. Adjacent to Alternate Water Supplies: The GSP notes that "to be dependent on groundwater there must not be other available water supplies" (GSP pp 2-104). This statement disregard's a GDE's adaptability and opportunistic approach to accessing water in which vegetation may vary reliance on surface water and groundwater between seasons and water years.[2] Therefore, the removal of potential GDEs that are within 50 feet of irrigated lands, 150 feet of managed wetlands, and 150 feet of perennial surface water does not consider the potential for GDEs shifting reliance between surface and groundwater. Additionally, vegetation near *interconnected* perennial surface waters may depend on sustained groundwater elevations to stabilize the gradient or rate of loss of surface water; meaning ecosystems near interconnected surface waters likely depend on sustainable groundwater elevations and constitute GDEs. Therefore, it is possible that any of these potential GDEs proximate to 'alternate water supplies' rely on groundwater during specific seasons or water years.

b. *Recommendations*:

i. Depth to Groundwater: Develop a hydrologically robust baseline from which to remove 'areas with a depth to groundwater greater than 30 feet' that relies on multiple, climatically representative years of groundwater elevation and that accounts for the inter-seasonal and inter-annual variability of GDE water demand.

---

[2] The Department assumes that potential GDEs removed under this step overlie shallow groundwater, otherwise they would have already been removed during the step of excluding potential GDEs that overlie a depth to groundwater of 30+ feet.

   ii. Adjacent to Alternate Water Supplies: Reevaluate potential GDEs previously removed due to proximity to irrigated lands, managed wetlands, and perennial surface waters. Err on the side of inclusivity until there is evidence that the overlying ecosystem has no significant dependence on groundwater across seasons and water year types. Ensure that riparian GDE beneficial users of groundwater and interconnected surface water are carefully considered in the analysis of undesirable results and minimum thresholds for depletions of interconnected surface waters.

4. **Comment #4** (Basin Setting, 2.3.5.4 Projected Water Budget, starting pp 2-130): Projected water budget assumptions may risk overestimating surface water availability and sustainable yield by not relying on best available information [23 CCR § 354.18(e)].
   a. *Issue*: Projected surface water budget assumptions may risk overestimating water availability. Overestimation of water availability can result in the overallocation of both surface and groundwater water resources, unnecessarily jeopardizing environmental beneficial users. Two water budget assumptions that do not rely on best available information and that underscore current sustainable yield estimations are as follows: 1) the climate change analysis predicting a net depletion of aquifer storage is not reflected in the projected water budget or estimated sustainable yield, rather it is presented as a separate analysis; and 2) projected surface water deliveries need to be updated to reflect any new regulatory reductions of surface water deliveries such as those that may be codified in the State Water Resources Control Board Water Quality Control Plan for the Bay Delta: San Joaquin River Flows and Southern Delta Water Quality.
   b. *Recommendation*: Amend the water budget and sustainable yield: 1) apply climate change estimates to the projected water budget and scale the sustainable yield accordingly; and 2) adjust surface water delivery estimates to reflect any new regulatory compliance.
5. **Comment #5** (Sustainable Management Criteria, 3.2.1 Groundwater Levels and 3.2.6 Depletions of Interconnected Surface Water, starting pp 3-1): Groundwater Level and Interconnected Surface Water sustainable management criteria do not protect against undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface waters.
   a. *Issues*:
      i. Proxy Metric: Before addressing the individual sustainability criteria for both Groundwater Levels and Depletions of Interconnected

Surface Water, the Department challenges the use of groundwater elevations as a proxy metric for Depletions of Interconnected Surface Water. The GSP does not provide evidence that a "significant correlation exists between groundwater elevations" and Depletions of Interconnected Surface Water [23 CCR § 354.36(b)(1)]. Instead, the GSP backs into the proxy metric by associating the proposed Groundwater Level minimum thresholds with the absence of significant and unreasonable surface water depletions, claiming that historical depletions of interconnected surface water had no associated undesirable results (GSP pp 3-19). The GSP offers few details to substantiate this claim that historical surface water depletions did not lead to undesirable results, and the GSP does not specify the modeling exercise used to determine the insignificance of historical surface water depletions. Provided the status of surface water allocations and aquatic ecosystems on rivers in the ESJ basin, the Department contests that any surface water depletions attributable to groundwater pumping are likely to be significant and unreasonable, particularly in the benchmark year of 2015 when groundwater pumping and surface water temperatures were critically high. Depleted flows in the lower San Joaquin River, many reaches of which are identified as interconnected in the GSP, contribute to increased in-river water temperatures. Groundwater extraction from interconnected aquifers contributes to depletion of instream flow (Barlow and Leake, 2012). Low flows and increased water temperatures in the lower San Joaquin River have been documented to negatively impact Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) (Hallock 1970, Marston 2012). Acknowledging that fish and wildlife beneficial uses and users of groundwater likely experienced undesirable results during historical pumping regimes, especially during critically dry years, the GSP cannot rely on groundwater elevation as a proxy metric for Depletions of Interconnected Surface Water. If a significant correlation is lacking between groundwater elevations and Depletions of Interconnected Surface Water, particularly at the representative monitoring well locations used to track groundwater elevations in the ESJ Subbasin, then groundwater elevations used as a proxy for surface water depletions may misinform groundwater management activities and poorly predict instream habitat conditions for fish and wildlife species. Accordingly, the application of Groundwater Level sustainable management criteria to Depletions of Interconnected Surface Water is inappropriate, as it is not grounded in a quantifiable and site-specific understanding of surface water-groundwater connectivity as required by 23 CCR § 354.28 (c)(6)(A).

ii. Undesirable Results: Groundwater Level 'undesirable results' and 'effects of undesirable results' do not specify impacts to environmental beneficial users such as terrestrial GDEs (GSP pp 3-3, 3-4). Additionally, the method used to identify undesirable results for Groundwater Levels (i.e., minimum threshold exceedances in groundwater elevation) is applied to the identification of undesirable results for the Depletions of Interconnected Surface Water without a reasonable justification. The indicator of undesirable results for Groundwater Levels is the measure of 25% of monitoring wells falling below their minimum thresholds for two consecutive (non-dry) years, yet the GSP does not prove a relationship between the Groundwater Level identification of undesirable results and the presence of undesirable results for Depletions of Interconnected Surface Water (see Comment #5.a.i). Effectively, the GSP does not connect identification of undesirable results for Depletions of Interconnected Surface Water to effects on interconnected surface water beneficial users per 23 CCR § 354.26 (b)(3). Finally, the GSP notes that groundwater levels that fall below the minimum threshold during hydrologically dry or critically dry years are not considered to be an indicator of undesirable results (GSP pp 3-3). This means proposed indicators of undesirable results for Groundwater Levels and Depletions of Interconnected Surface Water do not exist for dry water years. This absence of undesirable results indicators for certain water years means beneficial users of groundwater and interconnected surface water may experience significant and unreasonable effects throughout the duration of dry or critical water years before the undesirable results are 'identified' and managed. Accordingly, there is no groundwater management accountability during the most challenging of years for water resource managers and fish and wildlife beneficial users alike.

iii. Minimum Thresholds and Measurable Objectives: Minimum thresholds and measurable objectives for Groundwater Levels, and by proxy, for Depletions of Interconnected Surface Water, are not

protective of environmental beneficial uses and users of groundwater and interconnected surface water. Minimum thresholds allow for a decrease of groundwater elevation from 2015, or a comparable historic low, for all representative monitoring sites (3-7); and measurable objectives are set at historically low groundwater elevations (GSP 3-8). These sustainability criteria suggest that groundwater elevations at all representative wells in the ESJ Subbasin can continue to decrease for the next 20 years, dropping further from historically low groundwater elevations during drought years, without witnessing undesirable results.
The ESJ Subbasin is characterized by DWR as 'Critically Overdrafted,' meaning "continuation of present water management practices [in the basin] would probably result in significant adverse overdraft-related environmental, social, or economic impacts" ("Critically"). However, according to the GSP, there are no areas within the basin that are considered to have 'significant and unreasonable existing issues' (GSP pp 3-4), therefore minimum thresholds allow for continued groundwater depletions.
Conceptually, there is a disconnect between the ESJ's 'Critically Overdrafted' designation and the GSP's claim that the basin has not experienced undesirable results, nor will it if groundwater levels continue to decrease. More specifically, the Department believes historical declines in terrestrial and aquatic groundwater dependent ecosystem viability, exacerbated by recent drought years, are evidence of undesirable results and further groundwater decline will undoubtedly lead to significant and unreasonable effects on fish and wildlife beneficial uses and users of groundwater and interconnected surface waters under the proposed sustainable management criteria. For example, further streamflow depletion attributable to groundwater pumping that lowers groundwater levels to meet minimum thresholds or even measurable objective may further compromise in-stream temperature targets in the lower San Joaquin River, adversely impacting in-stream species (see Comment #5.a.i). Accordingly, the Department does not believe groundwater levels above the proposed minimum thresholds and below the proposed measurable objectives (in the margin of operational flexibility) will allow the basin to achieve sustainability, particularly with respect to avoiding undesirable results for fish and

wildlife beneficial uses and users of groundwater and interconnected surface water.

b. *Recommendation*:

   i. Proxy Metrics: To justify use of groundwater elevations as a proxy metric for Depletions of Interconnected Surface Water, the GSP should either specify how groundwater elevations are significantly correlated to surface water depletions; or define an expeditious path to identifying the location, quantity, and timing of surface water depletions caused by groundwater use, per 23 CCR § 354.28(c)(6)(A), to better inform sustainability criteria for Depletions of Interconnected Surface Water.

   ii. Undesirable Results: Specify Groundwater Level 'undesirable results' and 'effects of undesirable results' for environmental beneficial users of groundwater and interconnected surface water. Specify undesirable result indicators for Depletions of Interconnected Surface Water that are relevant to beneficial users of surface waters. Identify undesirable results indicators for dry and critically dry water years for all sustainability indicators.

   iii. Minimum Thresholds and Measurable Objectives: Reconsider minimum thresholds and measurable objectives, accounting for undesirable results for fish and wildlife beneficial uses and users of groundwater and interconnected surface water. Design sustainable management criteria that reflect a 'Critically Overdrafted' subbasin designation by seeking to improve current groundwater conditions rather than allowing for continued aquifer depletions over the next two decades. For example, historical groundwater pumping has likely contributed to stream disconnection illustrated in figure 2-66 (GSP 2-99); resulting in depleted stream flows and reduced baseflows in ESJ Subbasin tributaries, and exacerbated high water temperatures in the lower San Joaquin River that negatively impact listed species such as the Chinook Salmon. Minimum thresholds and measurable objectives should reflect an effort to prevent further degradation to interconnected surface waters and to avoid undesirable results, rather than risk magnifying historical undesirable results through lowered groundwater elevations.

6. **Comment #6** (Sustainable Management Criteria, 3.6 Degraded Water Quality, starting pp 3-10): The GSP wrongly abdicates responsibility for specific constituents by implying there is no nexus between specific groundwater contaminants and groundwater pumping (GSP pp 3-11).

a. *Issue*: The GSP identifies two primary water quality constituents of concern in the ESJ Subbasin: salinity and arsenic (GSP pp 2-76). The GSP only specifies sustainability management criteria for salinity. The GSP explains that other constituents, including arsenic, are managed through other regulatory programs, and suggests that because GSAs do not have land use authority, they lack an ability to manage for such constituents as arsenic (GSP pp 3-11). Science suggests that over-pumping of aquifers can cause clay layers to compress and release dissolved arsenic, resulting in an increase of arsenic in extracted water ("Groundwater"). Thus, groundwater pumping actions can affect the presence, movement, and concentration of naturally occurring arsenic in groundwater, potentially increasing anthropogenic and ecosystem exposure to arsenic contamination. According to SGMA statue, GSAs have the authority to establish groundwater extraction allocations, among other relevant authorities [WC § 10726.4]. Because arsenic contamination can be impacted by groundwater pumping, and because GSAs have the authority to manage groundwater pumping, the ESJGA has a viable management lever over arsenic contamination in the ESJ Subbasin.

b. *Recommendation*: Draft a plan to investigate the relationship between groundwater pumping and the presence, movement, and concentration of arsenic in the ESJ Subbasin and include the plan in the GSP submitted to DWR by January 2020. Develop sustainability criteria for arsenic accordingly and in partnership with existing regulatory programs by the first 5-year GSP update due in January 2025.

7. **Comment #7** (Monitoring Networks, starting pp 4-1): Number and distribution of groundwater monitoring wells are insufficient for analysis.

   a. *Issue*: The current monitoring network lacks a sufficient number and representative distribution of shallow groundwater monitoring wells to monitor impacts to environmental beneficial uses and users of groundwater and interconnected surface waters [23 CCR § 354.34(2)]. Few wells are near interconnected surface waters or concentrations of GDEs; and therefore, there are few data points on shallow groundwater level trends. These data are critical to understanding groundwater management impacts on fish and wildlife beneficial uses and users of groundwater, including GDEs and interconnected surface water habitats, that are impacted disproportionately by shallow groundwater trends.

   b. *Recommendation*: Install additional shallow groundwater monitoring wells near GDEs and interconnected surface waters, potentially pairing multiple-completion wells with streamflow gauges for improved understanding of surface water-groundwater interconnectivity.

8. **Comment #8** (Project and Management Actions; 6.1 Projects, Management Actions, and Adaptive Management Strategies; starting pp 6-1): Demand reduction management actions lack emphasis and specificity critical to ESJ Subbasin sustainability goal achievement.
   a. *Issue*: The GSP project and management actions focus on supply augmentation, with only three projects intended to conserve groundwater through metering and systems optimization. Though the GSP reserves the flexibility to implement demand-side management in the future (GSP pp 6-1), there are no specifics as to how the ESJGA would implement demand management. This lack of specificity on how demand will be managed may lead to deprioritization or delayed implementation of demand management actions, which can undermine a basin's ability to achieve sustainability goals. Considering the ESJ Subbasins' current unsustainable rate of groundwater consumption and considering the cost and timing challenges associated with supply augmentation projects, a balanced portfolio approach to achieve groundwater sustainability should include demand-management strategies.
   b. *Recommendation*: Add specific measures for initiating demand reduction on an earlier timeline in the ESJ Subbasin to account for groundwater pumping lag impacts, supply-augmentation project implementation challenges, and a scaled ramping-down of groundwater use that is a necessary ingredient in San Joaquin Valley long-term groundwater sustainability. Be specific about triggers, timing, and expected outcomes of demand-management actions.

CONCLUSION

In conclusion, the ESJ Subbasin Draft GSP does not comply with all aspects of SGMA statutes and regulations. The Department deems the GSP insufficient in its consideration of fish and wildlife beneficial uses and users of groundwater and interconnected surface waters. The Department recommends that ESJGA address the above comments before GSP submission to DWR. If these comments are not integrated, the Department may recommend to DWR an 'incomplete' or 'inadequate' plan determination based on the following regulatory criteria for plan evaluations:

1. The assumptions, criteria, findings, and objectives, including the sustainability goal, undesirable results, minimum thresholds, measurable objectives, and interim milestones are not reasonable and/or not supported by the best available information and best available science. [23 CCR § 355.4(b)(1)] (See Comment #2, 3, 4, 5, 7)

ATTACHMENT 2

2. The GSP does not identify reasonable measures and schedules to eliminate data gaps. [23 CCR § 355.4(b)(2)] (See Comment #7)
3. The sustainable management criteria and projects and management actions are not commensurate with the level of understanding of the basin setting, based on the level of uncertainty, as reflected in the GSP. [23 CCR § 355.4(b)(3)] (See Comment #5, 6, 8)
4. The interests of the beneficial uses and users of groundwater in the basin, and the land uses and property interests potentially affected by the use of groundwater in the basin, have not been considered. [23 CCR § 355.4(b)(4)] (See Comment #1, 2, 3, 4, 5, 7)
5. The projects and management actions are not feasible and/or not likely to prevent undesirable results and ensure that the basin is operated within its sustainable yield. [23 CCR § 355.4(b)(5)] (See Comment #8)
6. The GSP does not include a reasonable assessment of overdraft conditions and/or does not include reasonable means to mitigate overdraft, if present. [23 CCR § 355.4(b)(6)] (See Comment #4, 8)

The Department appreciates the opportunity to provide comments on the ESJ Subbasin Draft GSP. Please contact Lauren Mulloy by email at Lauren.Mulloy@wildlife.ca.gov with any questions.

Sincerely,

Kevin Thomas
Regional Manager, North Central Region

Enclosures (Literature Cited)

ec: *California Department of Fish and Wildlife*

Joshua Grover, Branch Chief
Water Branch
Joshua.Grover@wildlife.ca.gov

Robert Holmes, Environmental Program Manager
Statewide Water Planning Program
Robert.Holmes@wildlife.ca.gov

Briana Seapy, Statewide SGMA Coordinator
Groundwater Program
Briana.Seapy@wildlife.ca.gov

ATTACHMENT 2

MaryLisa Cornell, Water Unit Supervisor
North Central Region
MaryLisa.Cornell@wildlife.ca.gov

Lauren Mulloy, Environmental Scientist
North Central Region
Lauren.Mulloy@wildlife.ca.gov

California Department of Water Resources

Craig Altare, Supervising Engineering Geologist
Sustainable Groundwater Management Program
Craig.Altare@water.ca.gov

Paul Wells, Eastern San Joaquin Subbasin SGMA Point of Contact
North Central Region Office
Paul.Wells@water.ca.gov

National Marine Fisheries Service

Rick Rogers, Fish Biologist
West Coast Region
Rick.Rogers@noaa.gov

Erin Strange, San Joaquin River Branch Lead
West Coast Region
Erin.Strange@noaa.gov

State Water Resources Control Board

James Nachbaur, Director
Office of Research, Planning & Performance
James.Nachbaur@waterboards.ca.gov

ATTACHMENT 2

Literature Cited

Barlow, P.M., and Leake, S.A., 2012, *Streamflow depletion by wells—Understanding and managing the effects of groundwater pumping on streamflow*: U.S. Geological Survey Circular 1376.

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Hallock, R.J., R.F. Elwell, D.H. Fry Jr. 1970. *Migrations of adult king salmon Oncorhynchus tshawytscha in the San Joaquin Delta as demonstrated by the use of sonic tags.* State of California. The Resources Agency. Department of Fish and Game. Fish Bulletin 151.

Marston, D, C. Mesick, A. Hubbard, D. Stanton, S. Fortmann-Roe, S. Tsao. T. Heyne. 2012. *Delta flow factors influencing stray rate of escaping adult San Joaquin River fall-run Chinook salmon (Oncorhynchus tshawytscha*). San Francisco Estuary & Watershed Science.

Naumburg E, Mata-Gonzalez R, Hunter R.G., McLendon T, Martin D.W. 2005. *Phreatophytic vegetation and groundwater fluctuations: a review of current research and application of ecosystem response modeling with an emphasis on great basin vegetation.* Environmental Management. 35(6):726-40.

Stanford: School of Earth, Energy & Environmental Sciences. *"Groundwater Quality in the Sustainable Groundwater Management Act (SGMA): Scientific Factsheet on Arsenic, Uranium, and Chromium."* or https://d3n8a8pro7vhmx.cloudfront.net/communitywatercenter/pages/293/attachments/original/1560371896/CWC_FS_GrndwtrQual_06.03.19a.pdf?1560371896

From: Mitchell Maidrand <Mitchell.Maidrand@stocktonca.gov>
Sent: Tuesday, October 1, 2024 11:01 AM
To: Katie Cole <kcole@woodardcurran.com>
Subject: RE: Draft GSP

Katie – I was reviewing the project tables in the GSP in the ES. For the City's projects there should be some changes if possible. For the groundwater recharge project – under current status it should state: Basin design in progress, construction to begin in spring of 2025. Also recharge should be stated to be 20k AFY. Capital cost should be $11.5 M. Under regulatory it should indicate CEQA required. C-1

For the AMI – current status should indicate AMI project in progress. Capital costs should indicate $17 M. Also, since it is in progress shouldn't we list it with the Category A projects? C-2

If we can make these changes in this version of the GSP prior to submittal to DWR that would be great. Thanks.

Mitchell Maidrand, P.E.
T2, D2
Deputy Director
Water Resources Division

Municipal Utilities Department
Delta Water Treatment Plant
11373 N. Lower Sacramento RD
Lodi, CA 95242
Phone: (209) 937-7353
Mobile: (916) 698-0293

You don't often get email from info@esjgroundwater.org. Learn why this is important

From: Bana Rousan-Gedese <banar@ccwd.org>
Sent: Monday, October 21, 2024 8:17 AM
To: info@esjgroundwater.org [PW] <info@esjgroundwater.org>
Subject: ESJGWA GSP Public Comment

Hello,

I would like to submit public comment on behalf of the Eastside San Joaquin GSA.

D-1
- In the Executive Summary, can Calaveras County be added to the description of the Eastside San Joaquin GSA in the second paragraph on page ES-1. It would then read as, "... Eastside San Joaquin GSA (Eastside GSA) (composed of Calaveras County Water District [CCWD], Calaveras County, Stanislaus County, and Rock Creek Water District)..."

D-2
- In Chapter 1, page 1-7, also in the description of the Eastside GSA, please add Calaveras County so the first sentence is, "Eastside San Joaquin GSA (Eastside GSA) is a partnership between Calaveras County Water District, Calaveras County, Stanislaus County, and Rock Creek Water District."

Thank you!

Bana Rousan-Gedese
Water Resources Specialist
banar@ccwd.org
Office: (209) 754-3090
Cell: (209) 419-1474

You don't often get email from info@esjgroundwater.org. Learn why this is important

From: Bana Rousan-Gedese <banar@ccwd.org>
Sent: Monday, October 7, 2024 12:16 PM
To: info@esjgroundwater.org [PW] <info@esjgroundwater.org>
Subject: Eastside GSA

Hello,

I am writing to ask that the CCWD and Calaveras County descriptions on page 1-7 be modified to read as follows:

D-3

Calaveras County Water District: The Calaveras County Water District (CCWD) provides water service to approximately 13,360 municipal and residential customers in six service areas and shares the same boundaries as Calaveras County. Supply for CCWD comes from reservoir releases on the Calaveras, Stanislaus, and Mokelumne Rivers for a total of approximately 6,000 AF/year for primarily agricultural and residential use. CCWD has several customers with riparian rights along the Calaveras River, has one service area that relies solely on groundwater, and has several areas that utilize recycled water.

Calaveras County: Calaveras County has a total area of 1,037 square miles and extends beyond the boundaries of the Eastern San Joaquin Subbasin. Calaveras County Water District is the only public water supplier to residents located in the portion of the county overlying the Subbasin. The only incorporated city, Angels Camp, is located outside of the Subbasin. Calaveras County had one of the fastest growing annual percent increases in population in California between 2000 and 2010 (CCWD, 2020). For the portion of Calaveras County that falls within the Eastern San Joaquin Subbasin, there are numerous domestic, municipal, and monitoring wells.

Thank you,

Bana Rousan-Gedese
Water Resources Specialist
banar@ccwd.org
Office: (209) 754-3090
Cell: (209) 419-1474

ATTACHMENT 2

CALAVERAS COUNTY WATER DISTRICT
120 Toma Court • San Andreas, CA 95249 • Main Line (209) 754-3543

Fritz Buchman, CE., T.E., CFM, Eastern San Joaquin Subbasin Plan Manager

RE: Comments on the Eastern San Joaquin Groundwater Authority's (ESJGWA) Groundwater Basin Sustainability Plan Update

Dear Mr. Buchman

D-4 The Calaveras County Water District (CCWD) would like to highlight the fact that Calaveras County wells, currently designated as Broad Network wells within the Plan update, are located within the recharge area of the basin and provide key basin health information. This fact was confirmed via the DWR-collected Aerial Electro Magnetics (AEM). The information these wells provide can be used throughout the life of the plan to further demonstrate the value of these shallow and deep recharge areas within Calaveras County. Their data, while illustrating groundwater interconnection, contribute to understanding the semi-consolidated tertiary bedrock aquifer, high-yielding water wells, and proximity to alluvial near-surface sediments.

CCWD has consistently provided groundwater measurements from several wells to help support the GWA and to continue to benefit from CASGEM reporting. D-5 CCWD would like to clarify why new CCWD wells are appearing in Tables 3-5 and 3-6 for groundwater quality monitoring, and what expectations are there regarding frequency, reporting, etc. D-6 CCWD would also like to clarify where CCWD's ongoing bi-annual well monitoring contributes to GSP groundwater level monitoring, given those wells don't appear in Section 3.3.1.2 details.

D-7 The data within the GSP update should reflect the hydrogeology historically conveyed by programs like CASGEM. This will help to ensure continuity amongst datasets and in turn avoid ambiguity relative to overall basin hydrogeology. Additionally, data collected by representative monitoring wells is enhanced by routine comparison of data from monitoring wells within the recharge area of the basin in Calaveras County.

D-8 The District is looking forward to adding valuable projects which will be submitted to the GWA to be included in future Annual Reports.

The District appreciates the hard work the GWA put into updating this plan and respectfully requests the District's input be given thoughtful consideration.

Thank you,

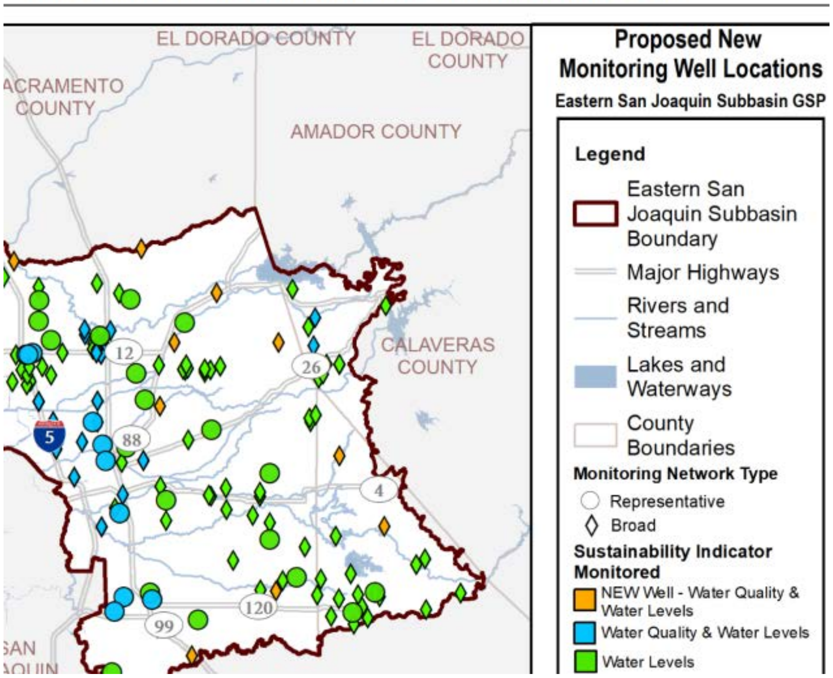
Michael Minkler, General Manager

ATTACHMENT 2

From: Pat Dunn <pat.dunn@nv5.com>
Sent: Tuesday, October 22, 2024 4:00 PM
To: Brandon Nakagawa <brandon.nakagawa@ssjid.gov>; ckipf@condorearth.com; sesser@condorearth.com <IMCEAUNDEFINED-sesser+40condorearth+2Ecom@namprd16.prod.outlook.com>
Cc: Bana Rousan-Gedese <banar@ccwd.org>; Jesse Hampton <JesseH@ccwd.org>; Suzanne Jarmusch <Suzanne.Jarmusch@nv5.com>; Damon Wyckoff (damonw@ccwd.org) <damonw@ccwd.org>
Subject: RE: Proposed Well Nest for Semi-annual Groundwater Quality Monitoring - 5921 Raindance Road

E-1 Thanks Brandon:
Please note discrepancies between Tables 4-1 and 4-4 and Figure 4-5. CCWD wells are not referenced on the tables but are on the Figure.

Figure 4-5: Proposed New Monitoring Well Locations (Shown in Orange)



Best Regards,
Pat Dunn, P.G., C.Hg.
NV5
Cell 916-221-0012

SIERRA CLUB
DELTA-SIERRA GROUP
MOTHER LODE CHAPTER

To: Members of the Eastern San Joaquin Groundwater Authority and Members of the Groundwater Sustainability Agencies (via info@esjgroundwater.org)

From: Mary Elizabeth M.S., R.E.H.S., Delta-Sierra Group Conservation Chair

Date: 9.11.2024

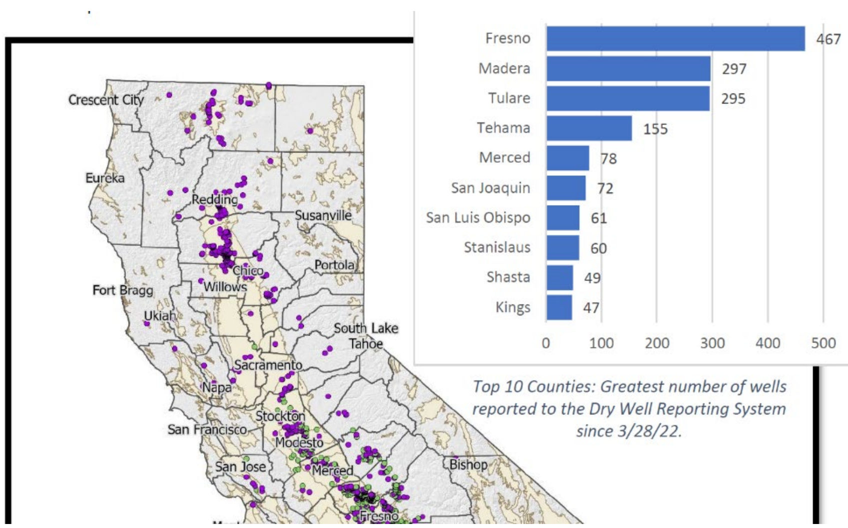
Re: Eastern San Joaquin Groundwater Authority (ESJGWA) Steering Committee 9.11.2024 Comments

The ESJGWA adopted a well mitigation program and ordinance on August 14, 2024 and in the minutes of the meeting a final ordinance copy signed was not included only that there was an attachment to the agenda which was clearly indicated as draft. Please send out the final copy for all those that submitted comments on the document as a means of stakeholder engagement.

F-1

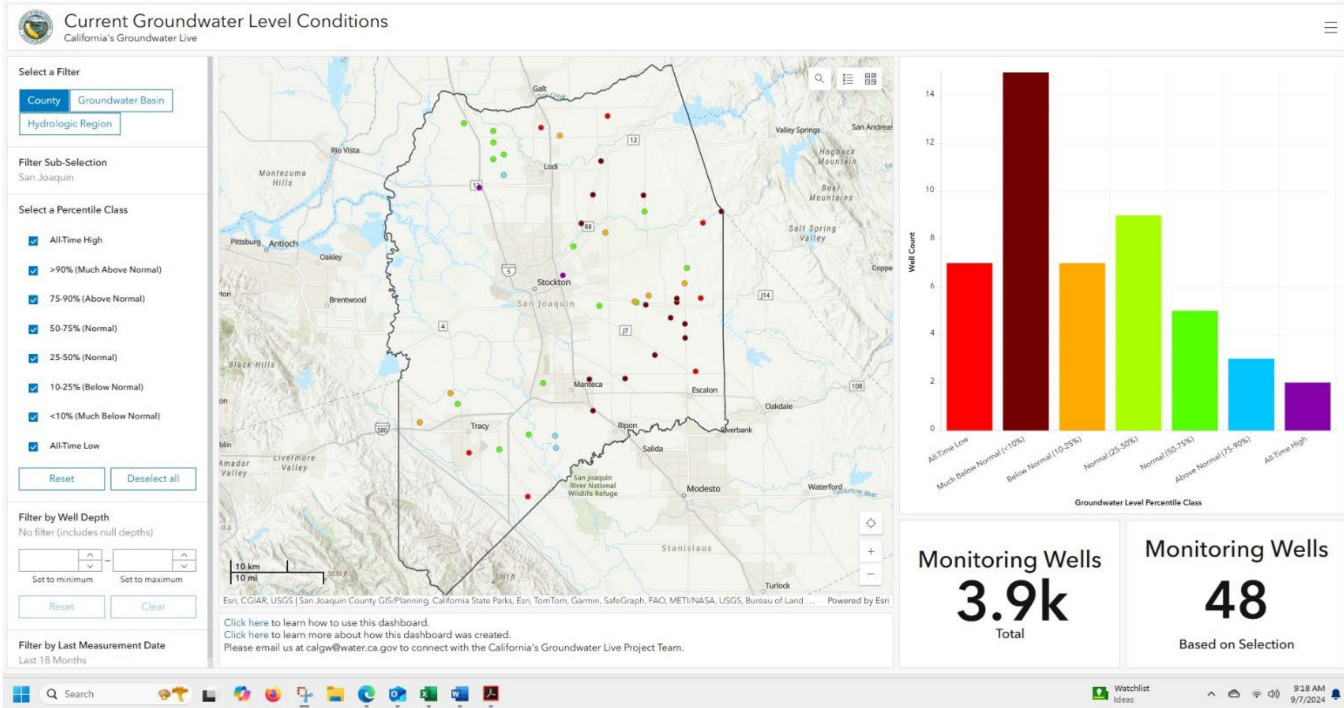
The implementation of this program is essential for the preparation for future drought conditions. Comments we submitted 4.10.2024 were not included in the minor revisions involving management, but those comments are still valid.

On March 6, 2024, the DWR released *Groundwater Well Permitting Report - Observations and Analysis of Executive Orders N-7-22 and N-3-23* which included San Joaquin County in the top 10 counties with dry wells since March 28, 2022 as shown below.[1] These DWR dry well data are reported voluntarily and would not include reports by individuals within a GSA.

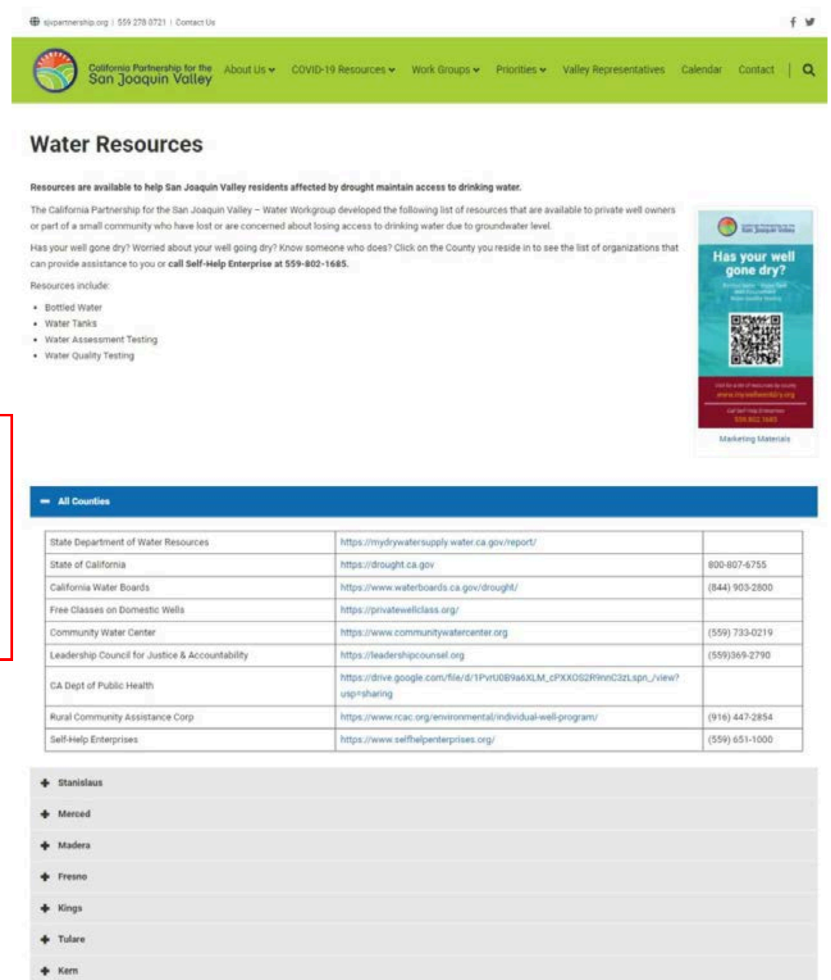


Recent groundwater data has been uploaded to DWRs groundwater data system as shown below, current as of 9.7.2024, indicates that there are areas in our community that is vulnerable to groundwater lowering events, either from drought or from overdrafted groundwater extraction.

[1] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Wells/Files/DWR-Well-Permitting-Analysis-Final_March2024.pdf?utm_medium=email&utm_source=govdelivery



When investigating resources linked to DWRs website I came across the San Joaquin Partnerships website which is notable that specific San Joaquin County resources were not listed to provide residents with a local contact while they are navigating the problem that brought them to the site.



F-2 I hope that the Groundwater Authority adds their well mitigation program to resources available to San Joaquin County residents residing within the Eastern San Joaquin Subbasin.

Additionally, while not lead the Eastern San Joaquin Groundwater Authority has been identified by guidance documents to be a key player in the SB552 drought planning effort and as such should be receiving regular updates on plan development in San Joaquin County to respond to domestic well and small water systems water supply problems related to drought.

F-3

As I was the only public member in attendance at the July 2024 meeting regarding the Stakeholder and Engagement Plan revision and the plan will not be released until the 5-year GSP update, stakeholder engagement is needed in a significant way. At that meeting there was acknowledgement that 5-year update will be heavily technical. The Groundwater Authorities insistence that the Technical Advisory Committee that regularly meets albeit on different topics all of which are current has created a deficient in the ability of residents to comprehend and provide comments on plans and reports that have a short 30 day comment period. Two substantial reports are under review concurrently. We hope that instead of overview meetings that there be some public information meetings on the technical topics.

You may reach me at melizabeth.sierra@gmail.com if you have any questions or wish to discuss these issues in more detail.

Sincerely,

Mary Elizabeth M.S., R.E.H.S.
Delta-Sierra Group, Conservation Chair, Sierra Club
Melizabeth.sierra@gmail.com

ATTACHMENT 2

Restore the Delta
2616 Pacific Ave #4296, Stockton, CA 95204
209-479-2053
www.restorethedelta.org

October 31, 2024

Eastern San Joaquin Groundwater Authority
1810 E Hazelton Ave
Stockton, CA 95205
Sent via email: info@esjgroundwater.org

Re: Eastern San Joaquin Groundwater Authority's Draft Groundwater Sustainability Plan

To Whom It May Concern:

Restore the Delta (RTD) works in the areas of public education, program and policy development, and outreach so that all Californians recognize the Sacramento-San Joaquin Delta as part of California's natural heritage, deserving of restoration. We interface with local, state and federal agencies to advance this vision.

We envision the Sacramento-San Joaquin Delta as a place where a vibrant local economy, tourism, recreation, farming, wildlife, and fisheries thrive as a result of resident efforts to protect our waterways. We seek water quality protections for all communities, particularly environmental justice communities and California Tribes, as well as community protections from flood and drought impacts.

Ultimately, our goal is to connect communities to our regional rivers and to empower communities to become the guardians of the estuary through participation in government planning, community science and waterway monitoring, and a sustainable local economy. We seek to build the next generation of water leaders by developing programs in science, land and water management, and the green economy. Rooted in the Clean Water Act, we work for a Delta with waters that are fishable, swimmable, and drinkable, and farmable.

We envision improvements in the Delta as opportunities for Delta Tribes, Delta farming communities, and environmental justice communities to gain greater equity in decision making and to share in the benefits from area natural resources management.

We are providing comments on the Eastern San Joaquin Groundwater Authority's ("Authority") draft Groundwater Sustainability Plan ("Plan"), pursuant to a January 2025 deadline for submission to the Department of Water Resources. Groundwater management in the Eastern San Joaquin Groundwater Basin is of direct interest to our organization due to potential Delta and Delta-adjacent impacts in the watershed.

We respectfully submit this letter for consideration in regard to the adoption of the amended Plan. After reviewing in detail, the amendments to the Plan, we have identified a number of flaws that the Authority should be aware of prior to the approval and adoption of the Plan. Accordingly, we lay out our key concerns and findings, below.

SGMA background and RTD position on SGMA

After one of the most severe droughts in state history, former California Gov. Jerry Brown signed into law the Sustainable Groundwater Management Act (SGMA) in 2014 to ensure better local and regional management of groundwater use by 2040. SGMA was crafted to shift traditional views of groundwater use away from the current siloed approach to encourage cities, counties, and irrigation districts to work together in a regional collaborative process.

SGMA requires over-drafted water basins to become sustainable (prevent overdrafts from pumping more than what is replenished during the year) by 2040. Over-drafting means more water is pumped from a groundwater basin than is replaced through sources like rainfall, irrigation water, streams fed by mountain runoff, and intentional recharge efforts (spreading surface water to feed into the basin).

The 70-square-mile Eastern San Joaquin Groundwater Subbasin is bounded by the Sierra Nevada foothills to the east, San Joaquin River to the west, Dry Creek to the north, and the Stanislaus River to the south. It's one of 21 basins and subbasins identified by the California Department of Water Resources (DWR) as being in a state of critical overdraft. Current analysis indicates that groundwater pumping offsets and/or recharge on the order of 95,000 acre-feet per year (AF/year) may be required to achieve sustainability.

Local stakeholders had until 2022 (in critically overdrafted basins until 2020) to develop, prepare, and begin implementation of Groundwater Sustainability Plans (GSP). The first reports of an area's effort toward sustainability were filed in 2020 and the first 5-year updates are required by January 2025. Plans include various projects and management actions that are supposed to help the basin reach a balance between inputs (rivers, rainfall, etc.) and outputs (pumping for irrigation, drinking water, etc.).

Summary of concerns

With public trust requirements of SGMA, the Authority has legal and fiduciary responsibilities for proper implementation of the Ground Water Sustainability Plan. We are concerned that the Authority has failed to follow State mandates. First, the compliance issues in regard to funding accountability put the entire subbasin at risk of sanctions and further punitive actions by the State. Second, fundamental stakeholder engagement is required by law and must be a part of the process through better community outreach, Tribal engagement, disadvantaged community inclusion, and small farmer protections. Additionally, the Plan the Authority is reviewing does not identify current permit applications for carbons sequestration projects that could affect the subbasin particularly, through CO2 sequestration. Poor planning for the future will, therefore, leave the Authority and its member agencies ill-prepared for future monitoring. Listed below are the flaws we have found in the current iteration of the Plan that will then be discussed in greater detail in descriptive narrative.

1. **Three Groundwater Sustainability Agencies have failed to develop groundwater sustainability proposals and must be brought into compliance to avoid state sanctions for the entire Subbasin. This process requirement should have been completed over the course of the last three years and ready for public review now.**
2. **San Joaquin County is diverting funding that is supposed to be used for local flood control and water management projects to pay for Authority fees.**
3. **The Authority needs to significantly improve its communications and community engagement methods to ensure the vast array of perspectives across the Subbasin are meaningfully incorporated into regional groundwater sustainability planning efforts.**
4. **None of the 43 groundwater sustainability projects listed in the draft plan are located in South Stockton, a historically disadvantaged community that requires investment in groundwater protections.**
5. **The plan should be amended to include protections for small farmers.**
6. **The plan does not adequately identify or address subsidence.**
7. **The plan needs to explicitly address future monitoring plans for geologic CO2 sequestration site proposals in the Subbasin, and ensure local groundwater monitoring programs are well-integrated into existing public monitoring networks.**
8. **At public meetings, and in the documents, sustainability has not been fully and adequately defined, and does not encompass a broad definition of sustainability that represents the public interest.**

Below are detailed sections regarding our concerns with the draft plan:

G-1

1. **The three GSAs that have failed to develop groundwater sustainability proposals must be brought into compliance to avoid state sanctions for the entire Subbasin. The lack of participation of three GSAs, including San Joaquin County, could cause all GSAs in the Subbasin to be subject to penalties from the State Water Board. These would not only impact farmers but also property owners in the cities and urban areas of San Joaquin County.**

The Eastern San Joaquin Groundwater Authority ("Authority") is a joint powers agency consisting of 16 Groundwater Sustainability Agencies (GSAs) that make up the Eastern San Joaquin Subbasin. The purpose is to coordinate the various GSAs' management of the basin, in accordance with SGMA. The updated Groundwater Sustainability Plan that the Authority and member GSAs were charged to submit to the state is supposed to show progress toward groundwater sustainability by 2040. GSAs that have had their GSPs found to be deficient have been subject to enforcement (probation) by the State Water Board. For the GSAs in Kings County, for instance, this has meant the imposition of fees on wells and a fee per acre foot of water pump (the implementation of this has been stayed temporarily by the court). Additional fees will impact small farmers and economically disadvantaged households situated in the County and dependent on groundwater wells.

G-1 con't

The three GSAs without plans are (1) San Joaquin County, (2) Central San Joaquin Water Conservation District, and (3) a Stanislaus County GSA in the southeast corner of San Joaquin/Stanislaus County. These GSAs have made no progress and have no proposals in place to work towards groundwater sustainability.

The failure of these three GSAs to develop their plans as stated above, could lead to sanctions by the State Water Board on all GSAs in the Subbasin, including per well charges along with additional charges per acre foot pumped. In the current agricultural economy such a charge would not be Sustainable and could potentially put small farmers out of business, create unemployment, reduce purchases of agricultural inputs, lower tax revenues, and subsequently property values.

G-2

2. **Because the San Joaquin County Board of Supervisors has diverted over $800,000 that was meant to be used for local flood control and water management projects to pay for Authority fees, most property owners are paying twice to meet SGMA requirements.**

Groundwater Sustainability Agencies (GSAs) share in the general operating and administrative cost of operating the Authority in accordance with percentages determined by the Authority Board of Directors. GSAs are solely responsible for raising funds for payment of their individual shares. The current scheme of shifting public funding designated for flood control to pay for San Joaquin County's GSA is double taxation, and by shortchanging flood control spending puts County residents at risk physically and financially from a flood incident.

San Joaquin County's GSA is comprised of unincorporated areas of San Joaquin County and the Tracy Basin. Specifically, San Joaquin County is paying its GSA fees with monies from Flood Control and Water Conservation District Zone 2, an investigation zone with the primary purpose of carrying out engineering, geologic, and other studies including the reclamation, storage, distribution, purchase, sale, use, conservation, and development of water including the management of combined surface water and groundwater supplies. Zone 2 gets its funding from agricultural landowners on a per acre charge of $.48 per acre plus a parcel charge of $.768, along with various other charges collected on beneficial properties.

More than 62% of the Zone 2 District's annual budget – $1,358,000 – is being diverted for Authority fees. Zone 2 money (according to the Zone 2 website) is being used to pay for the eastern subbasin monitoring ($138,000), GWA fee ($25,000), a GSP/SGMA consultant ($25,000), and an additional contribution to the ESJ GWA ($225,000) for a total of $413,800 for the Eastern Subbasin. Payment for the Tracy subbasin adds another $231,267 for a total of $802,840 from Zone 2.

The reason given for not assessing fees on the areas encompassed in the San Joaquin County GSA is that the Board of Supervisors did not want to address issues associated with the implementation of Proposition 218 or engage in establishing a "beneficial" district that would be subject to fees. The consequence is that others are being required to subsidize the San Joaquin GSA with their Zone 2 payments and still paying Authority assessments through the charges from their respective GSA, which is effectively double taxation. This is an equity concern for disadvantaged households and an economic hardship for small farming businesses.

G-3

3. **The Authority needs to significantly improve its communications and community engagement methods to ensure proper stakeholder engagement and that the vast array of perspectives across the Subbasin are meaningfully incorporated into regional sustainability planning efforts.**

It's been over a year since the 2023-2024 Civil Grand Jury published a scathing review of the Authority's planning activities. Many of the issues raised by the Grand Jury, including a lack of transparency and inequitable community engagement practices, remain unresolved. Jurors recommended a variety of measures to the Authority for improving accessibility and transparency (e.g. updating its website with meeting times, agendas, and minutes; disclosing financial and project information, etc.), and diversifying community engagement.

Despite these recommendations, meaningful stakeholder and community engagement efforts have remained insufficient, especially in communities like Stockton, the largest city in the subbasin and broader Sacramento-San Joaquin Delta region, which has the highest proportion of environmental justice (EJ) communities in California. Overall, nearly 30% of the Delta's population belongs to EJ communities that are disproportionately impacted by the degradation of Delta waterways. This environmental degradation affects their health, well-being, and economic opportunities.

The Authority has failed to proactively engage with Tribal Nations and Disadvantaged communities from the inception of the agency and throughout ongoing development of the overarching Groundwater Sustainability Plan for the subbasin. Both are listed as proper stakeholders in the Plan and SGMA regulations. The Plan has been in development for three years, yet meaningful outreach and community involvement only began in the final four months. This last-minute effort to engage EJ communities is unacceptable. The absence of consistent engagement from the project's onset failed to prioritize the voices and concerns of those most impacted, reinforcing a long-standing pattern of exclusion. Three meetings were originally planned, but at the most recent public meeting, when community members asked budget-related questions, they were directed to speak with county representatives privately rather than having an open discussion.

Similarly, the Authority has done little to address accessibility issues for engaging in plan development. The requirement for public comments to be submitted in writing, for instance, creates challenges for community members who lack access to the internet and computer literacy and removes a layer of transparency between communities.

Lackluster engagement and inaccessibility issues add to the history of limited public events and outreach, especially concerning the Eastern San Joaquin GSP, highlighting a systemic issue: critical EJ communities were not adequately consulted and lack of stakeholder outreach. Waiting until the final phase of a three-year process to involve these communities undermines the potential for equitable outcomes. Participation from the beginning would have advanced shared concerns while shaping groundwater sustainability planning efforts in ways that protect health and livelihood. Going forward, the Authority must adopt a more inclusive and transparent approach to ensure these communities have a meaningful role in water management decisions.

One of the Grand Jury's recommendations was for the Authority to "identify ways to better find and engage with members of disadvantaged communities (DACs), including non-English speakers, in the San Joaquin Subbasin." The Authority responded that it would consider ways to expand language access in its pending "Communications and Engagement Plan", which was to be posted within 10 days after its adoption (GJR, p. 183). As of writing, this plan has not been made publicly available.

To support the 5-year Periodic Evaluation of the GSP and development of the 2024 GSP Amendment, the Authority's Steering Committee approved the formation of a Project Management Committee (PMC), "comprising six GSA volunteers representing the varied interests in the Subbasin and covering both urban and agricultural areas" who met 20 times on a bi-monthly basis. The "20 meetings" described in the draft plan were not publicly accessible.

Further, against the recommendation of the Grand Jury, the Authority Board of Directors refused to amend its bylaws and update its website to reflect the actual meeting times of the Board. The Authority's reasoning for its lack of transparency was that board meeting frequency is variable. The Authority also refused to formalize the status of its Technical Advisory Committee as a standing committee and bring it into compliance with the requirements of the Ralph M. Brown Act. These actions show an unwillingness to integrate more diverse perspectives into the Authority's planning processes.

G-4

4. **None of the 43 groundwater sustainability projects listed in the draft plan are specifically designated to benefit South Stockton. A historically disadvantaged community that requires investments in groundwater protections (e.g. water recycling, stormwater reuse, aquifer recharge, etc.).**

The GSAs have identified 43 projects for potential development that either replace groundwater use (offset) or supplement groundwater supplies (recharge) to meet current and future water demands. Project types include direct and in-lieu recharge, intra-basin water transfers, demand conservation, water recycling, and stormwater reuse. Furthermore, the Authority failed to hold the City of Stockton accountable for not analyzing groundwater conditions thoroughly in South Stockton in order to meet environmental justice needs for this historically redlined community.

On the heels of three years of lackluster engagement with disadvantaged communities and Tribes, the list of proposed beneficial projects in the plan is, unsurprisingly, largely concentrated away from communities who have historically been harmed the most by inequitable water and land management planning. This represents a missed opportunity for project development at the intersection of groundwater recharge and floodplain restoration in San Joaquin County that could've been highly competitive for federal and state funding if environmental justice considerations had been prioritized in the initial scoping phase.

Going forward, we request that the Authority encourage member GSAs to emphasize how their proposed projects can advance environmental justice and offer meaningful community benefits, including unincorporated areas of East Stockton that fall in the County. Ideally, projects should be co-designed from the start with community-based organizations who are experts on local environmental and public health challenges. Enhancement of projects and methodology can only be accomplished with more equitable community engagement practices.

G-5

5. The plan needs to be amended to explicitly outline protections for small farmers.

In 2023, the California Legislature passed AB 779, which sets new terms for comprehensive adjudication of groundwater rights in civil court. This SGMA add-on became effective this year. It asks courts to consider the "water use of small farmers and disadvantaged communities," in SGMA-related decisions (for the purposes of the bill, small farmers are those who earn between $10,000 and $400,000 in gross income). Several areas in need of revision include subsidence and small farm protections from substantial fees and undue burdens.

Subsidence leads to undesirable results on farmland. Dr. Steven Deveral from Hydro Focus based out of Davis, CA points out in his *Simulation of Subsidence Mitigation Effects on Island Drain Flow, Seepage, and Organic Carbon Loads on Subsided Islands Sacramento–San Joaquin Delta* how subsidence is affected by groundwater pumping (Deveral, 2017). We recommend looking over this study and making sure to consider his findings when setting up a subsidence baseline to be in compliance with AB 779.

G-5

The Authority must ensure small farmers and disadvantaged communities are protected. Disproportionately burdening small farmers with fees, further meetings, and administrative processes that will have negative impacts on their small farms is a further failure of the public

G-5

trust responsibility of the Authority. With over three hundred thousand acres of agricultural land in the subbasin consideration for this stakeholder group must be research and addressed to provide proper protections for small farmers.

G-6

6. **The plan needs to explicitly address future monitoring of potential groundwater contamination risks associated with geologic CO2 sequestration site proposals in the subbasin and ensure local groundwater monitoring programs are well-integrated into existing public monitoring networks.**

The Plan lacks a section reviewing emerging industries and the potential for impacts to groundwater. Successful implementation of CO2 sequestration projects proposed in the western part of the subbasin demands careful coordination between project operators and groundwater protection efforts. To facilitate redundancy and data-sharing, extensive groundwater monitoring systems required under US EPA Class VI Underground Injection Control permits should be integrated into the existing subbasin monitoring network. Additionally, the results should be made publicly available.

G-6

The current sustainability indicators and minimum thresholds in the draft plan should be expanded to include monitoring for CO2-related impacts, including changes in groundwater acidity, pressure gradients, and water quality parameters. Regular testing for acidity levels near injection sites should be integrated into the GSP's measurable objectives with clear guidelines for corrective action if monitoring reveals potential impacts to groundwater quality and quantity. These protections are essential to prevent undesirable results and ensure the long-term viability of the region's groundwater resources.

G-6

7. **As full analysis and plans have not been completed for all GSAs, environmental justice needs and concerns have not been addressed or incorporated into basin projects, subsidence is not being accurately addressed, and misuse of public funds continue with San Joaquin County GSA operations, the plan fails to adequately define or demonstrate sustainability as required under the law.**

Conclusion

In summation, Restore the Delta has reviewed the Eastern San Joaquin Groundwater Authority's draft Groundwater Sustainability Plan and found the document with its efforts to be lacking critical components. The failure of three GSAs to develop groundwater plan, and the Authority's failure to ensure that San Joaquin County's GSA properly allocates funds place the entire subbasin at risk of sanctions. The minimal engagement of stakeholders by the Authority does not meet environmental justice requirements for SGMA as required by law, or meet the standards for public trust responsibilities of proper outreach, collaboration, and good neighbor efforts. There are no disadvantaged community projects in the County's most pollution burdened areas, and a lack of protections for small farmers. Finally, future planning for emerging industry coordination must be added to the Plan and the Authority's goals. Collectively, this Plan falls short of DWR requirements and the intentions of the purpose of state and local agency efforts. These cumulative flaws make the amendment incomplete and not to standards set by SGMA. Restore the Delta recommends deep consideration of these issues prior to submitting this plan to DWR for Subbasin certification.

Respectfully Submitted,

Michael Machado
President
Restore the Delta

Barbara Barrigan-Parrilla
Executive Director
Restore the Delta

Ivan Senock
Deputy Director

Sara Medina
Sustainable Agriculture Program Manager

Davis Harper
Carbon and Energy Program Manager

ATTACHMENT 2

SIERRA CLUB
DELTA-SIERRA GROUP
MOTHER LODE CHAPTER

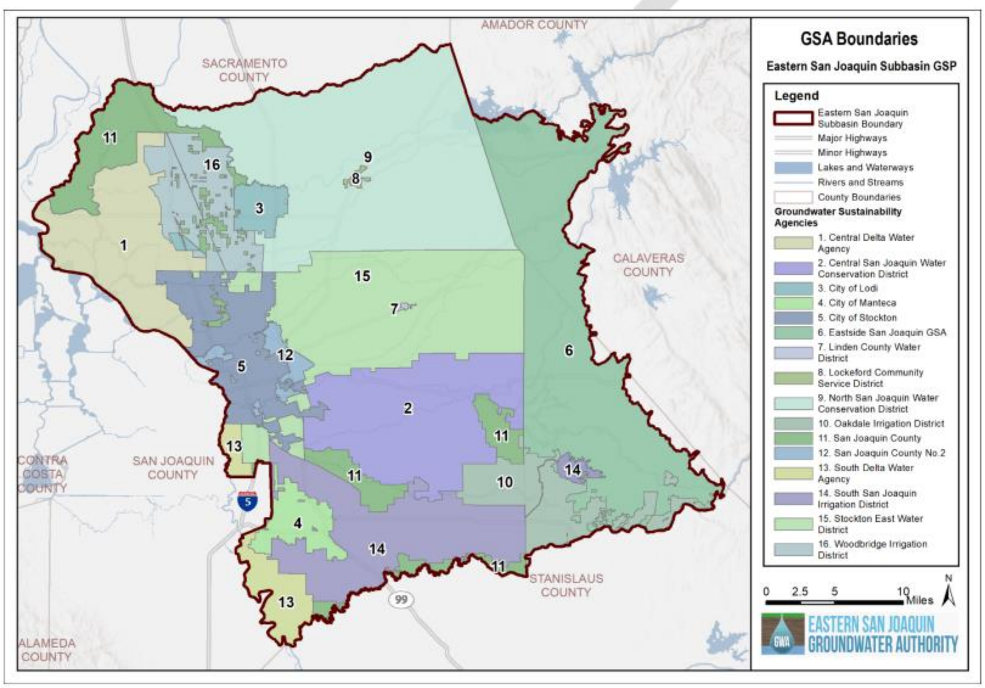
10.31.2024

Eastern San Joaquin Groundwater Authority Board
Members of the GSAs in the Eastern San Joaquin Subbasin
P. O. Box 1810, Stockton, CA 95201
via info@esjgroundwater.org

Re: Draft Eastern San Joaquin Groundwater Sustainability Plan Amendment (2024)

The Delta-Sierra Group of the Mother Lode Chapter, of the Sierra Club has over 600 members throughout San Joaquin County which includes a large portion within the Eastern San Joaquin Subbasin as shown below. The Mother Lode Chapter includes all areas within the Eastern San Joaquin Subbasin including San Joaquin County, Calaveras County and Stanislaus County. Due to the length of the Draft Eastern San Joaquin Groundwater Sustainability Plan Amendment (Draft 2024 GSP Amendment) and short review time, our comments will primarily relate to stakeholder engagement, a problem that continues affecting the ability of stakeholders to meaningfully engage in the development and implementation of the groundwater sustainability plan (GSP).

Figure 1-3: Eastern San Joaquin Groundwater Sustainability Agencies



Stakeholder Engagement

H-1

The Delta-Sierra Group (DSG) has written numerous letters regarding the availability of the draft 5-year update of the 2020 GSP and revised 2022 GSP, ad hoc technical meeting transparency, and information availability on the Eastern San Joaquin Groundwater Authority (ESJGWA) website, www.esjgroundwater.org, since the 2022 GSP update in response to the Department of Water Resources (DWR) determination that the 2020 GSP

H-1, cont.

was deemed incomplete. These DSG correspondence submittals have also been posted on the DWR SGMA Portal. The 2022-2023 San Joaquin Grand Jury reported on several issues related to monetary and information transparency which was published June 2023. While some improvements have been made, a sustained effort and systemic changes to stakeholder engagement have not occurred and continues to plague the ability of stakeholders to meaningfully engage in the development and implementation of the GSP. For example, two rounds of DWR facilitation grants for the purpose of developing an updated stakeholder communication and engagement plan have not yielded a public plan. These DWR facilitation providers assist GSAs all over the state and why a draft communication and engagement plan has not been made available in the Eastern San Joaquin Subbasin is perplexing. The ESJGWA will spend over 1 million dollars, including Zone 2 Groundwater Investigation property assessment dollars for this GSP Amendment, primarily developed, without public input. The water managers of the groundwater sustainability agencies (GSAs) have known and been working on the overdrafted aquifer for many years with limited public involvement, yet groundwater overdrafts persist. The Sustainable Groundwater Management Act (SGMA) adopted 10 years ago is the State of California's answer to persistent groundwater over pumping in critically overdrafted basins in our state, like the Eastern San Joaquin Subbasin. Since the State of California adopted the SGMA, progress has been made to increase data availability and guidance has been developed to help local water agencies move towards sustainability. Many years will be needed to achieve sustainability that responds to water use changes and hydrologic changes relating to climate change, while continuing efforts to maximize groundwater use. A well mitigation program, not yet implemented, and a demand management strategy are included in the Draft 2024 GSP Amendment with the expectation that wells will continue to go dry as the maximum groundwater use is determined until sustainable conditions are achieved.

H-2

The Draft 2024 GSP Amendment was released October 1, 2024 with a 30 day comment period consisting of fifteen documents as shown below which had not been released previously for public stakeholder review.[1]

- Notice of Intent to Adopt an Amended Groundwater Sustainability Plan
- Executive Summary (Public Draft)
- Chapter 1 Agency Information, Plan Area, and Communication (Public Draft)
- Chapter 2 Basin Setting (Public Draft)
- Chapter 3 Sustainable Management Criteria (Public Draft)
- Chapter 4 Monitoring Networks (Public Draft)
- Chapter 5 Data Management System (Public Draft)
- Chapter 6 Projects and Management Actions (Public Draft)
- Chapter 7 Plan Implementation (Public Draft)
- Chapter 8 References (Public Draft)
- Appendices (Public Draft)
  - Chapter 1
  - Chapter 2
  - Chapter 3
  - Chapter 5
  - Chapter 6

[1] https://www.esjgroundwater.org/Documents/GSP

When combined these Draft 2024 GSP Amendment documents comprise 1602 pages with an unreasonable expectation that stakeholders are going to be able to review and engage in the development of the plan with a 30 day comment period. This is disappointing and not surprising despite correspondence requests in January 2024 for a 90 day public review comment period that was included in the December 2023 ESJ 2025 GSP Update Scope of Work.[2] The Notice of Intent to Adopt an Amended Groundwater Sustainability Plan released 7.24.2024 clarified this 90 day review period and included the following statement which illustrates the restriction of information preventing all stakeholders from participating in the development of the Draft 2024 GSP Amendment.[3]

H-2, cont.

> Cities or counties that receive this notice may request in writing to consult on the proposed amended GSP. Please submit any such requests to the undersigned using the contact information below within thirty (30) calendar days of receipt of this notice.

The general public, groundwater users, domestic well owners, and small water systems which are vulnerable to groundwater overdraft due to excessive groundwater extraction for various uses, primarily agriculture, were not invited to participate in consultation meetings while the Draft 2024 GSP Amendment was developed. The three 2024 workshops: well mitigation program, communication and engagement plan development, and GSP amendment overview, were held in the late afternoon-early evening and were the first outreach meetings since 2019,before a final report was submitted to DWR. ESJGWA meetings are not forums for discussions between groundwater users and plan managers. The notion that public meetings of ESJGWA provided adequate information to make meaningful comments is not evidenced especially when presentations are not made available in advance of the meeting or in some cases following the meeting. The general public including groundwater users are seeing the report contents for the first time between 10.1.2024 and until 10.31.2024. The Sierra Club will be submitting additional comments to DWR for their consideration while reviewing the Final 2024 GSP Amendment as more than 30 days are needed to review technical aspects contained therein.

H-3

The adopted stakeholder communication and engagement plan from the 2020 GSP was not implemented after the 2020 GSP submittal to DWR. The San Joaquin 2022-2023 Grand Jury requested that by 11.1.2023 the ESJGWA develop specific methods to engage with disadvantaged communities and communication with non-English speaking groups. The ESJGWA stated in its 9.23.2023 response that a community and engagement plan was under development using a Department of Water Resources facilitation grant. A draft of this plan has not been released to the public and scant information was presented at the second 2024 outreach meeting since 2019 whose purpose was to present the communication plan and which was attended by one member of the public not affiliated with a Groundwater Sustainability Agency (GSA). Furthermore, the ESJGWA issued correspondence dated 9.11.2024 stating that a communication and engagement plan recommended by the 2023-2024 San Joaquin County Grand Jury will be adopted on 12.11.2024 by the ESJGWA.[4] This communication and engagement plan which is referenced in the Draft 2024 GSP Amendment is absent with only a placeholder, Appendix 1-H. No draft communication and

[2] ESJ 2025 GSP Update Scope of Work December 2023 link

[3] Notice of Intent to Adopt July 2024 link

[4] 2024 ESJGWA Response submitted regarding the 2023-204 San Joaquin County Grand Jury Report link

H-3, cont. engagement plan is available for public review. Without adequate public availability of information, as issues are considered, stakeholders without access to relevant information cannot meaningfully participate in the development or implementation of the adopted GSP.

H-4 The third 2024 outreach meeting since 2019 occurred on 9.25.2024 before the release of the Draft 2024 GSP Amendment and included an informative presentation slide deck which as of 10.28.2024 was not posted on the outreach page.[5] Since the third outreach meeting was for the purpose of engaging with interested stakeholders and not an agendized meeting of the governing body of the ESJWGA, the fact that material presented was not posted would not be a violation of California Government Code Title 5, Division 2, Part 1 Powers and Duties Common to Cities, Counties, and Other Agencies, Section 54957.5. Violations of this provision of not posting meeting materials in advance of the meeting or immediately after so that members of public can participate, is business as usual, in the Eastern San Joaquin Subbasin and records of how this practice inhibits participation has been documented in comments submitted at various times since before the first GSP was submitted in 2020. For example, the material presented at the 9.11.2024 ESJGWA meeting is still not posted nor are the approved 2024 meeting minutes after 3.13.2024 posted on the website.[6] Minutes posting was a practice which the ESJGWA agreed to do in response to the 2022-2023 San Joaquin Grand Jury Report on the ESJGWA policies and practices.[7]

2018 Groundwater Sustainability Workgroup Meetings Legacy

H-5 During the development of the initial GSP submitted to DWR in January 2020, a facilitation grant was obtained from DWR for the purpose of outreach and included the Stakeholder Workgroup which met after normal work hours on a monthly basis to review and discuss topics considered during the GSP development. Without a formal vote by the ESJGWA Board, no further meetings were held even though the adopted outreach plan was included in the GSP submitted to DWR both in 2020 and 2022. The last meeting with a record on the ESJGWA website was June 2019. No subsequent meetings on a quarterly/annual basis to discuss GSP implementation and reporting occurred. The Draft 2024 GSP Amendment continues to reference this outreach effort from five years ago and while it was a good example of outreach, the outreach ended five years ago without a replacement. The Draft 2024 GSP Amendment stated "The Workgroup included members from a variety of organizations who represent one or more of the interested parties' groups. Table 1-4 lists the organizations and interests represented on the Workgroup. While this Workgroup was not active during the 2024 GSP amendment process, the information collected during **their involvement remains relevant and a guiding factor in this update and GSP implementation**." (emphasis added)

The Final 2024 GSP Amendment should include a summary of the referenced information that was deemed relevant from June 2018- August 2019 that was relied upon during the development of the Draft 2024 GSP Amendment. Include an explanation of how the Workgroup would have guided the restriction of draft information availability during this update when the Workgroup was able to review draft chapters during their review process.

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[5] Five-Year GSP Update and Amendment Meeting and Outreach webpage as of 10.28.2024

[6] ESJGWA Meeting Agenda webpage as of 10.28.2024

[7] 2023 ESJGWA Response submitted regarding the 2022-2024 San Joaquin County Grand Jury Report link

H-5, cont. Finally, as many conditions have changed since 2019, how has the stakeholder workgroup thoughts from more than five years ago relevantly guided GSP implementation?

H-6 "The original goals of the 2018 Outreach and Engagement Plan are still relevant in the recent iterations of this plan". The 2018 plan is the only adopted public plan though never it was never fully implemented despite these bulleted statements:

- Keep an interested list of stakeholders informed and aware of opportunities for involvement through email communications and/or their preferred mode of communication.

On multiple occasions the DSG has requested that meetings that have a zoom/teams videoconferencing component be recorded for stakeholders that are unable to attend daytime meetings to view the meeting contents and discussions at a preferred time. Please include in the Final 2024 GSP Amendment how meeting recordings will be incorporated into stakeholder communications.

H-7

- Engage DWR for facilitated support to aid in the development of the GSP

Multiple emails were sent to the current DWR facilitation support staff which were not returned. Please provide clear directions to stakeholders about communication expectations between ESJGWA staff and the public in the Final 2024 GSP Amendment.

H-8

- Open ESJGWA planning efforts to the public with agendas and meeting minutes published on the ESJGWA website

Minutes are not separately published after approval nor are presentations included with the agenda posting so that stakeholders unable to attend the meeting can submit relevant comments for consideration prior to ESJGWA Board/Steering Committee actions. The Final 2024 GSP Amendment should include a discussion about how open meetings can be facilitated when meeting materials are not posted in advance of the meeting.

H-9

- Inform and obtain comments from the general public through public meetings held on an approximately quarterly basis

There are no regular evening meetings either quarterly nor annually in coordination with the submittal of the annual report to inform and obtain comments other than at the ESJGWA Board or Steering Committee meetings that are infrequently held and often cancelled as evidenced in the meeting website record referenced previously. ESJGWA Board of Directors or Steering Committee meetings are very rarely held for purposes of a workshop.

H-10

- Facilitate productive dialogue among participants at Advisory Committee, Workgroup, and public meetings

A dialogue regarding information availability and public attendance at ad hoc technical advisory committee (ad hoc project management committee) began on 9.11.2024 during an ESJGWA meeting, then staff counsel interrupted the dialogue resulting in the acting chair of the meeting to remind staff counsel of the ability of ESJGWA Board members to ask questions. Again, this dialogue, albeit limited, occurred at the prerogative of a ESJGWA Board member, and was not recorded. The Final 2024 GSP Amendment must include the methodology by which these productive dialogues will be facilitated and the means by which recordings will be made available for stakeholders unable to attend live meetings.

- Provide timely and accurate public reporting of planning milestones through the distribution of outreach materials and posting of materials on the ESJGWA website
H-11 for the GSP.

Draft annual reports are not available to review before adoption by the ESJGWA. The Final 2024 GSP Amendment should describe the public review processes of various planning milestones that will occur at intervals throughout the implementation of the GSP and which are reviewed during the annual plan development process.

The California Department of Water Resources (DWR) released in October 2023 a report, "A Guide to Annual Reports, Periodic Evaluations, & Plan Amendments", which provides guidance when developing required reports.[8] This guidance document includes some consideration about when an amendment is to be prepared one of which is "a GSA may determine to amend a Plan to incorporate changes or additions that are desirable or necessary to comply with public disclosure and stakeholder engagement requirements or policies."

The possibility exists that some of these communication and engagement issues may be
H-12 related to lack of knowledge and understanding rather than a deliberate disregard to the SGMA outreach requirements and good governance.[9] As the implementing agency for the GSP, the ESJGWA cannot hide behind the SGMA language that the GSAs are the primary agency responsible for outreach as was mentioned several times in responses to the 2022-2023 San Joaquin County Grand Jury report. This is not to say that all GSAs are not doing some outreach communications and providing opportunities to engage. However, the GSA with the largest population of residents, some of which pay the highest fees for water, the City of Stockton GSA, do not hold regular meetings to discuss the GSP implementation and monitoring. The City of Stockton held a very rare meeting on 10.2.2024 (one day after the public Draft 2024 GSP Amendment release date) of their Water Advisory Group to recommend that the City Council Water Committee consider adoption of the 2024 GSP Amendment. Then the City Council Water Committee on 10.10.2024 approved the motion 2024-10-10-0302 adopting the GSP and authorizing the ESJGWA to submit the GSP to the DWR before even a final report was prepared. [10]

Perhaps, DWR would be willing to present to the GWA and all GSA members information contained in their guidance documents regarding stakeholder outreach to ensure that stakeholders can meaningfully engage in the development and implementation of groundwater sustainability plans.

- Maintain an active communications tracking tool to capture stakeholder engagement and public outreach activities and to demonstrate the reporting of GSP outreach

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[8] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/GSP-Implementation-Guidance-Report.pdf

[9] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Assistance-and-Engagement/Files/Guidance-Doc-for-GSP---Stakeholder-Communication-and-Engagement.pdf

[10] Draft Minutes 10.10.2024 accessed 10.31.2024 https://stockton.granicus.com/GeneratedAgendaViewer.php?view_id=58&clip_id=8824

activities through the use of qualified facilitators to obtain, consider, and integrate feedback accordingly throughout the planning process.

H-12, cont.

Note in October 2023, the DSG discovered that not only are there never any responses to correspondence that we submit but that the "official email address" for the GWA was not being monitored and that was the email that all SGMA Portal comments were then being sent. Additionally, comments that were addressed to ESJGWA and all GSA members may not be distributed to all GSA members as a California Public Records Act request to a GSA did not yielded after 21 days, a letter which we submitted to the ESJGWA addressed to all GSA members on 9.11.2024.[11]

Ad Hoc Committees and Public Information

All of the discussions of drafts throughout the plan amendment development process were not public, instead utilizing an ad hoc project management committee formed by the ESJGWA Board of Directors Chair. According to the ESJGWA these technical ad hoc committee meetings do not have to be open to the public because the ad hoc committee are formed for specific purposes and for a limited amount of time.

The ESJGWA ad hoc project management committee formed in December 2023 included six GSA staff representing agricultural and urban interest which met bi-monthly for an unspecified amount of time. This ad hoc project management committee not only reviewed and guided the GSP amendment development process but was also tasked with coordinating other SGMA implementation efforts including the development of a well mitigation program, coordinating stakeholder outreach and engagement, and annual and long-term budgeting, reviewing draft work products and other meeting materials. These meeting materials and draft work products were never made public to allow stakeholders the same access to information on a regular basis throughout the development process.

H-13

The ESJGWA ad hoc project management committee that did not hold open meetings was also responsible for recognizing and flagging items requiring discussion and directions from "stakeholders", the ESJGWA Steering Committee and Board of Directors. This ad hoc project management committee seems to have a considerably greater focus than a reasonable person would describe as a narrow focus and meetings should have been public. No disclosure of the "stakeholders" that were involved in these discussions or were any of the recommended directions that these "stakeholders" provided was disclosed in the Draft 2024 GSP Amendment. During the 9.11.2024 ESJGWA meeting there was expressed a desire for this group to continue beyond the plan amendment period.

The ad hoc project management committee membership was disclosed in the ESJWRM Version 3.0 Model Update dated October 2024 that was included as part of the Draft 2024 GSP Amendment. These six individuals were consulted during meetings closed to the public regarding the model update on which many decisions regarding the condition of the subbasin are based. Additionally, individual GSAs were not consulted directly during this Eastern San Joaquin Water Resources Model (model) update. Whether or not GSA staff, not members of the ad hoc project management committee, were allowed to listen in on these model development and refinement meetings was not specifically disclosed. The

[11] CA PRA Information not found

importance of the model refinement and assumptions cannot be stressed enough because the model is the basis for decision making and determining when sustainability is achieved:

H-13, cont.

- Developing understanding of Subbasin inflows, outflows, and change in storage under variety of conditions and planning horizons (historical, current, future)
- Understanding of current and historical groundwater storage and depletions of interconnected surface water
- Estimating Subbasin sustainable yield
- Evaluating impact of demand reduction on Subbasin sustainability
- Evaluating impact of climate change on Subbasin sustainability
- Developing or evaluating Sustainable Management Criteria (SMC) for groundwater levels, groundwater storage, and depletion of interconnected surface water
- Evaluating projects and management actions needed to reach sustainability
- Providing information on Subbasin data gaps or focus needs

H-14

The annual update on the model is estimated to cost $100,000. The Final 2024 GSP Amendment should include a schedule of workshops regarding the model that are held on zoom/teams and that are recorded so that members of the public can have a better understanding of the consequences of various assumptions. Additionally, there should be an avenue by which stakeholders can discuss questions and concerns regarding the model.

H-15

Model updated assumptions were considered, with and without climate change, to develop projected conditions baseline with demand reduction and with projects and management actions. In order to “fit” the model to zero average annual storage changes, two assumptions were used and disclosed:

- Urban Demand: Urban per capita water use was reduced by 15% under both model conditions. **This reduction is not indicative of how potential future urban demand cutbacks may be implemented**.
- Agricultural Demand: Agricultural groundwater pumping was reduced in areas further than one (1) mile from streams by reducing agricultural acreage. Larger users of agricultural groundwater in ESJWRM were reduced at higher percents compared to smaller users. **This reduction is not indicative of how potential future agricultural demand cutbacks may be implemented**.

H-16

The conditions and assumptions used for the climate change baseline included DWR climate related guidance using a future scenario of 2070 climate forecasts that combined 10 global climate models (GCMs) for two different representative climate pathways to generate central tendency scenarios in the datasets used in this analysis. Discussions about these conditions and assumptions with the general public are needed to increase understanding of expected changes in conditions, particularly when making assumptions that may or may not be implemented regarding changes in water use within the subbasin. The Final 2024 GSP Amendment should include a description of these climate pathways developed by DWR as there may be other applications of these pathways as communities develop climate resiliency plans and NOAA releases updated precipitation frequency estimates. Communities in San Joaquin, Stanislaus, and Calaveras counties have

H-16, cont.

experienced in the last five years the hottest temperatures, longest droughts, and intense precipitation storms causing flooding and loss of life.

H-17

How or if this guiding ad hoc program management committee considered the disadvantaged communities throughout the Eastern San Joaquin Subbasin was not disclosed though a map of those areas deemed disadvantaged by the State of California was provided in the Draft 2024 GSP Amendment as included below.

Figure 1-8: Disadvantaged Communities (DACs)

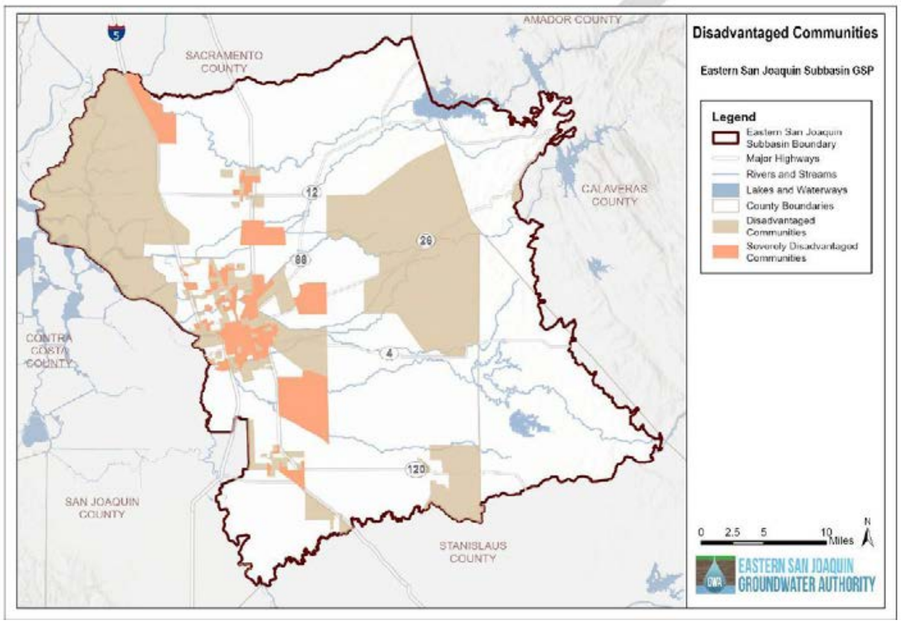
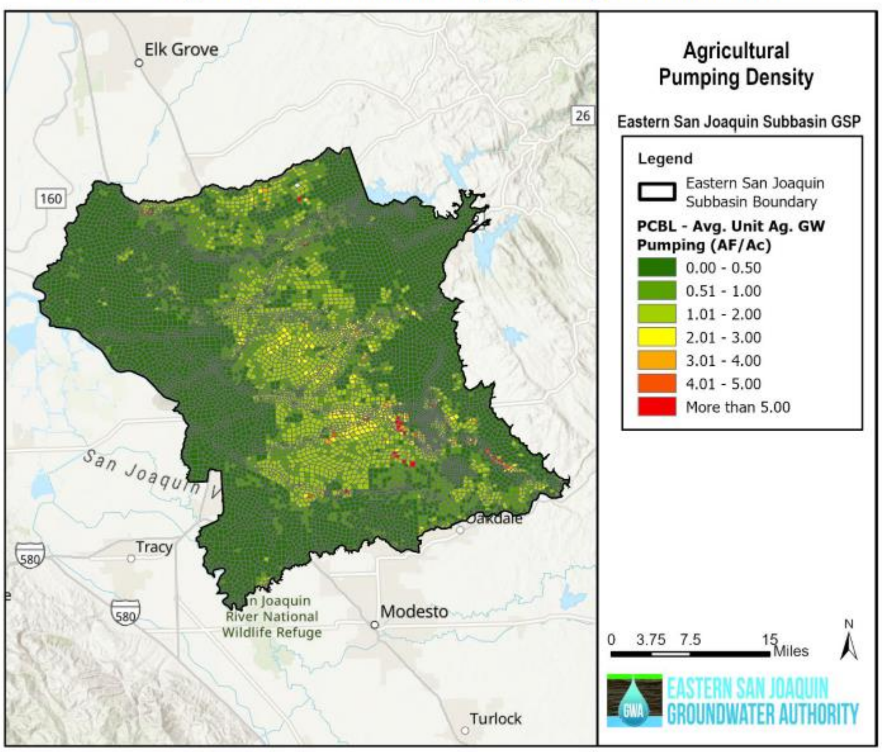


Figure 52: Agricultural Groundwater Pumping Density for PCBL Version 3.0



Large proportions of the eastern disadvantaged communities in the subbasin are co-located where the greatest decrease in groundwater levels have occurred related to over pumping of groundwater. The over pumping in these rural area in eastern San Joaquin County is principally related to agricultural development as shown in the groundwater pumping density diagram from the model for conditions where there was the assumption of demand reduction which may or may not be a program that is developed and/or implemented.

Over pumping groundwater not only impacts disadvantaged communities but all well owners can be significantly affected when a well goes dry or decreased yields experienced.

The 7.6.2023 DWR determination that the 2022 Revised GSP was approved, included within the Draft 2024 GSP Amendment, recommended that several corrective actions be incorporated into GSP updates including the human right to water and protective minimum thresholds. Technical Memorandum No. 1 – Groundwater Levels (TM-1) dated 10.1.2024 described the updated approach to minimum threshold above which undesirable results should not occur. Release of this TM-1 that while dated 10.1.2024 was reported to have been completed months ago, in advance of 10.1.2024, would have been an important gesture of an openness and transparency during the GSP development process.

The 2024 minimum thresholds overall were deemed more protective of drinking water sources. The 23 representative monitoring wells shown on the map below are those whose water depth is the basis of determining if the sustainable goals are achieved. The TM-1 stated that new minimum thresholds were included in the Draft 2024 GSP Amendment with six of the representative monitoring wells having new groundwater minimum threshold levels which were increased by an average of 7.6 feet, and three wells having new minimum threshold levels which were lowered by an average of 1.7 feet. Also reported was the installation of new nested monitoring wells to fill some data gaps. When comparing the areas of heavy agricultural groundwater extraction, disadvantaged communities, and well distribution, concerns remain that "no undesirable results" can be a paper exercise even with considering an extended radius around the representative monitoring wells.

H-17, cont.

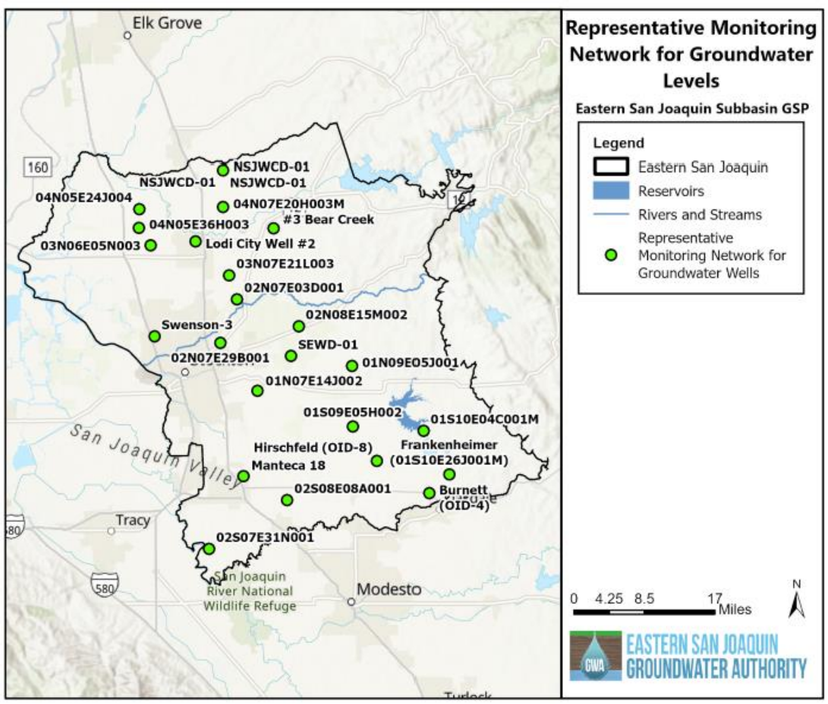


Figure 1: Representative Monitoring Network for Groundwater Levels

The ESJGWA Board maintains that the domestic well and small water system drought readiness relating to SB552 implementation is a San Joaquin County project having nothing to do with the SGMA. DWR specific guidance regarding the relationship between the SGMA and SB552 was provided in links to the County and ESJGWA.[12] There have

[12] Alignment and Coordination Water Shortage Planning for Rural Communities and Sustainable Groundwater Management. March 2023

H-17, cont.

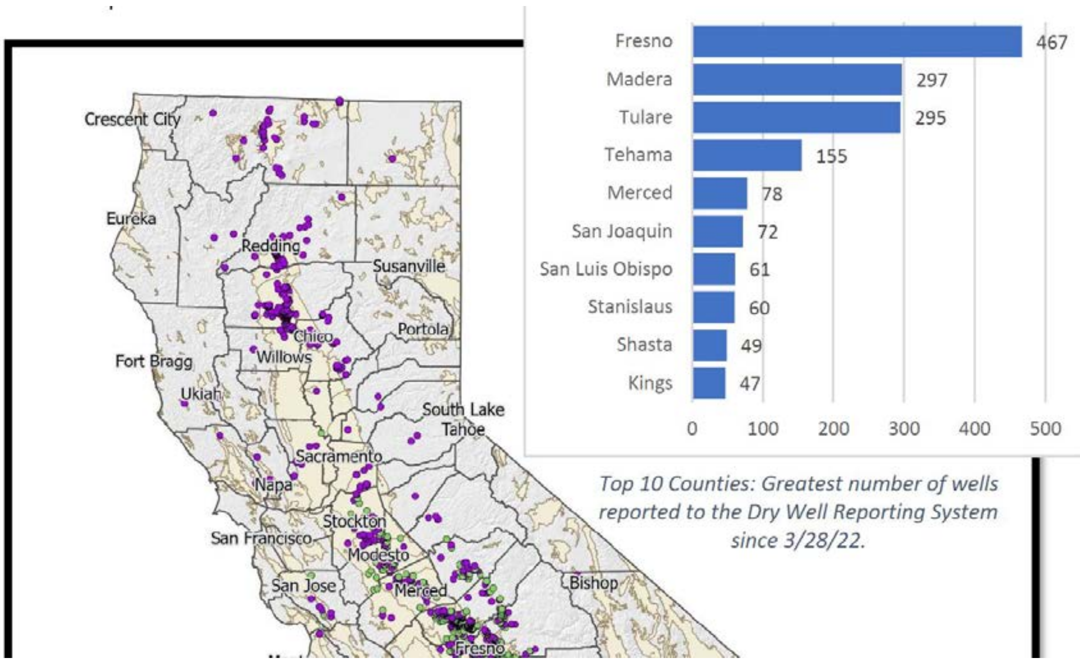
been no public meetings resembling a domestic well and small water system drought task force other than a verbal presentation by OES/SJC Public Works at a San Joaquin Advisory Water Commission meeting last summer. The San Joaquin Advisory Water Commission that meets rarely was suggested to be the forum for the drought domestic well and small water system task force. The Final 2024 GSP Amendment must include a discussion of how this coordination and alignment outlined in DWR guidance will be implemented.

H-18

The ESJGWA Board of Directors have continued to attest that the Subbasin did not experience significant numbers of dry wells as included in the Resolution adopting a dry domestic well mitigation program.

The DSG has submitted periodically screenshots from the DWR My Dry Well database and submitted comments in April 2024 which included the following regarding dry wells in addition to recommendations and comments regarding the draft dry well mitigation program.

> On March 6, 2024, the DWR released *Groundwater Well Permitting Report - Observations and Analysis of Executive Orders N-7-22 and N-3-23* which included San Joaquin County in the top 10 counties with dry wells since March 28, 2022 as shown below.[13] These DWR dry well data are reported voluntarily and would not include reports by individuals within a GSA.



> While San Joaquin County groundwater users have not experienced dry wells as frequently as Fresno County, San Joaquin County experienced 20% more occasions of a well going dry than neighboring Stanislaus County. Once again, we disagree with the characterization that "the GSAs in the Eastern San Joaquin Subbasin have not experienced significant dry well reports as reported by the State of California Dry Well Reporting System or as reported by individuals within the GSAs."

[13] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Wells/Files/DWR-Well-Permitting-Analysis-Final_March2024.pdf?utm_medium=email&utm_source=govdelivery

H-19 A well mitigation program was adopted by the Board of Directors of the Eastern San Joaquin Groundwater on 9.11.2024 and included in Appendix 3-J. The DSG submitted comments regarding drafts of the well mitigation program. Once a draft program was drafted and made available for review, the DSG received no indication that the submitted comments were received or considered. The DSG looks forward to opportunities to provide comments as the dry well mitigation is implemented and processes developed.

H-20 The Final 2024 GSP Amendment should include a dated and finalized dry domestic well mitigation program and a timeline for the program implementation with specific steps that can be monitored for accountability. The DSG appreciates the efforts of the North San Joaquin Water Conservation District including Steve Schwabauer and Jennifer Spaletta for their leadership in drafting up an initial concept outline for the program which has been requested for many years and which we were invited to comment along with Clean Water Action on the initial concept outline. An acknowledgement was received but further opportunities to be involved in discussions/dialogues were not presented other than formal comments which were submitted in March and April 2024 by the DSG. A response to comments or a disclosure of comments received was not provided. Of course, a California Public Records Act request can be made but since the SGMA specifically included a requirement to engage with stakeholders in the development and implementation of GSPs, the expectation is that information would be readily available to interested parties without the need for a formal PRA submittal to county counsel.

Please reach out to discuss any issue which has been presented and we look forward to reading the Final 2024 GSP Amendment and submitting comments to DWR.

Sincerely,

Mary Elizabeth M.S., R.E.H.S.,
Delta-Sierra Group, Conservation Chair, Sierra Club
Melizabeth.sierra@gmail.com

Margo Praus
Delta-Sierra Group Chair, Sierra Club

cc: Sean Wirth, Mother Lode Chapter Conservation Chair, Sierra Club

ATTACHMENT 2

Stockton Environmental Justice
Education and Advocacy

Eastern San Joaquin Groundwater Authority Board 10.31.2024
Members of the GSAs in the Eastern San Joaquin Subbasin
P. O. Box 1810, Stockton, CA 95201
via info@esjgroundwater.org

Re: Draft Eastern San Joaquin Groundwater Sustainability Plan Amendment (2024)

While celebrating homecoming and the 100 year anniversary of the University of the Pacific in Stockton, CA I heard a talk by the Stockton Poet Laurate, Jazmarie LeTour, about voices and advocacy and was inspired to write this poem.

Ode to Outreach

Same Old, Same Old, Same Old

Broken record that skips, skips, skips

I-1 Over the parts that allow all groundwater users to meaningfully engage with the development and implementation of the plan, the plan, the plan

For what, for what, for what

Expediency, privacy, withholding of power, because we know better, and you know your place, know your place, know your place

By Mary Elizabeth, October 16, 2024

Please do better because the stakeholders in the Eastern San Joaquin Subbasin are valuable components of sustainable solutions.

Sincerely,

Mary Elizabeth, M.S., R.E.H.S.
melizabeth.sierra@gmail.com

APPENDIX 1-J.
RESPONSE TO PUBLIC COMMENTS

Comment #	Commenter Name	Organization Represented	Date Comment Received	Response
A-1	Brent Barton	Barton Ranch	10/3/2024	It continues to be the intent and overarching goal of the Subbasin to reach sustainability through the implementation of projects. It is the responsibility of individual GSAs to plan for, fund, and implement projects that best meet their needs. The Demand Management Program is designed to be a backstop in the event that projects are not sufficient in helping the Subbasin reach sustainability.
B-1	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	An expanded explanation of the data limitations to identifying potential GDEs was included in Appendix 3-C to include the lack of monitoring wells near GDEs. This is highlighted more clearly as a data gap within the GSP. This data gap will be filled by a commitment, on the part of the GSAs, to doing a field verification exercise at identified potential GDEs to evaluate water source and species present. This field verification will be completed by the 2030 Periodic Evaluation.
B-2	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	Once the field verification study is complete ahead of the 2030 Periodic Evaluation, the results of the study will inform what type of Projects & Management Actions might be needed to reduce impacts on the identified GDEs. This PMA would be included in a 2030 GSP Amendment, if it is needed.
B-3	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	As noted by CDFW, because of the lack of groundwater level data and site-specific surface water availability information, it is a challenge to differentiate a potential GDE that has partial reliance on GW with the current toolset available. Field verification of potential GDEs planned to address these data gaps will provide valuable information to confirm presence of GDEs and associated water availability.
B-4	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	Figure 3 in the ISW TM displays the percentage of time that streams are connected in the ESJWRM. The text was revised to reflect that 75% connectivity time does not indicate if streams are considered ISWs or not, but is rather used as a comparison point for the analysis since the model outputs show that most of the major rivers are connected at least 80% of the time historically. Additionally, due to insufficient shallow groundwater data near surface water courses in the Eastern San Joaquin Subbasin, there is significant uncertainty in model calibration and the identification of interconnected surface waters (ISWs), which is required by GSP regulations. This will be reevaluated in the 2025 Periodic Evaluation, as mentioned in the response to comment B-10.
B-5	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	The analysis of small streams and creeks in the 2024 GSP Amendment was limited by data availability, not by the use of streams/creeks for irrigation conveyance. Major streams and creeks are included in the ESJWRM model and calibrated with observed streamflow data. Several small streams and creeks do not have gages on them, which makes data input and calibration more challenging. The ISW TM will be amended to reflect that small streams and creeks were excluded because of data availability and the identification of these water bodies for ISW analysis will be included as a data gap.
B-6	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	The GSAs currently do not have the tools required to confidently establish an SMC based on volume, timing, and rate of depletions due to groundwater pumping. In the absence of timely DWR guidance, groundwater levels are used for the ISW SMC since they can be directly measured and facilitate proactive monitoring and management of stream depletions, without depending on model simulations with a degree of uncertainty. As mentioned in the response to comment B-10, additional ISW analyses will be conducted before the next 5-year GSP update.
B-7	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	Before publicly displaying the simulated stream-aquifer interactions on a sub-reach and monthly scale, additional streamflow and groundwater level data from shallow perforate wells should be collected to validate and increase certainty in the spatial and temporal findings on a refined scale. A refined analysis of ISW is noted as a data gap. Additionally, the frequency of monitoring of some ISW RMN wells will be increased with transducers funded from the ARPA to enhance understanding of stream-aquifer interactions and model calibration.

Comment #	Commenter Name	Organization Represented	Date Comment Received	Response
B-8	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	Statements related to avoiding undesirable results because of rising Chinook salmon population in 2015 will be removed and the complexity of survival rates, spawning success, habitat availability, and other factors will be noted.
B-9	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	Interim methodologies were considered during development of the ISW, however were excluded for various reasons. At the time of analysis, there were no groundwater level observations since the wells are newly installed. There were insufficient nearby wells with shallow perforations and recent groundwater levels that could be used as a proxy. Lastly, simulated groundwater levels were not used to determine the SMCs since the ESJWRM is not calibrated to the level of certainty to solely establish ISW SMCs. Ultimately there are insufficient data to establish SMCs and a stable target to which to manage groundwater resources. Groundwater level observations at the new ISW representative monitoring network wells will be shared via Annual Reports and used to develop SMCs in the methodology described in the ISW TM.
B-10	Morgan Kilgour	California Department of Fish & Wildlife	10/30/2024	The ISW has been updated to include a commitment to reevaluating the ISW undesirable result and SMCs, with supporting analysis from the ESJWRM, before the next 5-year Periodic Evaluation. This allows for adequate time to include the latest DWR ISW guidance and ESJWRM model improvements.
C-1	Mitchell Maindrand	City of Stockton	10/1/2024	Edits have been incorporated in the Periodic Evaluation, Executive Summary, Chapter 6, and Chapter 7.
C-2	Mitchell Maindrand	City of Stockton	10/1/2024	Edits have been incorporated in the Periodic Evaluation, Executive Summary, Chapter 6, and Chapter 7. Note that although this will be listed as a Category A project, it will not be modeled.
D-1	Bana Rousan-Gedese	Calaveras County Water District	10/21/2024	Edits have been incorporated into Executive Summary.
D-2	Bana Rousan-Gedese	Calaveras County Water District	10/21/2024	Edits have been incorporated into Chapter 1.
D-3	Bana Rousan-Gedese	Calaveras County Water District	10/7/2024	Edits have been incorporated into Chapter 1.
D-4	Michael Minkler	Calaveras County Water District	10/31/2024	Comment noted. Wells that were previously in the Broad Monitoring Network can still be monitored and their data submitted to DWR.
D-5	Michael Minkler	Calaveras County Water District	10/31/2024	These are part of the new WQ network to provide vertical resolution of WQ in this part of the basin. Expectations are that these wells will be monitored for TDS and Chloride bi-annually. The GWA has contracted with Condor to complete this monitoring for the Subbasin. The monitoring will be billed to the appropriate agencies going forward.
D-6	Michael Minkler	Calaveras County Water District	10/31/2024	If these wells were part of the CASGEM reporting requirements, they will still be monitored and reported bi-annually as they have been historically. This data will continue to be available for any additional analysis of groundwater trends. Wells in the representative network are used to evaluate against sustainable management criteria under SGMA. CCWD has not had any representative monitoring network wells in the GSP to date including the 2024 Plan Amendment, but this can be reconsidered in the future.
D-7	Michael Minkler	Calaveras County Water District	10/31/2024	Analysis as part of the annual report looks at all wells with available data to assess groundwater conditions, beyond the representative monitoring networks. The representative wells are primarily used for assessing progress toward sustainability for the groundwater levels indicator.
D-8	Michael Minkler	Calaveras County Water District	10/31/2024	Comment noted. All GSAs are encouraged to continue pursuing projects that can support Subbasin sustainability.

ATTACHMENT 2

Comment #	Commenter Name	Organization Represented	Date Comment Received	Response
E-1	Pat Dunn	NV5	10/22/2024	CCWD wells were part of the Broad monitoring network. The broad monitoring network was not used to evaluate progress toward sustainability and did not have SMC. To streamline monitoring efforts, the Broad monitoring network was removed from the GSP. Figure 4-5 has been replaced to remove reference to the Broad network, making it consistent with Tables 4-1 and 4-4.
F-1	Mary Elizabeth	Delta-Sierra Group of Sierra Club	9/11/2024	The Dry Domestic Well Mitigation Program was provided in the Public Draft as Appendix 3-J. The final GSP, once approved by the GSAs, will be posted on the esjgroundwater.org website.
F-2	Mary Elizabeth	Delta-Sierra Group of Sierra Club	9/11/2024	All GSAs are encouraged to add groundwater resources available to their residents on their respective webpages, including the Dry Domestic Well Mitigation Program documents.
F-3	Mary Elizabeth	Delta-Sierra Group of Sierra Club	9/11/2024	The GWA agrees that public engagement is important for an effective GSP. The Communication & Engagement plan being prepared under the DWR facilitation support services grant will address how the GWA can better reach more stakeholders.
G-1	Michael Machado, Barbara Barrigan-Parrilla, Ivan Senock, Sara Medina, Davis Harper	Restore the Delta	10/31/2024	It continues to be the intent and overarching goal of the Subbasin to reach sustainability through the implementation of projects. It is the responsibility of individual GSAs to plan for, fund, and implement projects that best meet their needs.
G-2	Michael Machado, Barbara Barrigan-Parrilla, Ivan Senock, Sara Medina, Davis Harper	Restore the Delta	10/31/2024	We understand the concerns regarding the diversion of funds and the impact on property owners. It is important to note that the administrative processes are designed to be equitable and consistent for all stakeholders. The goal is to ensure that everyone is subject to the same rules and procedures, which helps maintain fairness across the board. Additionally, Authority fees are essential for the successful implementation of the Sustainable Groundwater Management Act (SGMA). These fees support the necessary infrastructure and management efforts to achieve sustainable groundwater management, benefiting the entire community.
G-3	Michael Machado, Barbara Barrigan-Parrilla, Ivan Senock, Sara Medina, Davis Harper	Restore the Delta	10/31/2024	Using a Facilitation Support Services grant from the Department of Water Resources, the GWA worked over the spring, summer, and fall of 2024 to solicit input and develop an updated Communication & Engagement Plan. This C&E Plan, provided as Appendix 1-H in the Final 2024 GSP Amendment, addresses how the GWA can improve its communications and community engagement efforts.
G-4	Michael Machado, Barbara Barrigan-Parrilla, Ivan Senock, Sara Medina, Davis Harper	Restore the Delta	10/31/2024	Note that the City of Stockton has been pursuing grand funding to acquire funding for smart metering in South Stockton. PMAs that achieve groundwater sustainability benefit the entire basin, including South Stockton.

Comment #	Commenter Name	Organization Represented	Date Comment Received	Response
G-5	Michael Machado, Barbara Barrigan-Parrilla, Ivan Senock, Sara Medina, Davis Harper	Restore the Delta	10/31/2024	We have reviewed the paper by Deverel (2017) and acknowledge that the land and water use subsidence mitigation strategies proposed in the paper may present additional challenges such as potential water quality effects, infrastructure investments, and the potential loss of agricultural income due to altered land use or reduced crop yields. However, these issues fall outside the scope of this GSP as they involve altering land use practices, which is beyond the purview of the Sustainable Groundwater Management Act. Any land use decisions proposed to offset subsidence and achieve the subbasin's groundwater sustainability goals would require coordination between land use planning and groundwater management entities. These decisions must also ensure that the water use and accessibility of water for small farmers and DACs are still being considered, in accordance with AB 779. Regarding administrative burdens on small farmers, the public engagement process is designed to be inclusive and open to everyone, ensuring that all voices are heard. While we understand the concerns about the impact on small farmers, it is essential to have consistent administrative rules to maintain fairness and equity across the board. We are committed to finding a balance that supports small farmers while upholding these principles.
G-6	Michael Machado, Barbara Barrigan-Parrilla, Ivan Senock, Sara Medina, Davis Harper	Restore the Delta	10/31/2024	Geologic CO2 sequestration projects fall under the California Environmental Quality Act (CEQA), which mandates additional monitoring. The Regional Monitoring Network (RMN) will oversee a regional and programmatic approach, rather than focusing on project-specific monitoring. Your concerns about integrating local groundwater monitoring programs and ensuring transparency with US EPA Class VI Underground Injection Control permits are noted and ideally regular testing for acidity levels near injection sites will be monitored on a project level through CEQA, outside of the GSP process.
H-1	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GWA agrees that public engagement is important for an effective GSP. The Communication & Engagement plan being prepared under the DWR facilitation support services grant will address how the GWA can better reach more stakeholders.
H-2	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	There is no requirement under SGMA that Subbasins release the GSP for public comment prior to GSA adoption and submittal to DWR. As noted by the commenter, DWR holds a 30-day public comment period once the approved GSP is received by DWR.
H-3	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The Communication & Engagement plan being prepared under the DWR facilitation support services grant will address how the GWA can better reach more stakeholders. This plan will be provided with the final compiled GSP.
H-4	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GSAs appreciate the commentor bringing this to the attention of the GWA; these materials are now posted. The posting of meeting materials is discussed in the Communication & Engagement (C&E) plan.
H-5	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	Because the 2024 GSP Amendment is an amendment to the 2020 GSP, work completed as part of the 2020 GSP remains relevant unless otherwise redlined or updated. Thus, components that the Workgroup meaningfully contributed to during the 2018-2019 stakeholder process remain relevant to the 2024 GSP Amendment. This includes the development of the Eastern San Joaquin Water Resources Model (ESJWRM), the development of the representative monitoring networks, the process for setting sustainable management criteria, and the development of projects and management actions, among other technical components. Technical aspects of amended components were discussed with the Project Management Committee (PMC) and administrative draft documents were provided to the GSAs during an Admin Review period. After GSA comments were addressed, the GSAs then released the Public Draft on October 1 for a 31-day public comment period. As noted by the commentor, DWR will also be providing an additional public review period within 20 days of receiving the 2024 GSP Amendment.

Comment #	Commenter Name	Organization Represented	Date Comment Received	Response
H-6	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GWA is in the process of re-evaluating how it plans to implement the new elements of the 2024 GSP Amendment, including the Communication & Engagement (C&E) plan. The commentor's concern related to recording meetings has been noted.
H-7	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GWA is in the process of re-evaluating how it plans to implement the new elements of the 2024 GSP Amendment, including the Communication & Engagement (C&E) plan. The commentor's concern related to clarifying communication expectations has been noted.
H-8	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GWA is in the process of re-evaluating how it plans to implement the new elements of the 2024 GSP Amendment, including the Communication & Engagement (C&E) plan. The commentor's concern related to posting meeting materials in advance has been noted.
H-9	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GWA is in the process of re-evaluating how it plans to implement the new elements of the 2024 GSP Amendment, including the Communication & Engagement (C&E) plan. The commentor's concern related to hosting quarterly public meetings has been noted.
H-10	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GWA is in the process of re-evaluating how it plans to implement the new elements of the 2024 GSP, including the C&E plan. These concerns about GWA process and governance have been noted and will be considered as part of that restructuring.
H-11	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GWA is in the process of re-evaluating how it plans to implement the new elements of the 2024 GSP, including the C&E plan, Dry Domestic Well Mitigation Program, and the demand management program.
H-12	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	Information related to stakeholder engagement and public outreach activities conducted by the GSAs is reported each year in the Subbasin's Annual Report, which is submitted to DWR by April 1.
H-13	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	A list of PMC members have been incorporated into Chapter 1, Section 1.1.4.2.
H-14	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The GWA will soon begin the process of outlining a more detailed development schedule for the Demand Management Program, which it anticipates will include a series of workshops and opportunities for public participation and engagement.
H-15	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The assumptions made for urban and agricultural demand are preliminary in the 2024 GSP Amendment and were used as an initial assumption to provide a starting point from which demand management program discussions could begin. The GWA is planning to outline a more detailed schedule during which these numbers will be refined. This will be designed to be an iterative process to ensure broad agreement on the methodology and ensure the latest data is incorporated.
H-16	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	An explanation of the global climate models used by DWR is included in Appendix 2-B of the 2024 GSP Amendment.
H-17	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	San Joaquin County is responsible for implementing the requirements of SB552. Given the County's membership in the ESJGWA as a GSA, the ESJGWA will coordinate with and support the County where needed. The Dry Domestic Well Mitigation Program included in the 2024 GSP Amendment shares similar goals to those expected as a result of SB552 implementation.
H-18	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The number of dry wells reported by the state for San Joaquin County are reported annually in the GSP's annual report. In San Joaquin County there were 12 reported water shortages due to dry wells between March 2023 and March 2024. The GWA's new Dry Well Mitigation Program is designed to step in to mitigate impacts of wells that go dry.
H-19	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	Public comments received at the June 26, 2024 informational meeting, March 13, 2024 Steering Committee meeting, April 10, 2024 Steering Committee meeting, and August 14, 2024 Steering Committee meeting were considered prior to the GWA adopting the program at its September 11, 2024 GWA Board meeting. The GSAs welcome input as the program is implemented.

ATTACHMENT 2

Comment #	Commenter Name	Organization Represented	Date Comment Received	Response
H-20	Mary Elizabeth & Margo Praus	Delta-Sierra Group of Sierra Club	10/31/2024	The Dry Domestic Well Mitigation Program was provided in the Public Draft as Appendix 3-J. The final GSP, once approved by the GSAs, will be posted on the esjgroundwater.org website.
I-1	Mary Elizabeth	Self	11/1/2024	The GWA is in the process of re-evaluating how it plans to implement the new elements of the 2024 GSP Amendment, including the Communication & Engagement (C&E) plan. This concern related to ensuring meaningful engagement during GSP implementation has been noted.

APPENDIX 1-K.
NOTICE OF INTENT TO ADOPT THE 2024 GSP AMENDMENT

ATTACHMENT 2

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

July 24, 2024

Via E-mail and U.S. Mail

Calaveras County
San Joaquin County
Stanislaus County
City of Escalon
City of Lodi
City of Manteca
City of Ripon
City of Stockton

Re: *Notice of Intent to Adopt an Amended Groundwater Sustainability Plan*

On behalf of the Groundwater Sustainability Agencies ("GSAs") comprising the Eastern San Joaquin Groundwater Authority (collectively, the "GSAs", as listed below), the Eastern San Joaquin Groundwater Authority ("Authority") hereby gives notice on behalf of its members that the GSAs intend to adopt an amended Groundwater Sustainability Plan for the Eastern San Joaquin Subbasin pursuant to California Water Code Section 10728.4. Pursuant to this section, this notice is provided to the cities and counties within the area of the proposed amended GSP.

The GSP, originally adopted by the GSA members of the Authority, was submitted to the Department of Water Resources ("DWR") on January 29, 2020, in compliance with the Sustainable Groundwater Management Act.[1] DWR completed its two-year review, and by letter dated January 28, 2022, determined the GSP to be incomplete and identified corrective actions to be completed within 180 days of the determination.[2] On July 27, 2022, the GSP was resubmitted to DWR. By letter dated March 2, 2023, DWR approved the resubmitted GSP and included a list of eight Recommended Corrective Actions to address in the Periodic Evaluation due January 2025.

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[1] Water Code §§ 10 720, *et seq*.

[2] DWR's letter determination can be accessed on DWR's SGMA Portal website: https://sgma.water.ca.gov/portal/gsp/status

The GSAs intend to address the Recommended Corrective Actions as part of the Periodic Evaluation and anticipate amending the GSP as a result. Each of the GSAs intends to hold separate public hearings to consider adoption of the amended GSP no sooner than ninety (90) days from the date of this notice.

Cities or counties that receive this notice may request in writing to consult on the proposed amended GSP. Please submit any such requests to the undersigned using the contact information below within thirty (30) calendar days of receipt of this notice.

For further information regarding the amended GSP, to download copies of the public draft of the amended GSP, and for other information regarding the amendment and readoption of the GSP, please visit www.esjgroundwater.org.

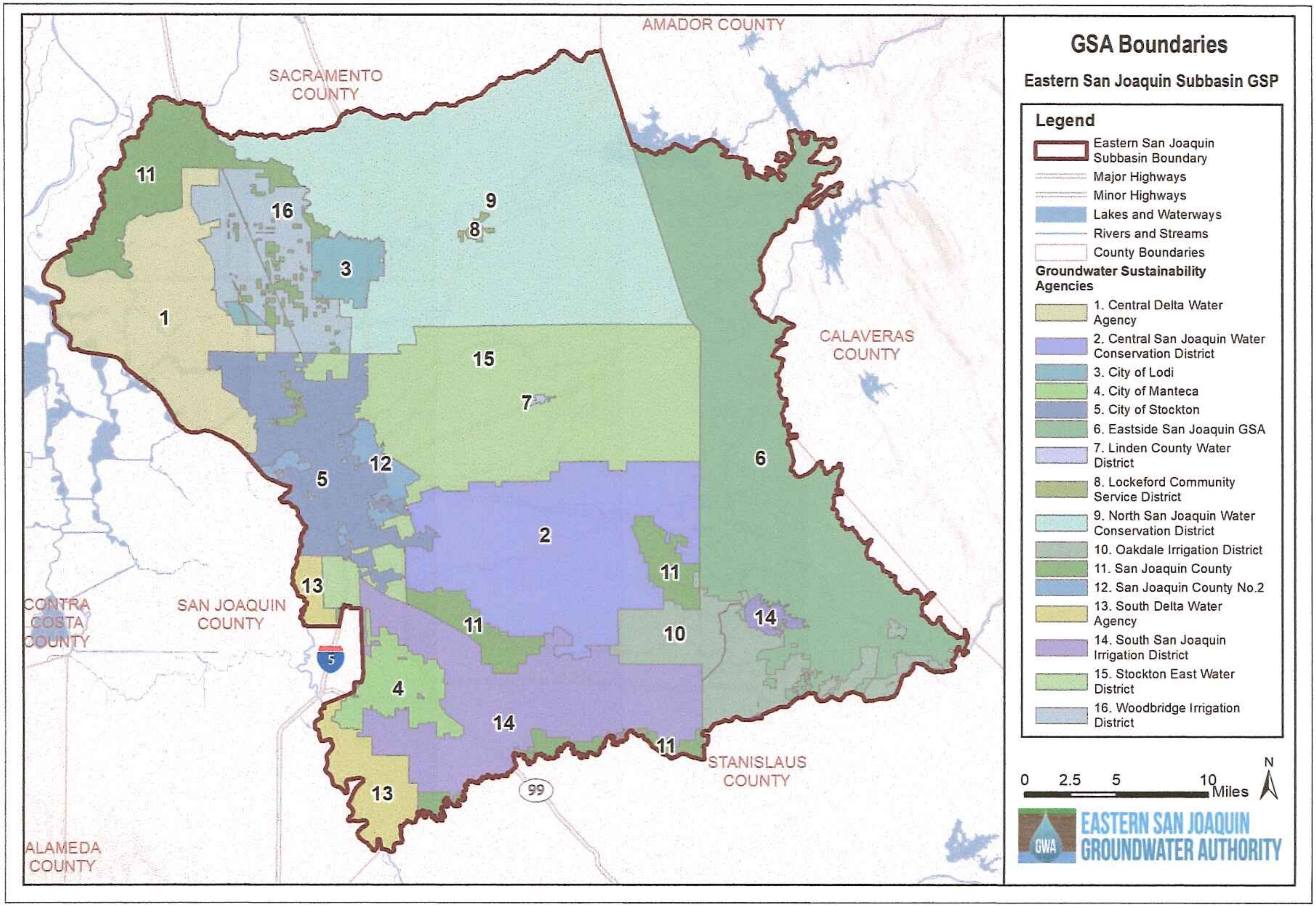
Sincerely,

Fritz Buchman, C.E., T.E., CFM
Eastern San Joaquin Subbasin Plan Manager
fbuchman@sjgov.org
209-468-3100

GSAs in the Eastern San Joaquin Groundwater Subbasin:
Central Delta Water Agency
Central San Joaquin Water Conservation District
City of Lodi
City of Manteca
City of Stockton
Eastside San Joaquin GSA
Linden County Water District
Lockeford Community Services District
North San Joaquin Water Conservation District
Oakdale Irrigation District
San Joaquin County GSA No. 1
San Joaquin County GSA No. 2
South Delta Water Agency
South San Joaquin GSA
Stockton East Water District
Woodbridge Irrigation District

ATTACHMENT 2

NOTICE OF INTENT TO ADOPT A GROUNDWATER SUSTAINABILITY PLAN



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APPENDIX 2-A.
EASTERN SAN JOAQUIN WATER RESOURCES MODEL (ESJWRM) REPORT

ATTACHMENT 2

Eastern San Joaquin Water Resources Model (ESJWRM)

AUGUST 2018

WOODARD & CURRAN

ATTACHMENT 2

EASTERN SAN JOAQUIN WATER RESOURCES MODEL (ESJWRM)

Final Report

August 2018

Prepared by

WOODARD & CURRAN

ATTACHMENT 2

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TABLES

FIGURES

APPENDICES

LIST OF ABBREVIATIONS

AF and AFY	Acre-Feet and Acre-Feet Per Year
ASTM	American Standard Testing Method
AWMP	Agricultural Water Management Plan
C2VSim	California Central Valley Groundwater-Surface Water Simulation Model
Cal Water	California Water Service Company Stockton District
CALSIMETAW	California Simulation of Evapotranspiration of Applied Water
CASGEM	California Statewide Groundwater Elevation Monitoring
CCWD	Calaveras County Water District
CDEC	California Data Exchange Center
CFS	Cubic Feet per Second
CIMIS	California Irrigation Management Information System
County	San Joaquin County
CSJWCD	Central San Joaquin Water Conservation District
CVHM	Central Valley Hydrologic Model
DEM	Digital Elevation Model
DWR	California Department of Water Resources
ESJ Subbasin	Eastern San Joaquin Groundwater Subbasin
ESJWRM	Eastern San Joaquin Water Resources Model
ET	Evapotranspiration
ETAW	Evapotranspiration of Applied Water
GBA	Eastern San Joaquin County Groundwater Basin Authority
GMS	Aquaveo Groundwater Modeling System
GPCD	Gallons Per Capita Per Day
GSA	Groundwater Sustainability Agency
GSE	Ground Surface Elevation
GSP	Groundwater Sustainability Plan
GWA	Eastern San Joaquin Groundwater Authority
IDC	IWFM Demand Calculator
IGSM	Integrated Groundwater and Surface Water Model
IRWMP	Integrated Regional Water Management Plan
IWFM	Integrated Water Flow Model
KH	Aquifer Hydraulic Conductivity
KV	Aquifer or Aquitard Vertical Hydraulic Conductivity
LCSD	Lockeford Community Services District
LCWD	Linden County Water District
MAF and MAFY	Million Acre-Feet and Million Acre-Feet Per Year
METRIC	Mapping Evapotranspiration at High Resolution with Internalized Calibration
NASS	National Agricultural Statistics Service
NRCS	Natural Resource Conservation Service
NSJWCD	North San Joaquin Water Conservation District
OID	Oakdale Irrigation District
OSWCR	Online System for Well Completion Reports
PRISM	Precipitation-Elevation Regressions on Independent Slopes Model

PSDI	Pore Size Distribution Index
RMS	Root Mean Square
SEWD	Stockton East Water District
SGMA	Sustainable Groundwater Management Act
SS	Aquifer Specific Storage
SSJID	South San Joaquin Irrigation District
SSURGO	Soil Survey Geographic Database
STATSGO2	Digital General Soil Map of the United States
SY	Aquifer Specific Yield
TAF and TAFY	Thousand Acre-Feet and Thousand Acre-Feet Per Year
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
WDL	Water Data Library
WID	Woodbridge Irrigation District

ACKNOWLEDGEMENTS

In December 2015, San Joaquin County (County) applied for Proposition 1's Counties with Stressed Basins Grant and received approval for $499,900. With a fifty percent cost share with the California Department of Water Resources, the County executed a contract with Woodard & Curran (formerly RMC Water and Environment), on September 13, 2016 to begin work on a hydrologic model for the Eastern San Joaquin Groundwater Subbasin. The purpose of the resulting model, the Eastern San Joaquin Water Resources Model (ESJWRM), is to support activities in long-term management of the Eastern San Joaquin Subbasin at the local scale, specifically focusing on meeting the goals and requirements of the Sustainable Groundwater Management Act.

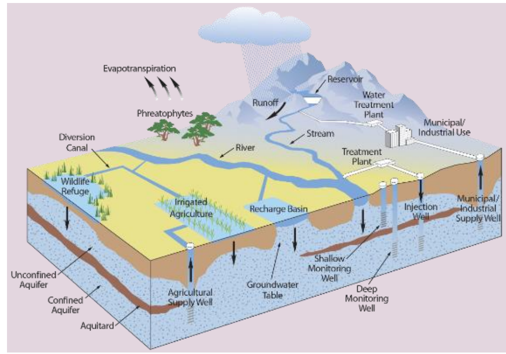
A technical committee provided quality assurance and technical support throughout the project, resulting in a groundwater model widely accepted by local shareholders and public agencies. The committee was an informal group consisting of technical representatives from local agencies, consultants with knowledge of the area, representatives for neighboring groundwater subbasins, Department of Water Resources (DWR) staff, and San Joaquin County personnel. Local agencies with consistent representation included San Joaquin County, Woodbridge Irrigation District, City of Lodi, North San Joaquin Water Conservation District, Lockeford Community Services District, Calaveras County Water District, City of Stockton, California Water Service Company Stockton District, Stockton East Water District, City of Lathrop, City of Manteca, South San Joaquin Irrigation District, City of Escalon, Oakdale Irrigation District, and Stanislaus County.

The Main Project Team included:

- Woodard & Curran (formerly RMC Water and Environment)
    - Alyson Watson, Project Principal
    - Ali Taghavi, Project Manager
    - Sevim Onsoy, Project Support
    - Jeanna Long, Data Management System Lead
    - Sara Miller, Project Engineer
- NV5

EXECUTIVE SUMMARY

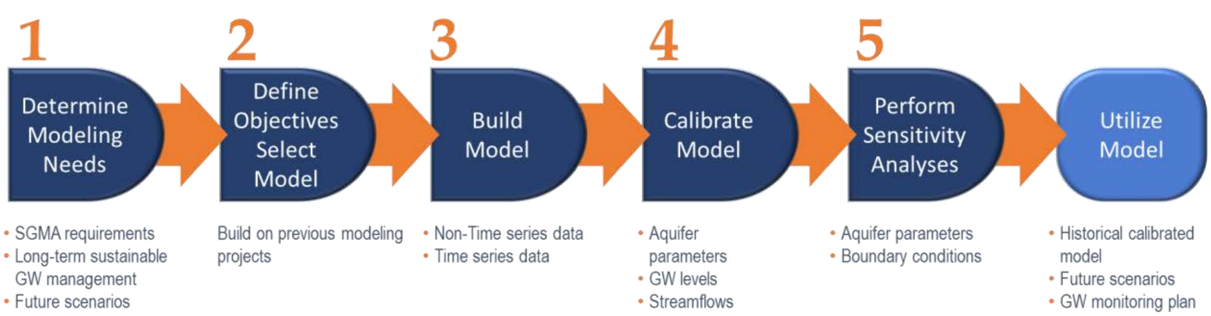
The Eastern San Joaquin Water Resources Model (ESJWRM) was developed to evaluate the surface water and groundwater resources in the Eastern San Joaquin Groundwater Subbasin (ESJ Subbasin) during recent historical hydrologic conditions. This period covers water years 1995 through 2015, and includes several above normal and wet years, as well as the most recent drought conditions. The model is designed to simulate the regional water resources conditions in the ESJ Subbasin, including the land surface processes, groundwater operations, stream and river systems, and the interaction between these resources.



Development of the ESJWRM occurred in an open and transparent process over approximately 24 months, starting in September 2016. Model development was a collaborative process between San Joaquin County staff, local water agencies, and Woodard & Curran, as consultant and developers of the model. The model was developed by partial funding from the Department of Water Resources (DWR), and as such, the DWR staff were engaged and collaborated in development of the model.

A technical committee provided quality assurance and technical support throughout the project, resulting in an integrated water resources model widely accepted by local shareholders and public agencies. The committee was an informal group consisting of technical representatives from local agencies, consultants with knowledge of the area, representatives from neighboring groundwater subbasins, DWR staff, and San Joaquin County personnel. Local agencies with consistent representation included San Joaquin County, Woodbridge Irrigation District, City of Lodi, North San Joaquin Water Conservation District, Lockeford Community Services District, Calaveras County Water District, City of Stockton, California Water Service Company Stockton District, Stockton East Water District, City of Lathrop, City of Manteca, South San Joaquin Irrigation District, City of Escalon, Oakdale Irrigation District, and Stanislaus County.

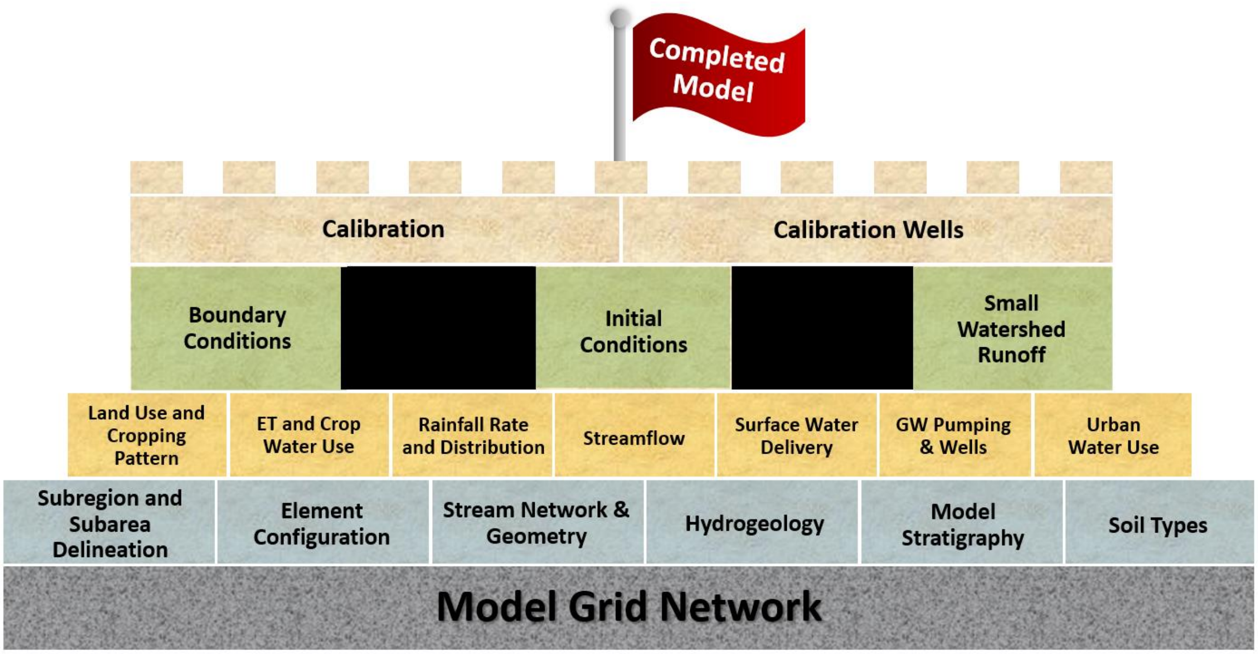
ESJWRM development followed a robust process as shown below. Modeling needs were established in early 2015, shortly after the passage of the Sustainable Groundwater Management Act (SGMA). Subsequently, modeling goals and objectives were discussed and established, and San Joaquin County was successful in securing funds through Proposition 1 to begin development of the model.



ESJWRM development required a significant amount of data and information, including hydrologic, hydrogeologic, topographic and soil conditions, land use and cropping patterns, urban and agricultural water demand, urban and agricultural water supplies, surface water conveyance and distribution systems, groundwater infrastructure and extraction, and irrigation practices. The following figure shows the type of data and information needed to develop the model. A collaborative process was followed to collect and analyze, fill data gaps, and develop proper assumptions for the use, context, and accuracy of the data, before analyzing and properly formatting the data for input in the model.

Once the model was constructed, appropriate state-of-the-art scientific and engineering protocols and guidelines were utilized to calibrate the model to ensure that:

- Water budgets generated by the model represent the regional and local understanding of the agricultural and urban entities represented in the model. The model-generated water budgets showing water demand and supply and the groundwater system are prepared and reported on both monthly and annual scales for urban and agricultural entities as well as at the subbasin scale.
- Monthly groundwater levels generated by the model at select observation wells throughout the subbasin closely follow the long-term annual trends and short-term seasonal fluctuations that are recorded and reported at the observation wells.
- Monthly streamflow generated by the model at select gauging stations closely follow the high and low flows as reported.

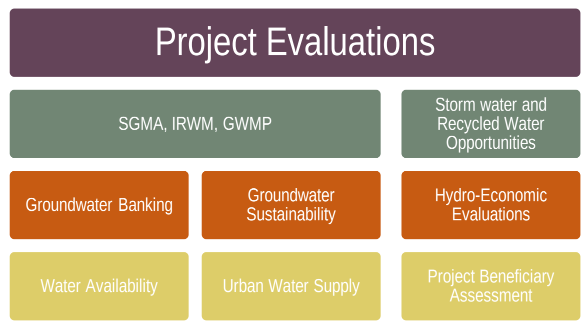


The calibrated ESJWRM provides detailed conditions of the ESJ Subbasin over the calibration period of water years 1996 through 2015. This calibrated model can be used for understanding subbasin characteristics and the effects of historical surface water and groundwater operations as well as irrigation practices or urban operations on the groundwater and surface water resources in the ESJ Subbasin. These include:

- Historical and current levels of development
- Subbasin operations under natural conditions
- Nature, extent, and rates of stream-aquifer interaction

- Effects and benefits of upstream regulation of rivers on the operations of the groundwater subbasin
- Effects of operations of regional water supply projects, including conjunctive use, on subbasin conditions
- Evaluation of water quality conditions in the subbasin

Additionally, the calibrated model can be used to develop baseline conditions representing projections of land use, population growth, water demand, and water supply conditions, as estimated based on local and regional planning activities. The baseline model, as a robust, defensible, and detailed tool, may be used for assessing the current and projected water resources conditions in the basin to support various local and regional planning projects and programs, such as the development and implementation of a Groundwater Sustainability Plan (GSP). ESJWRM may also be used to evaluate the effectiveness of different projects that may be proposed through the GSP development process. The fine scale of the model also provides the opportunity for individual Groundwater Sustainability Agencies (GSAs) to evaluate the effects of ESJ Subbasin conditions on smaller GSA areas.



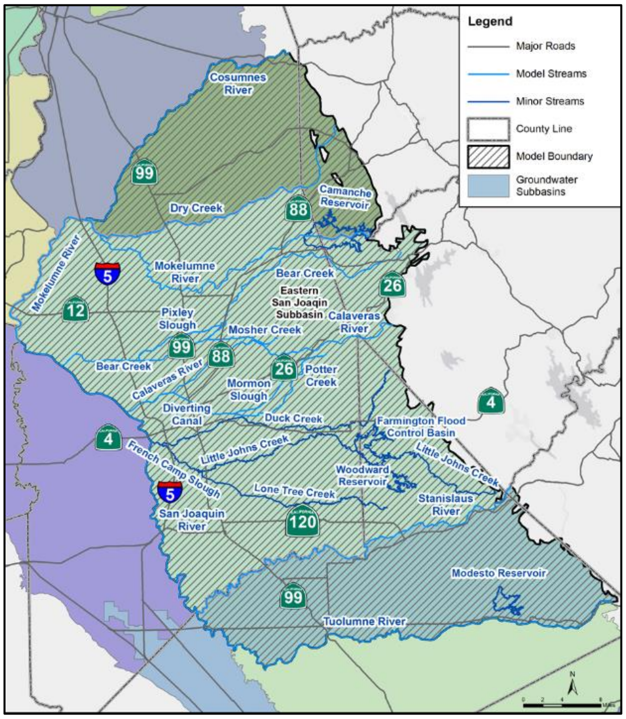
Some of the key features of the ESJWRM are as follows:

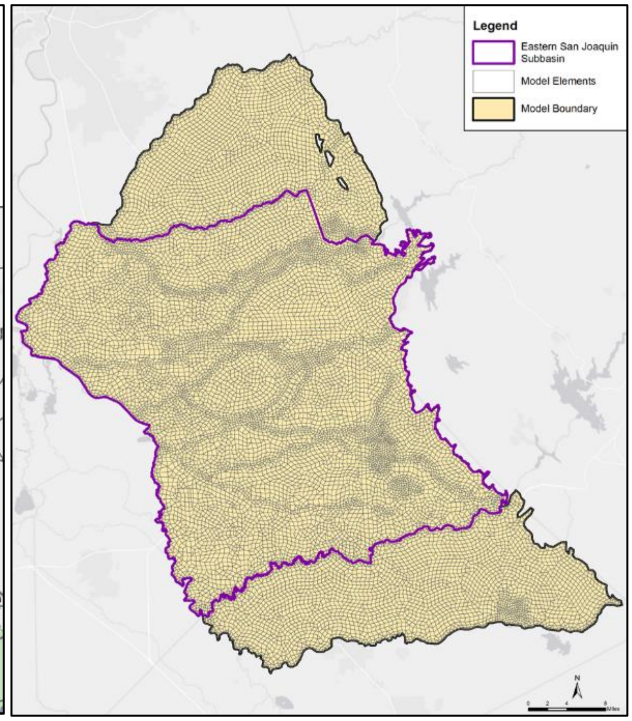
Model Platform

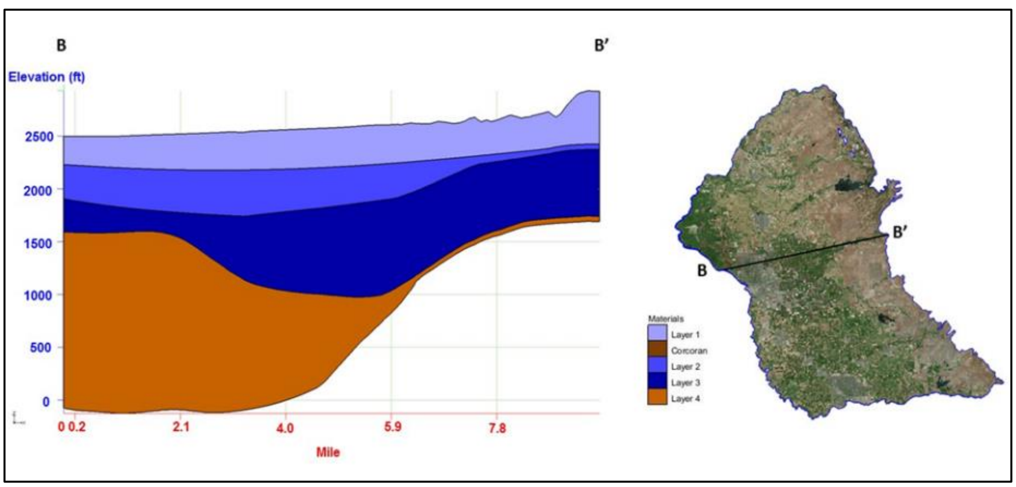
The model code platform is the DWR's Integrated Water Flow Model (IWFM-2015). This code platform was developed by DWR to simulate the integrated hydrologic conditions of a groundwater basin, with interactions between the surface water, groundwater, and stream system. The code platform has specific strengths in the calculation of agricultural water demand in a predominantly agricultural area, such as the Eastern San Joaquin Subbasin. The code platform is supported by the DWR modeling support staff for local and regional applications, including SGMA implementation.

Model Area

The model covers the entire area of the Eastern San Joaquin Groundwater Subbasin, as defined by DWR Bulletin 118, as well as the areas of the Modesto and Cosumnes Groundwater Subbasins (the basins immediately north and south of the ESJ Subbasin). The model area is subdivided into small units (elements). A comprehensive integrated hydrologic process and analysis is conducted at each model element, and surface water and groundwater flows are calculated and simulated across elements, and throughout the entire model area on a monthly time step, in such a way that mass balance is preserved every month. Additionally, each element represents the geologic and hydrogeologic conditions of the subsurface environment as represented by four model layers in a conceptual context.

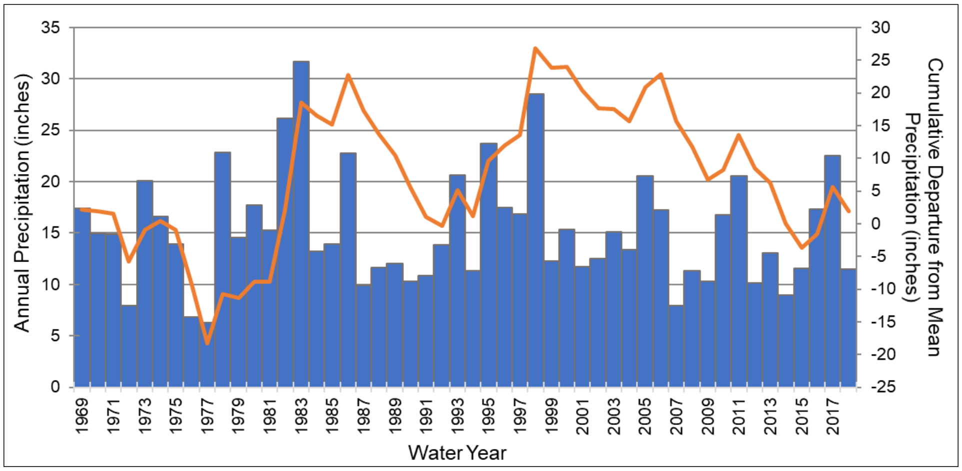


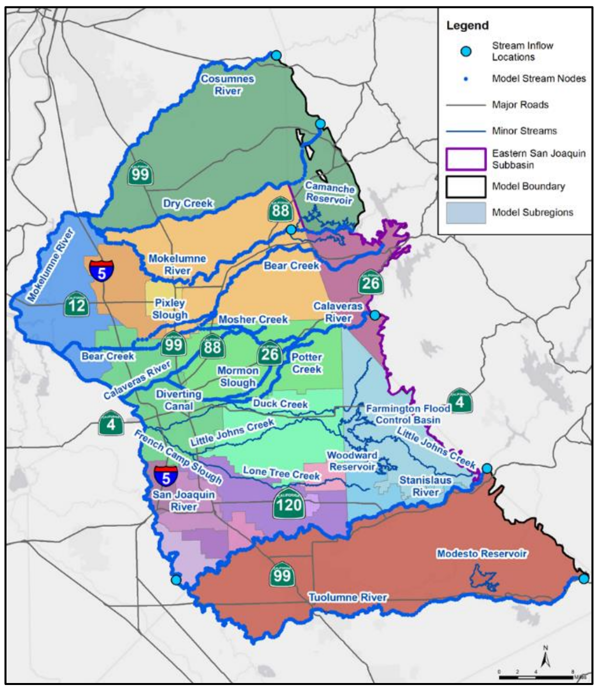




Hydrology

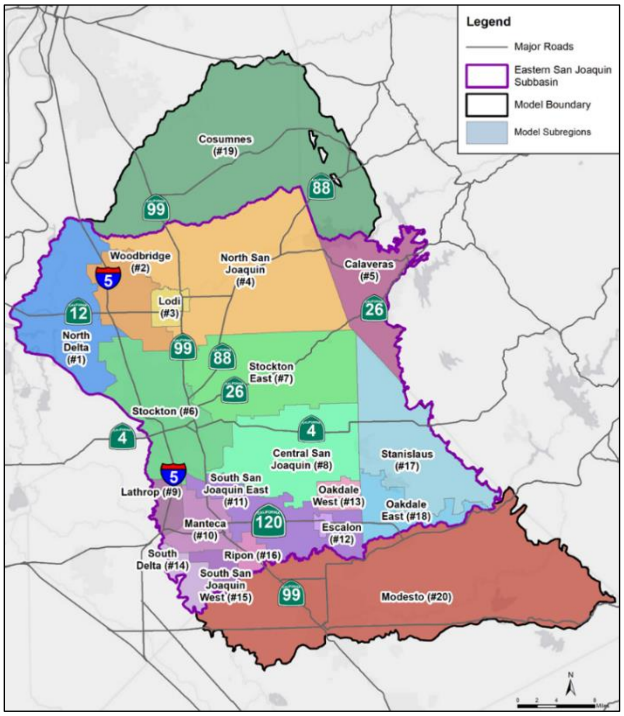
The model contains 50 years of hydrologic period (water years 1969 through 2018), which provides opportunities to assess the basin conditions during above normal, below normal, and drought periods. The model is calibrated during the period of 1996-2015, during which there are more robust and defensible data available for model calibration. In addition, the model includes major and minor rivers and creeks in the area and calculates stream-aquifer interaction along the major rivers and creeks. The minor creeks and canals represented in the model are used for conveyance of irrigation water and drainage.

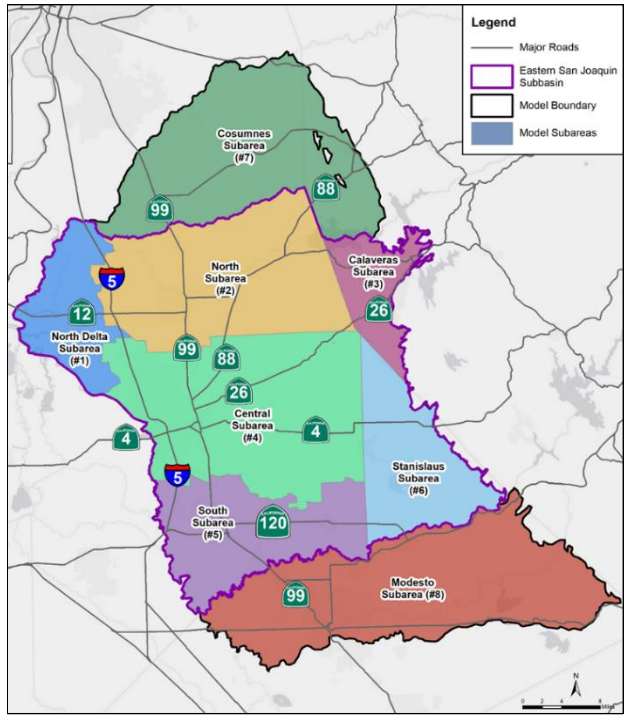




Model Subareas

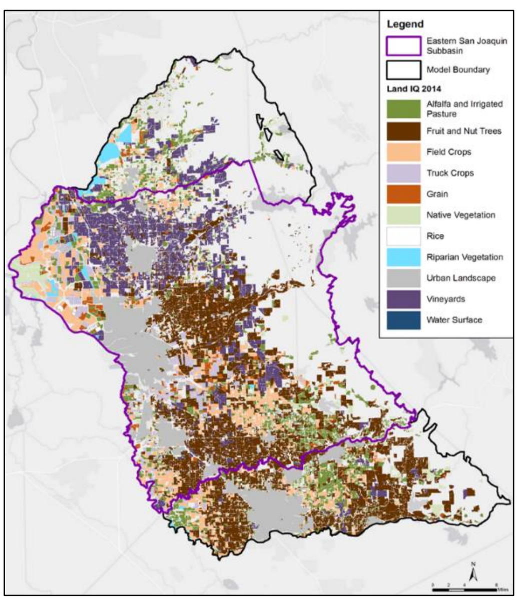
The model elements are aggregated into larger geographic areas, which represent individual agricultural and urban entities (Subregions) and larger planning areas (Subareas). These larger areas can be used to prepare model input data and to analyze model generated water budgets for planning purposes.

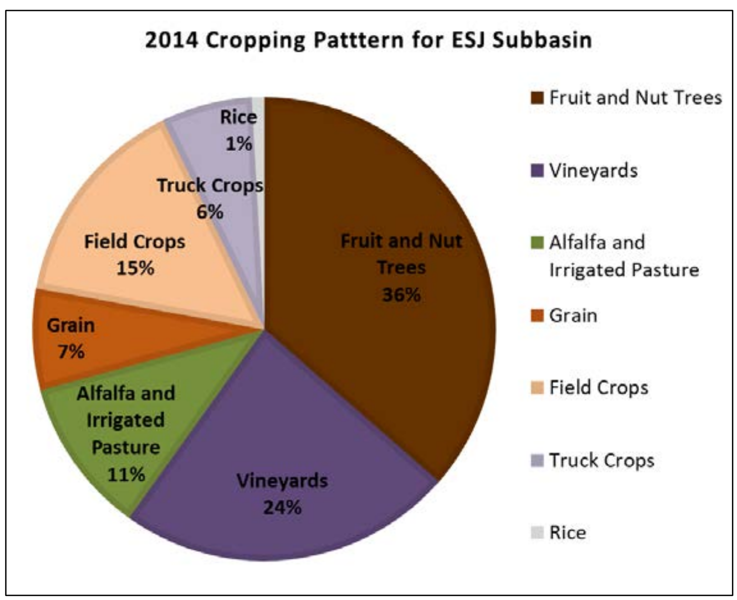




Land Use and Agricultural Cropping Pattern

A key data set used in the model is the distribution of land between agricultural, urban, native, and riparian land use categories, as well as acreages of major crops in the agricultural lands. This information is prepared and processed based on land use surveys prepared and reported by the DWR (DWR, 1993-2000), remote sensing data from the United States Department of Agriculture called CropScape (USDA NASS, 2007-2015), and the DWR Land IQ dataset (DWR, 2014). This information was compiled, analyzed, and evaluated for each model element; compared and cross-checked with data and information from the agricultural entities; and finalized for use in the model.

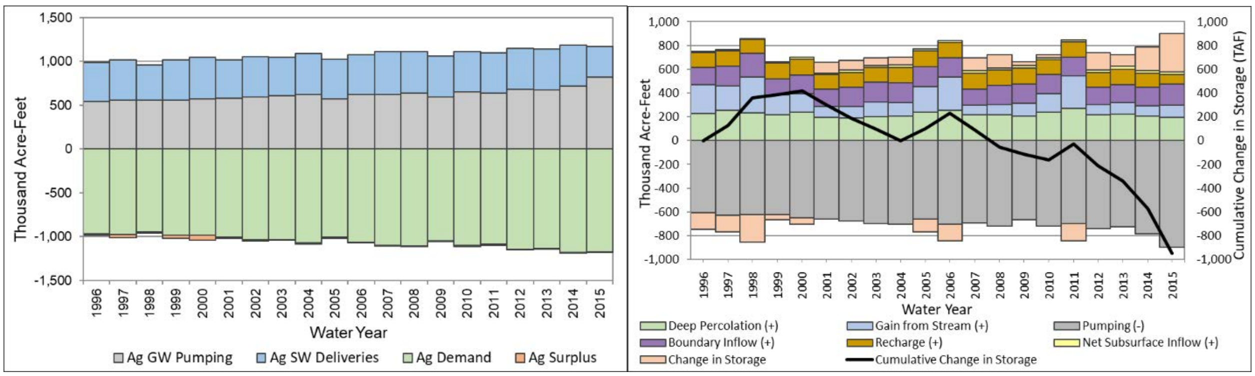




Water Budgets

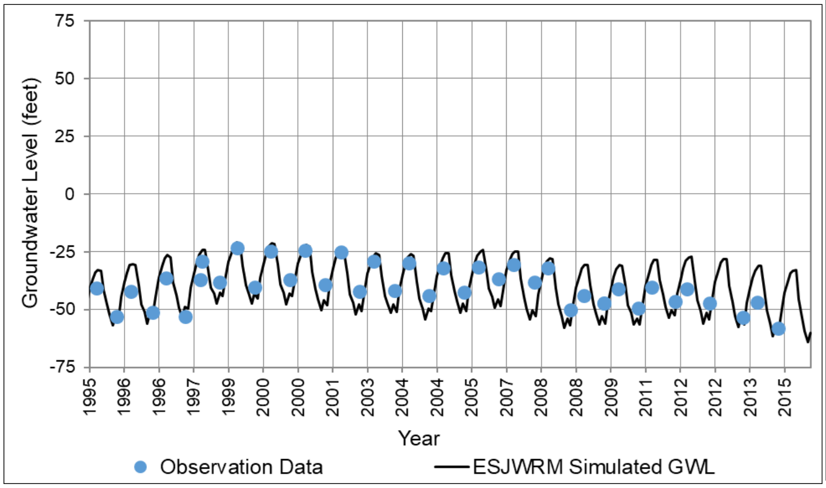
The model produces water budgets for land surface processes, including an estimate of urban and agricultural water demands, and water supplies. In addition, the model produces water budgets for the groundwater system, including groundwater pumping to meet irrigation demand and urban water needs, deep percolation from rainfall and irrigation applied water, subsurface flows from neighboring groundwater subbasins and the Sierra Nevada foothills, seepage from unlined conveyance canals, and flows between the stream and the aquifer system. The model can present this information on both a monthly and annual basis. Local operations data and information was collected from various water users and model parameters were adjusted to calibrate the model outcome to the reported values. Model calibration was conducted in an open and transparent process to ensure that the water budgets and model calibration results are properly representing the conditions of the groundwater basin to the extent that information is available.

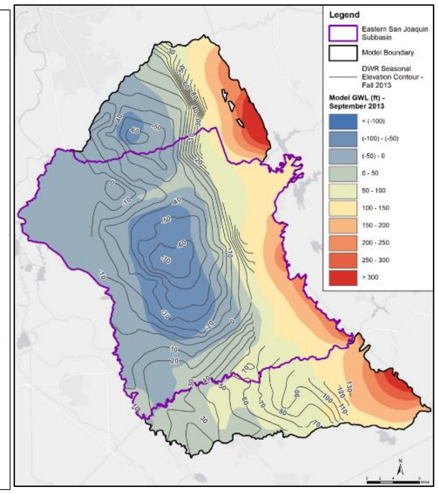
An annual representation of the groundwater budget can reveal overall changes in groundwater storage, as depicted in the chart below. Uncertainties are inherent in every data set and calculation. Through a systematic sensitivity analysis, the range of impacts of uncertainties on model calculations was quantified. Knowledge of this range of uncertainties can assist in providing flexibility in decisions that rely on model results. The average annual depletions in groundwater storage for the historical period of 1996-2015 is estimated to be about 24,000 to 70,000 acre-feet per year (AFY), with an average depletion of 47,000 AFY.

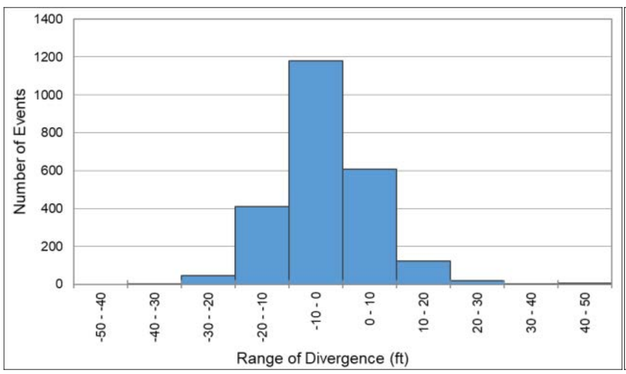


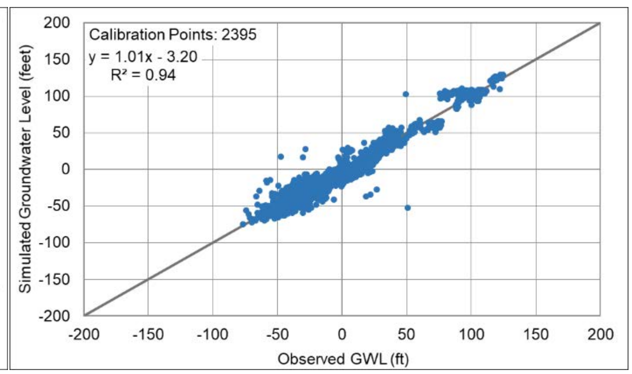
Groundwater Levels

The model-calculated groundwater levels are calibrated to observed groundwater levels at key wells over time. The typical goal of this calibration process is to adjust hydraulic parameters that influence the movement of groundwater such that the groundwater levels calculated by the model at the specific observation wells throughout the model area track short-term seasonal fluctuations and long-term trends as closely as possible. A typical model produced result is shown in the chart below. Once calibrated, the model produces regional groundwater levels for select points in time, as shown in the figure below. Model calibration statistics are represented in the following figures, which indicate that 75% of model calculated groundwater levels are within 10 feet of reported observations, and 97% are within 20 feet of reported observations. Given the uncertainties in the measurement of reported values, as well as uncertainties in model calculations, and expected calibration results for similar models as reported in the scientific communities, this statistic represents a very good model performance.



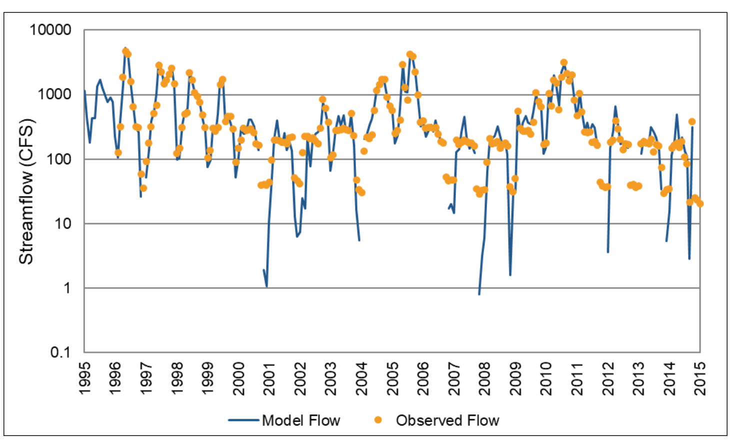






Streamflows

The model calculates flow of water in the stream system throughout the basin. Streamflows are subject to the diversion of water for beneficial agricultural uses or urban consumption, return flows from irrigation practices, runoff of rainfall, as well as gains and losses due to interaction with the groundwater system. The model stream system is calibrated to reported flows at the downstream gauging stations. The chart below shows the comparison between model calculated streamflow and gauge records on Mokelumne River at Woodbridge. The results indicate that the model is capable of simulating both the low and the high flows reasonably well.



Conclusions and Recommendations

The ESJWRM, in its current state, is a robust, comprehensive, defensible and well-established model for assessing the water resources in the ESJ Subbasin under historical and projected conditions. The following recommendations are to be considered for further refinements and enhancements of the model:

- **Continue engagement with local groundwater users and managers**. Continue working with local agencies and groundwater users in ESJ Subbasin to further understand the local operations of the groundwater system and improve representation of groundwater users in the ESJWRM.
- **Refinement of boundary flows**. The current boundary flows at the northern, western, and southern boundaries of the model area are based on an older version of the C2VSim with adjustments made based on initial groundwater levels assumed for the beginning of the model (October 1994). DWR is currently in the process of updating the C2VSIm model. Once the latest fine grid version (C2VSim-2015) is publicly available, boundary flows for the ESJ model area should be verified and updated, as necessary.
- **Enhance variability of potential evapotranspiration**. The current version of the IDC used for estimation of the consumptive use of crops in the ESJWRM uses monthly potential ET values that are the same for all years during the model period. Given that there may be annual variability in the potential ET data with possible effects on the annual estimation of crop water demand, it is recommended to use more detailed data with temporal variability to develop a full time series of ET values for use in the model.
- **Refine surface water deliveries in Cosumnes and Modesto Subbasins.** The surface water deliveries in the Cosumnes and Modesto Subbasins are currently at the subregion level and do not have the detailed spatial resolution of other areas within the ESJ Subbasin. This data may need to be verified and updated as modeling efforts in those subbasins progress to meet the requirements of SGMA.
- **Update C2VSim based on ESJWRM**. The fine grid version of C2VSim was developed by the DWR to evaluate the integrated surface water and groundwater conditions at a regional scale; whereas, the ESJWRM is capable of evaluation at the local scale. To increase the accuracy of regional groundwater conditions in the fine grid C2VSim, the County is encouraged to work with DWR to provide data and information for further refinement and update of C2VSim in the ESJWRM area.
- **Develop model update schedule**. In order to keep the ESJWRM up-to-date and current for analysis of water resources and especially for supporting SGMA implementation, it is recommended that the model be updated every 3 to 5 years. A possible update schedule can be kept consistent with the GSP updates, with a lead time of 2 to 3 years relative to the GSP update schedule.

1. INTRODUCTION

1.1 Goals of Model Development

The Eastern San Joaquin Water Resources Model (ESJWRM) was developed primarily to evaluate the current and recent historical groundwater conditions of the Eastern San Joaquin Groundwater Subbasin (ESJ Subbasin) and simulate various future condition scenarios as part of the Groundwater Sustainability Plan (GSP) preparation process under the Sustainable Groundwater Management Act (SGMA). ESJWRM will also be used to evaluate the effectiveness of different projects that may be proposed through the GSP development process. The fine scale of the model also provides the opportunity for individual Groundwater Sustainability Agencies (GSAs) to evaluate the effect of changing ESJ Subbasin conditions on smaller GSA areas.

1.2 Eastern San Joaquin Groundwater Subbasin

The ESJ Subbasin underlies portions of San Joaquin, Calaveras, and Stanislaus counties, with the majority of the area in San Joaquin County (Figure 1). San Joaquin County is located in the northeastern San Joaquin Valley and contains portions of the Sacramento-San Joaquin River Delta.

In 2014, the ESJ Subbasin was categorized as a high priority groundwater subbasin under the California Statewide Groundwater Elevation Monitoring (CASGEM) program. The ESJ Subbasin has been identified by the California Department of Water Resources (DWR) as critically overdrafted and is included in the List of Critically Overdrafted Basins finalized in January 2016. As a critically overdrafted subbasin, GSAs in the ESJ Subbasin must develop a GSP by January 31, 2020 that details how the ESJ Subbasin will be managed in a sustainable manner by 2040. The other groundwater subbasins immediately surrounding the ESJ Subbasin are not critically overdrafted except for the Delta-Mendota Subbasin (Figure 2).

The major municipalities in the ESJ Subbasin are the cities of Lodi, Stockton (including California Water Service Company Stockton District or Cal Water), Lathrop, Manteca, Ripon, and Escalon. The major agricultural water providers in the ESJ Subbasin include Woodbridge Irrigation District (WID), North San Joaquin Water Conservation District (NSJWCD), Stockton East Water District (SEWD), Central San Joaquin Water Conservation District (CSJWCD), South San Joaquin Irrigation District (SSJID), and Oakdale Irrigation District (OID). The major municipalities and agricultural water providers are all GSAs. Other agencies which supply water or have land use authority within the ESJ Subbasin and have been designated as GSA's are San Joaquin County, Stanislaus County (in combination with CCWD and Rock Creek Water District), Calaveras County Water District (CCWD), North and South Delta Water Agencies, Lockeford Community Services District (LCSD), and Linden County Water District (LCWD). The 17 GSAs covering ESJ Subbasin and their corresponding member agencies are listed in Table 1. The water purveyors are shown in Figure 3a and the GSAs are shown in Figure 3b.

Table 1: ESJ Subbasin GSAs and Member Agencies

GSA	Member Agency
Central Delta Water Agency	Central Delta Water Agency
Central San Joaquin Water Conservation District	Central San Joaquin Water Conservation District
City of Lathrop	City of Lathrop
City of Lodi	City of Lodi

GSA	Member Agency
City of Manteca	City of Manteca
City of Stockton	City of Stockton
Eastside San Joaquin GSA	Calaveras County Water District Stanislaus County Rock Creek Water District
Linden County Water District	Linden County Water District
Lockeford Community Services District	Lockeford Community Services District
North San Joaquin Water Conservation District	North San Joaquin Water Conservation District
Oakdale Irrigation District ESJ Subbasin GSA	Oakdale Irrigation District
San Joaquin County	San Joaquin County
San Joaquin County No. 2	San Joaquin County Cal Water
South Delta Water Agency	South Delta Water Agency
South San Joaquin GSA	South San Joaquin Irrigation District City of Ripon City of Escalon
Stockton East Water District	Stockton East Water District
Woodbridge Irrigation District	Woodbridge Irrigation District

1.3 Local Coordination

The development of the ESJWRM took place in an open and transparent process. The 17 GSAs of the ESJ Subbasin coordinate SGMA activities through the formation of the Eastern San Joaquin Groundwater Authority (GWA). The Eastern San Joaquin County Groundwater Basin Authority (GBA) was the organizational structure for agency coordination of water resources activities before SGMA regulations and the formation of the GWA. Many of the GBA/GWA agency members participated in a Technical Review Committee, which acted as the forum to review model input data and assumptions, as well as calibration results. The Technical Review Committee helped to facilitate major modeling decisions, provided input data, and reviewed results. The monthly Technical Review Committee meetings were open to all interested parties and generally consisted of technical representatives from local agencies, consultants with knowledge of the area, representatives for neighboring groundwater subbasins, DWR staff, and San Joaquin County personnel. Presentations given to this group are included in Appendix A and highlight major model configuration decisions, data analysis, and draft model results.

Local agencies with consistent representation at the Technical Review Committee meetings included San Joaquin County, WID, City of Lodi, NSJWCD, LCSD, CCWD, City of Stockton, Cal Water, SEWD, City of Lathrop, City of Manteca, SSJID, City of Escalon, OID, and Stanislaus County.

1.4 Model Platform

The ESJ Subbasin has been modeled since the mid-1980s. In 1993, as part of the Bureau of Reclamation's American River Watershed Investigation, an integrated model was developed based on the Integrated

Groundwater and Surface Water Model (IGSM) code. This model was developed in coordination with the San Joaquin County (County) and DWR and was used to analyze several conjunctive use programs and projects. In 2001, the San Joaquin County IGSM model was converted to a DYNFLOW platform (a proprietary finite element groundwater flow model) and was used for the County's Water Management Plan (CDM, 2008). The model originally simulated a period of October 1969 through September 1993 and was updated in 2007 for the Eastern San Joaquin Integrated Regional Water Management Plan (IRWMP) to simulate hydrologic conditions through September 2006. The proprietary nature of DYNFLOW makes the model not suitable to support subbasin analysis as part of GSP development per SGMA requirements.

With the award of Proposition 1's Counties with Stressed Basins Grant, the determination was made to combine data from the older models into a new, local-scale model using DWR's code that updated and replaced IGSM, called Integrated Water Flow Model (IWFM). IWFM is an open-source, finite element simulation code that supports triangular and quadrilateral elements (Dogrul et al., 2017a). It was specifically designated in GSP regulations as being supported by DWR for water budget development and SGMA compliance. It is also the code used for DWR's California Central Valley Groundwater-Surface Water Simulation Model (C2VSim), the fine grid version of which is being refined and enhanced by DWR to support SGMA activities throughout the Central Valley at the regional scale (Brush et al., 2013). C2VSim was developed using the same methodology and source data as were ESJWRM's datasets. To maintain consistency, ESJWRM relies on C2VSim for many of its datasets.

The IWFM Demand Calculator (IDC) is the stand-alone root zone component of IWFM that simulates land surface and root zone flow processes (Dogrul et al., 2017b). It calculates agricultural and urban water demands using inputs including climate conditions, soil parameters, and land use types and distribution. It can be run separately or combined with IWFM. IDC data development and results in this documentation are included as part of all other IWFM datasets and results. The IDC major data pieces and draft results were initially presented in a February 1, 2018 Technical Memorandum (Appendix B).

At the October 26, 2016 Technical Review Committee meeting, the decision was made to keep the model domain the same as for the DYNFLOW model. The County's DYNFLOW model included the ESJ Subbasin, as well as the Cosumnes Subbasin to the north and the Modesto Subbasin to the south. The ESJ Subbasin is the primary model area and the secondary model area includes the Cosumnes and Modesto Subbasins. The physical model boundaries are included in Table 2 and shown in Figure 4.

Table 2: Physical Model Boundaries

Boundary	Entire Model	Primary Model Area (ESJ Subbasin)
North	Cosumnes River	Dry Creek and County Boundary (including Mokelumne River)
East	Sierra Nevada Foothills	Sierra Nevada Foothills
South	Tuolumne River	Stanislaus River
West	San Joaquin River	San Joaquin River

2. MODEL DEVELOPMENT

This section presents the source and analysis of input data used in the development of ESJWRM. This includes spatial and temporal information for hydrologic and hydrogeologic data sets included in the model, as well as physical parameters and assumptions.

2.1 Model Input Data

The historical ESJWRM simulates water years 1995 through 2015 (October 1, 1994 through September 30, 2015). All data and computations are performed on a monthly time step. IWFM model files and corresponding major data sources and report sections are referenced below in Table 3.

Table 3: ESJWRM Major Model Data

Major Data Category	Minor Data Category	Data Source	Report Section
Hydrogeological Data	Geologic Stratification	C2VSim	2.9
	Aquifer Parameters	USGS Texture Model	4.7
Stream Data	Stream Configuration	C2VSim & San Joaquin County	2.3
	Stream Inflow	USGS & USACE Stream Gauges	2.3
	Calibration Gauges	USGS & CDEC Stream Gauges	4.3
Hydrological Data	Precipitation	PRISM & CalSIMETAW	2.4
Agricultural Water Demand	Land Use	DWR CropScape Land IQ Ag Commissioner's Report Local Information	2.6
	Evapotranspiration	C2VSim METRIC Local Information	2.7
	Soil Properties	SSURGO & STATSGO2	2.5
Urban Water Demand	Population	U.S. Census Bureau & Local Information	3.2
	Per Capita Water Use	Local Information (UWMPs)	3.2
Water Supply	Groundwater Pumping	Local Information	3.3.2
	Surface Water Deliveries	Local Information	3.3.1
Other	Boundary Conditions	C2VSim & Local Information	2.11
	Initial Conditions	C2VSim	2.12
	Small Watersheds	C2VSim	2.10
	Calibration Wells	DWR & Local Information	4.5

The hydrologic period used to build the model data files was water years 1969 through 2018 (October 1, 1968 through September 30, 2018). This allows for future work to use a longer model run time using actual historical rainfall and stream inflow records.

2.2 Model Grid and Reporting Units

The finite element grid was developed using Aquaveo's Groundwater Modeling System (GMS) software. The grid includes quadrilateral and triangular elements based on selected input lines and control points. Features included in the development of the model grid are shown in Figure 5 and included:

- Groundwater subbasin boundaries
- Hydrologic and hydrogeologic features (i.e., major and minor streams, reservoirs/lakes, and outcroppings)
- City spheres of influence boundaries
- ESJ Subbasin GSA boundaries
- County boundaries
- Subsurface flow patterns
- Other boundaries

The model grid contains 16,054 elements and 15,302 nodes with an average element area of 76.5 acres (Figure 6). The average node spacing is 0.37 miles overall, ranging from about 0.28 miles near hydrologic features to 0.42 miles in other areas. There was a 0.75-mile buffer included around the streams to transition from the finer to coarser node spacing. Primary objectives during grid development were to maintain a manageable number of elements and nodes, to optimize resolution for data analysis, to contain a finer resolution along rivers to allow for better simulation of stream-aquifer interaction, to optimize the model run time, and to streamline model output.

The model elements are grouped into 20 model subregions that are used to organize input data for the model and report standard model output water budgets (Figure 7). Subregion borders were delineated using boundaries including city spheres of influence, water agencies, subbasin, and county lines. These subregions are aggregated into 8 larger units (model subareas), which are the primary units to present results and are used for basin-scale planning (Figure 8). ESJ Subbasin, the primary model area, is made up of 6 subareas and 18 subregions or a total of 772,377 acres (about 1,207 square miles). The entire ESJWRM area covers 1,228,194 acres (about 1,919 square miles). A description of model subregions, including the subarea they are part of and the number of model elements they contain, is in Table 4.

Table 4: Model Subregions and Subareas

Subregion Number	Subregion Name	Subarea Name and Number	Number of Elements
1	North Delta	North Delta Subarea (#1)	872
2	Woodbridge	North Subarea (#2)	485
3	Lodi		104
4	North San Joaquin		1,969

Subregion Number	Subregion Name	Subarea Name and Number	Number of Elements
5	Calaveras	Calaveras Subarea (#3)	664
6	Stockton	Central Subarea (#4)	1,074
7	Stockton East		1,314
8	Central San Joaquin		929
9	Lathrop	South Subarea (#5)	119
10	Manteca		224
11	South San Joaquin East		632
12	Escalon		33
13	Oakdale West		128
14	South Delta		254
15	South San Joaquin West		74
16	Ripon		86
17	Stanislaus	Stanislaus Subarea (#6)	1,312
18	Oakdale East		332
19	Cosumnes	Cosumnes Subarea (#7)	2,378
20	Modesto	Modesto Subarea (#8)	3,071

2.3 Stream Configuration and Stream Inflow

The model hydrology is represented by 25 model stream reaches, which are largely defined to start and/or end at confluences. Major streams include Cosumnes River, Dry Creek, Mokelumne River, Bear Creek, Calaveras River, Stanislaus River, Tuolumne River, and San Joaquin River (Figure 9). Many of these streams route water along connecting sloughs and canals, including Pixley Slough, Mosher Creek, Potter Creek, Mormon Slough, and Diverting Canal. As described in Section 2.2, the model grid was designed to include other hydrologic features such as major reservoirs or other important streams that may be simulated in ESJWRM in the future. Hydrologic features used during grid development (i.e., reservoirs and minor streams) include Camanche Reservoir, Duck Creek, Farmington Flood Control Basin, French Camp Slough, Little Johns Creek, Lone Tree Creek, Modesto Reservoir, Tracy Lakes, and Woodward Reservoir (Figure 5 and Figure 9). These hydrologic features represent important drainage and conveyance water courses in the model, while the model streams interactively simulate flows and stream-aquifer interaction at every model stream node.

The streams and creeks are represented in the model by 1674 stream nodes on a quarter-mile interval. The number of stream nodes and their refined resolution provide increased accuracy when depicting stream-groundwater interaction. Physical characteristics, including the stream invert elevation, channel width, and a stream flow rating table, were obtained from the closest C2VSim stream nodes and United States Geological Survey (USGS) Digital Elevations Models (DEM).

Time series of stream inflow data is available from 7 USGS and the United States Army Corps of Engineers (USACE) gauging stations. This data is consistent with C2VSim streamflow data (Brush, 2013). A table of stream input data and a map of available stream gauge locations may be found in Table 5 and Figure 9.

There was not sufficient data available for Bear Creek to generate a full time series record and it is only receiving runoff and/or drainage from nearby model elements.

Table 5: Summary of ESJWRM Stream Inflow Data

Stream	Stream Node	Source	Gauge Name	Period of Record	Average Annual Streamflow (acre-feet)
Cosumnes River	1	USGS	USGS 11335000: Cosumnes River at Michigan Bar, CA	October 1907 to present/ongoing	365,000
Dry Creek	140	USGS	Estimated in C2VSim by correlation with USGS 11329500: Dry Creek near Galt, CA	Not continuous October 1926 to December 1997	25,000
		USGS	Estimated in C2VSim by correlation with USGS 11335000: Cosumnes River at Michigan Bar, CA	Used October 1987 to September 1995 and January 1998 to present/ongoing	
Mokelumne River	290	USGS	USGS 11323500: Mokelumne River below Camanche Dam, CA	October 1904 to present/ongoing	525,000
Calaveras River	758	USGS	USGS 11308900: Calaveras River below New Hogan Dam near Valley Springs, CA	February 1961 to September 1990	151,000
		USACE	New Hogan Dam releases	October 1990 to present/ongoing	
Stanislaus River	1033	USGS	USGS 11302000: Stanislaus River below Goodwin Dam near Knights Ferry, CA	February 1957 to present/ongoing	575,000
Tuolumne River	1248	USGS	USGS 11289650: Tuolumne River below Lagrange Dam near Lagrange, CA	October 1970 to present/ongoing	835,000
San Joaquin River	1497	USGS	USGS 11303500: San Joaquin River near Vernalis, CA	October 1923 to present/ongoing	3,089,000

ESJWRM also specifies how water routes at forks in the rivers. Ten percent of Bear Creek flows through Pixley Slough before returning to Bear Creek, while 90% continues in Bear Creek. Eighty percent of Calaveras River flows through Mormon Slough and the Diverting Canal before returning to Calaveras River, while 20% continues in Calaveras River.

2.4 Precipitation

Rainfall data for the model area is derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) database used in the DWR's CALSIMETAW (California Simulation of Evapotranspiration of Applied Water) model. The database contains daily precipitation data from October 1, 1921 on a 4-kilometer grid throughout the model area. ESJWRM has monthly rainfall data defined for every model element in order to preserve the spatial distribution of the monthly rainfall. Each of the model elements was mapped to the nearest of 364 available PRISM reference nodes, uniformly distributed across the model domain. The resulting average annual precipitation is shown in Figure 10.

Figure 11 shows the annual rainfall in the model area and the cumulative departure from mean, which is an indication of long-term rainfall trends in the area. The minimum precipitation during the simulation period was in water year 2007 with 8.0 inches, while the maximum occurred in water year 1998 with 28.5 inches. The average precipitation was 15.1 inches, with 9 above average and 12 below average simulation years.

2.5 Root Zone Soil Parameters

The soil properties specified in the model are field capacity, wilting point, total porosity, saturated hydraulic conductivity, and pore size distribution index (PSDI). A recent update to IWFM added the capability to specify a separate saturated hydraulic conductivity for areas covered by rice or wetlands, which prevents the overestimation of deep percolation during periods of ponded water. All the soil properties are used to determine the soil types and characteristics of each model element.

DWR's IWFM Soil Data Builder (DWR, 2017) was used in conjunction with the United States Department of Agriculture (USDA) Soil Survey Geographic Database (SSURGO) (USDA, 2017a) soil data to determine the five soil properties for each model element. The IWFM Soil Data Builder extracts the SSURGO data relevant to the model area (in this case, 6 counties) and associates it with each grid element. For ESJWRM elements where SSURGO data was incomplete, USDA's Digital General Soil Map of the United States (STATSGO2) data were used instead (USDA, 2017b). In total, a little over 3,500 elements (about 22% of all elements) used STATSGO2 data for at least one of the parameters. Editing of soil parameters is a standard part of IDC calibration and the final soil parameter values and their spatial distributions are discussed and shown in figures in Section 4.2.

Model elements are associated with the four hydrological soil groups according to their runoff potential and infiltration characteristics. ESJWRM elements with their corresponding hydrologic soil group are shown in Figure 12. The Natural Resource Conservation Service (NRCS) (USDA NRCS, 2009) defines these hydrological soil groups as follows:

- Group A – Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
- Group B – Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures.

Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

- Group C – Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.
- Group D – Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential.

2.6 Land Use and Cropping Patterns

For the model to calculate water supply requirements, every model element needs to have land use defined for every year of the simulation. ESJWRM includes 23 irrigated crop categories and 4 general land use categories. All of the irrigated crop categories except for rice are simulated as non-ponded crops, meaning they are grown without standing water. Rice is simulated as both no decomposition (assumed 20% of total rice area) and flooded decomposition (assumed 80% of total rice area) to represent the current understanding of local growing practices. The general land use categories include urban landscape (e.g., residential areas, golf courses, and school fields), water surface (e.g., streams, lakes, and reservoirs), riparian vegetation (e.g., native vegetation located near surface water), and native vegetation. The irrigated crop categories were combined into 6 high-level groupings of crops with similar water use or irrigation practices. Table 6 lists the land use categories.

The crop categories are identical to those in C2VSim, except that ESJWRM breaks out almonds, cherries, pistachios, and walnuts as individual categories. This was done at the request of the Technical Review Committee based on the importance and amount of these crops in the ESJ Subbasin.

Spatial land use data was used to specify land use types and crop acreages for each model element for each year. The three major reference sources include DWR land use surveys, CropScape, and Land IQ. As crop categories were not consistent across all the land use data sources, individual mappings matched up each crop type to model land use category.

DWR conducts periodic land use surveys for each county that include over 70 different crop categories, as well as urban and native vegetation, for each parcel or field (DWR, 1993-2000). DWR land use surveys have high accuracy due to extensive ground truthing. For ESJWRM, the land use surveys by county were merged and assumed to represent water year 1995 in the model. The surveys used include:

1. San Joaquin County (1996)
2. Sacramento County (1993)
3. Amador County (1997)
4. Calaveras County (2000)
5. Stanislaus County (1996)

Data for water years 2007 through 2015 are from the USDA's remote sensing CropScape data (USDA NASS, 2007-2015). CropScape includes 256 land use categories that come from annual satellite imagery collected during the growing season on 30-meter by 30-meter pixels. Based on reports on the CropScape website, the level of accuracy for this data is about 85-97% for crop-specific land cover categories. Although this level of accuracy is relatively high, the accuracy varies depending on many factors, including the time of the satellite image, growing season timing, cloud cover, type of crop, and maturity state of the crop.

DWR retained Land IQ to develop a statewide assessment of agricultural land use in summer 2014. Land IQ used remote sensing methods to collect and process the data at the parcel scale, which was then ground truthed for a reported overall accuracy of 96.6% (DWR, 2014). In ESJWRM, this data was used as verification of CropScape 2014 data and, in some cases, as replacement or enhancement of the CropScape data. Land IQ did not include a native vegetation category, so any blank land was assumed to be native vegetation.

Table 6: Land Use Categories

Land Use Type	Model Category	Grouped Categories
Irrigated Crops	Almonds Cherries Citrus & Subtropical Other Orchard Pistachios Walnuts	Fruit and Nut Trees
	Vineyards	Vineyards
	Alfalfa Pasture	Alfalfa and Irrigated Pasture
	Grain	Grain
	Corn Cotton Dry Beans Field Crops Safflower Sugar Beets	Field Crops
	Cucurbits Onion & Garlic Potatoes Tomato Fresh Tomato Processing Truck Crops	Truck Crops
	Rice	Rice
Other Land Use	Urban Landscape Water Surface Riparian Vegetation Native Vegetation	

Local data and knowledge was also utilized to refine and correct, when necessary, the cropping acreages developed based on the DWR land use surveys and CropScape years. To fill the gap between 1995 and 2007, all land use and crop categories were interpolated at the spatial resolution level of the model element. Thus, the geographic distribution of interpolated land use and cropping patterns are honored.

Consistent mappings were developed to link crop categories from the various data sources to model categories based on previous work done for C2VSim. Adjustments were made, as needed, at the element level to ensure that the land use and cropping pattern trends over time are reflective of local data. These adjustments were mostly based on local knowledge and information received from various entities, including irrigation districts, water districts, and municipalities.

Figure 13 and Figure 14 show the spatial distribution of the major land use categories in the ESJ Subbasin for 1995 and 2015. Figure 15 shows the annual trends of land use categories in the ESJ Subbasin.

Figure 16, Figure 17, and Figure 18 show the spatial distribution of the irrigated crops for 1995, 2014, and 2015. Figure 19a-19g show the annual cropping patterns, by high level categories, for the entire ESJ Subbasin and major model subareas.

Overall, land use trends from 1995 through 2015 show significant increases in total and irrigated agricultural acreage, with about 384,000 irrigated acres in ESJ Subbasin at the beginning of simulation and about 398,000 acres with agricultural production by 2015. This change from native to agricultural area brings additional stresses on the hydrological system, particularly as the majority of this increase comes from conversion to higher water permanent crops, particularly vineyards, almonds, and walnuts. This translates to a higher water requirement, largely provided either by groundwater or surface water, though changes in irrigation methods may mitigate some of the increased water need due to land use changes.

Not all the subareas show an increase in agricultural land; many remain relatively consistent through the entire simulation period. When there was a decrease in agricultural land, there was a compensating increase in urban land, indicating the expansion of urban areas.

2.7 Evapotranspiration

The crop evapotranspiration (ET) requirement is an important factor in agricultural demand estimation. Every ESJWRM land use category (except for water surface) plus small-stream watersheds must have average monthly values used for the entire simulation. To allow for spatial variability within the model, ET rates are also defined by model subregion.

The ET values are based on a variety of sources, including locally-developed data for the SSJID and the OID Agricultural Water Management Plans (AWMPs) (SJJID, 2015; OID, 2016) and averages for DWR's CIMIS (California Irrigation Management Information System) Zone 12 developed using the Mapping Evapotranspiration at High Resolution with Internalized Calibration (METRIC) methodology, which is a remote-sensing based technology to estimate crop actual ET. Based on discussions with locals (pers. comm. Jennifer Spaletta representing NSJWCD and Bryan Thoreson representing SSJID), deficit irrigation of vineyards was simulated in ESJWRM with reference to the growing season ET values in the Lodi area (Prichard).

In IWFM, ET represents the net vertical water flux from the land surface and root zone through the upper model boundary. Figure 20 shows the range in annual evapotranspiration rates from the various sources for the 27 categories. Final model ET depends on the model subregion, with SSJID and OID using their locally-developed ET rates and the remainder of the model using the METRIC data.

2.8 Drainage

Surface water drainage (e.g., runoff from rainfall and excess applied water) for each model element is assigned to a stream node representing where the drainage ultimately flows to. These drainage patterns were delineated using the USGS Watershed Boundary Dataset for 12-digit hydrologic units, also called subwatersheds. Each 12-digit hydrologic unit located within the model boundaries was associated with the model stream node it ultimately drained into through both visual analysis as well as information provided on the subwatersheds. Elements falling within the hydrologic units were assigned to the model stream node indicating the ultimate surface water drainage direction. A total of 94 unique stream nodes receive surface water drainage in ESJWRM from 79 subwatersheds. Figure 21 shows these stream nodes and the subwatersheds mapped to the model elements.

2.9 Model Layering

The subsurface zone is characterized by four model layers (three freshwater aquifers and one saline aquifer) representing the different geology from the ground surface to the bedrock. A small portion of the southwestern part of the subbasin has a confining unit of Corcoran Clay. The layering extents and thicknesses are all consistent with C2VSim. Descriptions of each of the model layers are listed below, from top to bottom.

- Layer 1: Layer 1 represents the top unconfined portion of the aquifer. The ground surface elevation (GSE), or the top of Layer 1, comes from the USGS DEM at a resolution of 10 meters. The bottom of Layer 1 is defined as the top of Corcoran Clay where the confining unit exists or else as the bottom of Layer 1 in C2VSim. The layer thickness is limited by the stream invert elevation and ranges from 34 to 966 feet. The GSE is shown in Figure 22 and thickness of Layer 1 is shown in Figure 23.
- Aquitard 1: Corcoran Clay (i.e., E Clay) separates Layers 1 and 2 in a small portion of the southwest corner of the model. The extent, thickness, and depth of the Corcoran Clay originated from the Central Valley Hydrologic Model (CVHM) Spatial Database. The depth to the Corcoran Clay, ranging from 20 to 280 feet below the GSE, is shown in Figure 24 and the thickness of the Corcoran Clay, ranging from 10 to 160 feet, is in Figure 25.
- Layer 2: Layer 2 represents the primary pumping layer and is beneath the confining layer where Corcoran Clay exists. Layer 2 is principally bounded on the top by the bottom of Layer 1 or the bottom of Corcoran Clay (where it exists) and on the bottom by Layer 2 in C2VSim. The thickness of Layer 2, ranging from 50 to 540 feet, is in Figure 26.
- Layer 3: Layer 3 extends to the base of fresh water. Information used in developing the bottom of Layer 3 includes data from Steven Springhorn of DWR's North Central Regional Office, Christopher Olvera of DWR's South Central Regional Office, and Williamson et al. 1989. The thickness of Layer 3, ranging from 50 to 1,335 feet, is in Figure 27.
- Layer 4: Layer 4 consists of the saline water ranging from the base of fresh water to the base of continental deposits and is a current non-production zone. Information used in developing the bottom of Layer 4 includes Page's 1974 Base and Thickness of the Post Eocene Continental Deposits in the Sacramento Valley and the thickness of the aquifer developed by Williamson et al. 1989. The thickness of Layer 4, ranging from 50 to 2,250 feet, is in Figure 28.

Cross sections of the model layering in various locations across the model extent can be seen in Figure 29a-29f.

2.10 Small-Stream Watersheds

The inflow from the eastern boundary of the model (i.e., Sierra Nevada foothills) originates from both gauged and ungauged watersheds. The simulation of gauged watersheds (i.e., stream inflows into the model) was discussed in Section 2.3 and shown in Figure 9. The simulation of the ungauged watersheds is explained in this section.

Flow from ungauged small watersheds is estimated based on precipitation rates and characteristics assigned to each identified ungauged watershed. A portion of flow from the small watershed enters the model area as surface runoff and flows to simulated streams. The remaining small watershed inflow infiltrates to groundwater.

ESJWRM simulates the ungauged eastern inflow using 39 distinct small watersheds (Figure 30), consistent with those on the eastern boundary of C2VSim. These were delineated originally from the USGS Watershed Boundary Dataset.

All subsurface inflows from these small watersheds are routed to model Layer 1 along specified groundwater nodes (Figure 30), with a user-defined maximum percolation rate at each node. Excess flows that do not infiltrate to groundwater enter the simulated streams at user-specified locations (Figure 30) delineated using a similar methodology to the drainage pattern discussed above in Section 2.8. The hydrologic conditions of these small watersheds used to estimate the subsurface and surface flows are represented using site-specific parameters (e.g., precipitation, surface layer soil parameters, runoff coefficient) based on C2VSim.

2.11 Boundary Conditions

As discussed in the previous section, inflows along the eastern boundary are represented using small watersheds. Boundary conditions define the subsurface inflows from all other boundaries of the model (i.e., northern, western, and southern), as well as areas with known groundwater levels.

Time series general head boundary conditions representing groundwater levels outside of the model area were defined for 596 boundary nodes on the northern, western and southern limits (i.e., along Cosumnes, Mokelumne, San Joaquin, and Tuolumne Rivers). Groundwater flow at the model boundaries was quantified based on the groundwater gradient across the model boundary. The head inside the model area is simulated by ESJWRM and the head outside the model area is based on historical groundwater elevation data from DWR's Water Data Library (WDL).

Additional groundwater boundary conditions were defined to simulate known groundwater elevations for the Sacramento-San Joaquin Delta and lakes or reservoirs (reservoir locations shown in Figure 5). ESJWRM specifies high groundwater levels at or near zero feet for 60 groundwater nodes representing the edges of the Sacramento-San Joaquin Delta. Using data available in C2VSim, seepage from Camanche Reservoir was represented by specifying the full time series of groundwater levels for the 270 groundwater nodes representing the reservoir. The other reservoirs in the model were not included in C2VSim, so did not have boundary conditions available to estimate reservoir seepage. Instead, Woodward Reservoir seepage is included as a stream diversion from Stanislaus River (see Section 3.3.1). Farmington Flood Control Basin is used primarily for flood control purposes. Any recharge is incidental to the operation of the dam and is currently not included in ESJWRM. Modesto Reservoir, as it is located outside of the focus area of ESJ Subbasin, was not simulated.

2.12 Initial Conditions

Groundwater heads for each model node and each layer at the beginning of the simulation (i.e., October 1, 1994) were developed using the DWR's WDL database and San Joaquin County's database of historical groundwater monitoring. Over 1,100 wells with data for Fall 1993, Fall 1994, or Fall 1995 were compiled and interpolated to create a raster representing initial groundwater levels for each model groundwater node. Due to the lack of information on well perforation and even depth for many of the WDL and San Joaquin County monitoring locations, the groundwater heads for each model layer are assumed to all begin at the same value. This assumption means the model needs about a year for groundwater levels to stabilize, so model results focus on water years 1996 through 2015 (a 20-year period). The initial conditions for ESJWRM representing October 1, 1994 are shown in Figure 31.

3. WATER SUPPLY AND DEMAND DATA

The following sections describe the data and methodology for the ESJWRM water demand and supply calculations. Agricultural and urban demand are calculated in the IDC portion of IWFM. Agricultural and urban supply are specified in IWFM's groundwater pumping and surface water diversion data.

3.1 Agricultural Water Demand

Agricultural water demand is the amount of irrigation water that is required to satisfy the crops evapotranspiration requirement. The IWFM Demand Calculator or IDC is designed to estimate the agricultural water demand for each model element through consumptive use methodology. The IDC calculations rely on model input data for historical crop acreage, irrigation practices (e.g., return and reuse fractions, irrigation period), soil moisture requirements, effective rainfall (the portion of rainfall available for crop consumptive use), crop evapotranspiration, and localized soil parameters. This data was compiled, analyzed, synthesized, and processed for input in ESJWRM.

Precipitation, land use, evapotranspiration, and soil properties are discussed in the relevant sections in Chapter 2. Irrigation period, using data from C2VSim, defines irrigation as either on or off for each crop and each month of the model simulation period. These were vetted and revised as necessary by the Technical Review Committee to better represent local practices in the ESJWRM area. Most trees are assumed irrigated from April through October (with almonds and pistachios from February through October), vineyards from May through October, most field crops from May through September, and most truck crops from April through September. Crops with irrigation assumed year-round include citrus and subtropical trees, irrigated pasture, alfalfa, and onions and garlic. Fractions to represent return flow (i.e., irrigation flow following the model drainage pattern discussed in Section 2.8) and reuse (i.e., the fraction of applied irrigation water to be reused for irrigation) are from C2VSim and are defined by subregion. For all ESJWRM, agricultural lands are given a 1% return flow and 1% reuse factor and urban landscape areas are assumed to have 15% return flow and 0% reuse.

3.2 Urban Water Use

IDC calculates urban demand based on per capita water use, population, and the breakdown of indoor versus outdoor water use by month. Figure 32 shows the annual population trends for each urban center. Figure 33 shows the annual per capita water use values of these urban centers used in the calculation of urban water demand.

Population and per capita water use for the major urban areas were largely provided directly by the urban areas or were obtained from the respective Urban Water Management Plans (UWMP). Additional annual population, including an estimate for rural urban areas, came from the United States Census Bureau and the California Department of Finance. Monthly per capita water use, commonly reported in gallons per capita per day (GPCD), was generally estimated for each urban entity using the annual population and monthly urban water use (provided by cities based on water delivery records). To estimate the urban water demand of rural domestic water areas, the average major urban area GPCD was combined with estimated rural population.

It was assumed that an annual average of 60% of urban water was used indoors and 40% was used outdoors. The monthly fractions entered into the model had the majority of urban water demand due to indoor activities from November through March and up to a maximum of 60% of urban water used outdoors for the remainder of the year.

The indoor/outdoor breakdown received concurrence from the urban water providers who attended the Technical Review Committee meetings. Population and per capita water use data were reviewed by the major urban areas and confirmed at the meetings (pers. comm. Kathryn Garcia from Lodi, Andrew Richle from Lodi, Michael Bolzowski from Cal Water, Greg Gibson from Lathrop, and Elba Mijango from Manteca).

3.3 Water Supply Summary

Both the agricultural and urban demands estimated by IDC are primarily met through the IWFM representation of surface water diversions and groundwater pumping. Other sources of water simulated in IWFM to meet demand include precipitation and existing moisture in the soil.

3.3.1 Surface Water

Historical surface water diversions for the simulation period were compiled from a combination of sources discussed in more detail in Section 3.4, including gauge data, water rights reports, UWMPs, AWMPs, and other sources. Some diversions were estimated based on historical demands. A summary of diversions simulated in the model is provided in Table 7, along with fractions for recoverable loss (i.e., percolation or canal seepage), non-recoverable loss (i.e., evaporation), and delivery (i.e., amount delivered is equal to the total amount minus the recoverable and non-recoverable losses).

The monthly data for all these diversions came from local agencies or C2VSim (Modesto Subbasin diversions and riparian diversions) as discussed in more detail in Section 3.4. Many diversions provide water across model subregions, so deliveries are assigned to a group of elements representing the delivery area. Diversions either are taken out of streams at specified model streams nodes or are imported into the model area (i.e., diversion location occurs upstream of stream inflow gauge). Figure 34 shows the stream nodes where diversions occurred.

Table 7: Summary of ESJWRM Surface Water Deliveries

ID	Description	Diversion Location	Delivery Area	Use	Fraction			Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery		
1	Mokelumne River to Woodbridge ID for Ag	Mokelumne River at Lodi Lake	Element group representing Woodbridge Irrigation District	Ag	30%	2%	68%	56,700	WID
2	Mokelumne River to City of Lodi (by agreement with Woodbridge ID)	Mokelumne River at Lodi Lake	Lodi Sphere of Influence	Urban	3%	1%	96%	5,000	WID

ID	Description	Diversion Location	Delivery Area	Use	Fraction			Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery		
3	Mokelumne River to City of Stockton for Delta Water Supply Project (by agreement with Woodbridge ID)	Mokelumne River at Lodi Lake	Element group representing Stockton area minus Cal Water	Urban	3%	1%	96%	5,400	WID
4	Mokelumne River to Contra Costa WD (by agreement with Woodbridge ID)	Mokelumne River at Lodi Lake	Export out of model	Urban	0%	0%	100%	2,000 (one year only)	WID
5	Mokelumne River to North San Joaquin WCD For Ag	Mokelumne River between Camanche Reservoir and Lodi Lake	Element group representing North San Joaquin WCD	Ag	10%	2%	88%	2,200	NSJWCD
6	Calaveras River to Bellota Pipeline to Stockton East WD WTP for M&I	Calaveras River at split with Mormon Slough	Stockton Sphere of Influence	Urban	3%	1%	96%	15,800	SEWD
7	Calaveras River to Calaveras County WD for Ag	Import (outside of ESJWRM)	Calaveras Subregion (Subregion 5)	Ag	9%	1%	90%	1,100	CCWD
8	Calaveras River to Stockton East WD for Ag	Calaveras River at split with Mormon Slough	Element group representing Stockton East Water District agricultural customers	Ag	40%	5%	55%	42,600	SEWD
9	Calaveras River to Farmington Groundwater Recharge Program	Calaveras River at split with Mormon Slough	Element group representing recharge locations	Ag	100%	0%	0%	1,300	SEWD
10	San Joaquin River at Empire Tract to City of Stockton for Delta Water Supply Project	San Joaquin River at Empire Tract just after junction with Bear Creek	Element group representing Stockton area minus Cal Water	Urban	3%	1%	96%	7,800	City of Stockton

ID	Description	Diversion Location	Delivery Area	Use	Fraction			Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery		
11	San Joaquin River to North Delta	San Joaquin River near North Delta Subregion	Element group representing North Delta	Ag	5%	1%	94%	107,000	Estimated by model
12	San Joaquin River to South Delta	San Joaquin River near South Delta Subregion	Element group representing South Delta	Ag	5%	1%	94%	14,200	Estimated by model
13	Farmington Reservoir via Lower Farmington Canal to Peters Pipeline to Stockton East WD WTP	Import (outside of ESJWRM)	Stockton Sphere of Influence	Urban	3%	1%	96%	33,300	SEWD
14	Farmington Reservoir via Lower Farmington Canal to Stockton East WD for Ag	Import (outside of ESJWRM)	Element group representing Stockton East Water District agricultural customers	Ag	15%	2%	83%	5,300	SEWD
15	Farmington Reservoir via Little Johns Creek and Lower Farmington Canal to Central San Joaquin WCD for Ag	Import (outside of ESJWRM)	Element group representing Central San Joaquin WCD	Ag	28%	2%	70%	38,800	SEWD
16	Stanislaus River to Farmington Groundwater Recharge Program	Import (outside of ESJWRM)	Element group representing recharge locations	Ag	100%	0%	0%	3,000	SEWD
17	Woodward Reservoir to South San Joaquin ID for Ag	Import (outside of ESJWRM)	Element group representing South San Joaquin ID minus Division 6	Ag	21%	6%	74%	195,300	SSJID
18	Stanislaus River at Goodwin Dam to Oakdale ID for Ag	Import (outside of ESJWRM)	Element group representing Oakdale ID	Ag	16%	1%	83%	111,100	OID

ID	Description	Diversion Location	Delivery Area	Use	Fraction			Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery		
19	Woodward Reservoir Seepage	Import (outside of ESJWRM)	Element group representing Woodward Reservoir	Ag	100%	0%	0%	17,500	SSJID
20	Woodward Reservoir to Nick C. DeGroot WTP to City of Manteca for M&I	Import (outside of ESJWRM)	Manteca Sphere of Influence	Urban	3%	1%	96%	6,300	AWMP/ UWMP
21	Woodward Reservoir to Nick C. DeGroot WTP to City of Escalon for M&I	Import (outside of ESJWRM)	Escalon Sphere of Influence	Urban	3%	1%	96%	0	AWMP/ UWMP
22	Woodward Reservoir to Nick C. DeGroot WTP to City of Lathrop for M&I	Import (outside of ESJWRM)	Lathrop Sphere of Influence	Urban	3%	1%	96%	1,100	AWMP/ UWMP
23	Woodward Reservoir to Nick C. DeGroot WTP to City of Ripon for M&I	Import (outside of ESJWRM)	Ripon Sphere of Influence	Urban	3%	1%	96%	0	AWMP/ UWMP
24	Tuolumne River to Modesto ID	Import (outside of ESJWRM)	Element group representing Modesto ID	Ag	15%	3%	82%	307,600	C2VSim
25	Tuolumne River to City of Modesto (via Modesto ID)	Import (outside of ESJWRM)	Element group representing City of Modesto	Urban	5%	1%	94%	30,600	C2VSim
26	Cosumnes River to Riparian for Ag	Along Cosumnes River near confluence with Mokelumne River	Element group representing riparian diverters	Ag	10%	2%	88%	4,300	C2VSim
27	Dry Creek to Riparian for Ag	Approximately midway along Dry Creek	Element group representing riparian diverters	Ag	10%	2%	88%	6,000	C2VSim

ID	Description	Diversion Location	Delivery Area	Use	Fraction			Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery		
28	Mokelumne River to Riparian for Ag	Approximately midway along Mokelumne River	Element group representing riparian diverters	Ag	10%	2%	88%	9,700	C2VSim
29	Calaveras River to Riparian for Ag	Calaveras River at split with Mormon Slough	Element group representing riparian diverters	Ag	10%	2%	88%	20,400	C2VSim
30	Stanislaus River to Riparian for Ag	Approximately midway along Stanislaus River	Element group representing riparian diverters	Ag	15%	3%	82%	20,700	C2VSim
31	Tuolumne River to Riparian for Ag	Approximately midway along Tuolumne River	Element group representing riparian diverters	Ag	15%	3%	82%	2,500	C2VSim
32	San Joaquin River to Riparian for Ag	San Joaquin River near confluence with Tuolumne River	Element group representing riparian diverters	Ag	15%	3%	82%	6,200	C2VSim
33	Woodward Reservoir to South San Joaquin ID Division 6 for Ag	Import (outside of ESJWRM)	Element group representing South San Joaquin ID Division 6	Ag	15%	2%	83%	5,200	SSJID

*RL = Recoverable Loss (canal seepage or recharge)
**NL = Non-Recoverable Loss (evaporation)
*** Averages calculated only for years with diversions occurring (i.e., non-zero average)

3.3.2 Groundwater Pumping

Groundwater pumping within ESJWRM is separated into well- or element-based pumping. The former largely includes district-operated wells that feed into the surface water supply network, while the latter includes estimated private groundwater pumping.

District pumping (or well pumping) is specified monthly throughout the simulation period. Data was provided by local agencies and included well locations, depths and perforations, use (agricultural or urban) and historical monthly pumping records. Table 8 lists the number of wells by type and agency included in ESJWRM. Figure 35 shows all the district pumping wells (separated by agricultural and municipal wells) in ESJWRM.

Table 8: Summary of ESJWRM Well Pumping

Agency	Number of Urban Pumping Wells	Number of Agricultural Pumping Wells	Average Annual Urban Pumping (acre-feet)	Average Annual Agricultural Pumping (acre-feet)
Cal Water	56	---	9,600	0
Escalon	4	---	1,400	0
Lathrop	6	---	2,200	0
Linden County WD	4	---	450	0
Lockeford CSD	4	---	530	0
Lodi	29	---	15,200	0
Manteca	15	31	9,500	1,300
Oakdale ID	---	24	0	5,800
Ripon	9	9	3,900	1,100
SEWD	5	---	3,100	0
SSJID	---	28	0	5,200
Stockton	37	---	9,300	0
Total Average Annual Pumping (acre-feet)			55,180	13,400

Private groundwater pumping quantities on an individual well basis are largely unknown, though aggregate estimates for private pumping are often included in planning documents (e.g., AWMPs, UWMPs, groundwater management plans). Therefore, private agricultural pumping in ESJWRM is estimated by IWFM on an element basis by assigning two virtual wells at the centroid of each model element. One well represents private agricultural pumping and one well represents rural residential pumping. These wells are used to calculate any additional pumping necessary to meet the agricultural and urban demand estimated by IDC for an element after district pumping and surface water has been distributed.

The perforation interval, which dictates the layers a simulated well extracts water from, were assigned separately to the agricultural and domestic (i.e., rural residential) wells. All agricultural wells were assumed to pump 40% from Layer 1 and 60% from Layer 2. Rural residential wells used a statistical analysis of perforation interval developed for C2VSim. Perforation interval data was compiled by DWR using data from the CASGEM and Online System for Well Completion Reports (OSWCR) databases. Simulated perforation intervals were assigned as the 5th and 95th percentiles of the well perforation interval data for each township/range block.

3.4 Water Supply Sources

This section provides a detailed description of the sources of water supply (both surface water and pumping) occurring in ESJWRM.

3.4.1 Delta Areas

The North Delta and South Delta Subregions (Subregion 1 and 14) are mostly assumed to cover the portion of the Sacramento-San Joaquin River Delta overlying the ESJ Subbasin. As discussed at the Technical Review Committee meetings, the majority of the agricultural water demand in these areas is known to be entirely served by surface water taken off the San Joaquin River. Therefore, almost all of the agricultural demand is assumed to be supplied by the San Joaquin River (Diversion #11 and #12 for North Delta and

South Delta, respectively). A small portion of the agricultural land is assumed to rely on groundwater via element pumping. All of the urban demand is supplied by small, private residential wells and is estimated in ESJWRM using element pumping.

Though Subregions 1 and 14 are assumed to represent the Delta, elements in Subregions 1 and 14 receive surface water from other diversions unrelated to the assumed riparian Delta diversions. A portion of WID's delivery area extends into Subregion 1 and is supplied by WID's diversion off the Mokelumne River (Diversion #1) as discussed in Section 3.4.2. Portions of other riparian diversions discussed in Section 3.4.19 extend into Subregions 1 and 14, specifically Dry Creek (Diversion #27) in Subregion 1 and San Joaquin River (Diversion #32) in Subregion 14.

3.4.2 Woodbridge Irrigation District

WID receives water from the Mokelumne River, which is provided to its agricultural customers through a distribution canal network or is sold to nearby municipalities. Through agreements, Lodi and Stockton use some of WID's surface water right beginning in water years 2013 and 2012, respectively (Diversion #2 and #3). In water year 2013, WID supplied Contra Costa Water District with a one-time transfer of 2,000 AF (acre-feet), represented by Diversion #4. Diversion #1 delivers water to the element group representing WID's service area, which spans portions of Subregion 1, most of Subregion 2, part of Subregion 3, and a small area of Subregion 6. The scale of the ESJWRM element grid is not refined enough to simulate deliveries on the parcel scale, so model elements may include parcels which do not in actuality receive surface water from WID.

Some of the agricultural demand (largely native landscape) adjacent to streams is met by the riparian diversion from Mokelumne River (Diversion #28) as discussed in Section 3.4.19. All remaining agricultural demand is estimated in ESJWRM as element pumping. All urban demand is likewise element pumping.

3.4.3 City of Lodi

The City of Lodi purchases surface water from WID, which it takes from the Mokelumne River adjacent to the city. Diversion #2 supplies part of the urban demand beginning in water year 2013, with all of the previous demand being met exclusively by groundwater. 29 municipal wells are simulated in the model, with at least 3 becoming inactive during the simulation period. Since Lodi began receiving surface water, its supply mix has steadily decreased its reliance on groundwater, from 100% of the urban demand in water year 2012 to 55% of the demand in water year 2015, with its increase in surface water use.

The agricultural land surrounding the current city boundaries is supplied by either WID on the west or NSJWCD to the east. Though the agricultural demand in these areas is small, WID's Diversion #1 or NSJWCD's Diversion #5, along with the riparian diversion from Mokelumne River (Diversion #28) (see Section 3.4.19), are able to supply some of the agricultural demand adjacent to Lodi. The city's wastewater treatment plant, located to the west of the city in Subregion #1, is surrounded by fields irrigated using recycled water from the treatment plant. Any additional agricultural or urban demand is estimated in ESJWRM as element pumping.

3.4.4 North San Joaquin Water Conservation District

NSJWCD receives water from the Mokelumne River, which is provided to its agricultural customers as Diversion #5. Historically, NSJWCD has not used its entire water right allotment and did not divert any water towards the end of the simulation (starting water year 2013).

Some of the agricultural demand adjacent to water is met by the riparian diversions from Dry Creek (Diversion #27) and Mokelumne River (Diversion #28) (see Section 3.4.19). Any additional agricultural demand is estimated in ESJWRM as element pumping, while small domestic urban demand is met by element pumping.

3.4.5 Lockeford Community Services District

LCSD is located within ESJWRM Subregion 4 and is surrounded by agricultural land under NSJWCD. LCSD has 4 municipal pumping wells used to meet all the urban demand generated by its customers. Some of the agricultural demand is met by the riparian diversion from Mokelumne River (Diversion #28) (see Section 3.4.19), while the remaining is met by element pumping.

3.4.6 Calaveras County

Only a small portion of Calaveras County extends into the ESJ Subbasin and the land is mostly unirrigated or native vegetation with small residential pockets and some irrigated agricultural parcels. CCWD uses a small amount of Calaveras River water for agricultural demand in the ESJ Subbasin (Diversion #7). Additional agricultural demand is met by the riparian diversion from Calaveras River (Diversion #29) (see Section 3.4.19) or element pumping. All the residential demand is met by element pumping.

3.4.7 Stockton Area

The Stockton area includes service areas of both the City of Stockton as well as Cal Water. San Joaquin County also manages water for several unincorporated areas in and around the city.

Both the City of Stockton and Cal Water purchase surface water for urban use from SEWD. The water originates from either the Calaveras or Stanislaus Rivers and is delivered to customers after treatment at the SEWD water treatment plant (Diversion #6 and Diversion #13). Additionally, Stockton began the Delta Water Supply Project in water year 2012 and built a water treatment plant, providing another source of surface water for the area from San Joaquin River at Empire Tract (Diversion #10) and Mokelumne River via agreement with WID (Diversion #3).

Stockton, Cal Water, and San Joaquin County maintain pumping wells for urban water use. Due to the scale of the element grid, many of the San Joaquin County areas were too small to be simulated separately from Stockton or Cal Water. Thus, San Joaquin County groundwater pumping is instead estimated by element pumping in ESJWRM. Stockton itself has 37 municipal wells in the area, though only about 14 are still active at the end of the simulation. Cal Water maintains a separate delivery area and operates 56 wells to meet urban demand, though only about 20 wells are active at the end of ESJWRM's historical simulation. Due to the complexity of the water supply in the area, the supply mix for urban water use in ESJWRM is difficult to separate by agency, though for the entire area is, on average, 70% surface water and 30% groundwater pumping with the reliance on groundwater decreasing toward the end of simulation due to the construction of the Delta Water Supply Project.

One riparian diversion from Calaveras River (Diversion #29) provides water to areas adjacent to the river (see Section 3.4.19). Additional agricultural demand may be met by surface water from WID (Diversion #1) where it extends into the northern part of the Stockton area or SEWD (Diversion #8 and Diversion #14). Any additional agricultural demand occurring in the area is supplied by the estimated element pumping.

3.4.8 Stockton East Water District

SEWD receives water from both Calaveras River (i.e., New Hogan Lake) and Stanislaus River (i.e., New Melones Lake) and sells water to its customers for both agricultural and municipal purposes. Agricultural water is delivered directly to customers scattered across the district area (model Subregions 6 and 7). Municipal water, as discussed in Section 3.4.7, is routed to SEWD's water treatment plant and is sold to the City of Stockton and Cal Water. Beginning in water year 2003, SEWD has operated groundwater recharge projects near its water treatment plant, utilizing water taken from both the Calaveras and Stanislaus Rivers.

In Table 7, SEWD's two urban diversions are Diversion #6 and Diversion #13, the two agricultural diversions are Diversion #8 and Diversion #14, and the two diversions used for recharge are Diversion #9 and Diversion #16. One riparian diversion from Calaveras River (Diversion #29) provides water to areas adjacent to the river (see Section 3.4.19). SEWD operates 5 urban pumping wells in the vicinity of the water treatment plant that are mixed with the surface water for use in the Stockton area and are utilized rarely (only during water year 2015 during the simulation period of ESJWRM). Any additional agricultural or urban demand is met by element pumping.

3.4.9 Linden County Water District

LCWD is located within ESJWRM Subregion 7 and is surrounded by agricultural land under SEWD. Though it receives no surface water, LCWD has 4 municipal pumping wells to meet all the urban demand generated by its customers. By the end of the simulation, only 2 of the wells are still active.

3.4.10 Central San Joaquin Water Conservation District

CSJWCD receives water from Stanislaus River (i.e., New Melones Lake) (Diversion #15) that is used for agricultural demand in model Subregion 8. Any additional agricultural demand is estimated as element pumping by ESJWRM. All the private residential urban demand is likewise calculated as element pumping.

3.4.11 South San Joaquin Irrigation District

SSJID's service area covers the agricultural lands around the cities of Manteca, Ripon, and Escalon. SSJID provides water to agricultural customers within the district using water from the Stanislaus River (taken out at Goodwin Dam) and then stored in Woodward Reservoir just east of the district's area in Stanislaus County. Diversion #17 represents the agricultural diversion from Woodward Reservoir that is delivered to SSJID's customers through its series of canals covering the district. Based on communication with SSJID, one portion of SSJID, Division 6 (formerly Division 9), began receiving more surface water beginning in water year 2011. An increase in surface water to Division 6 (near Ripon in Subregions 15 and 16) is simulated using Diversion #33. Diversion #19 represents the seepage from Woodward Reservoir as SSJID had monthly data estimating the groundwater recharge due to the reservoir. Diversion #30 simulates the riparian diverters along Stanislaus River (see Section 3.4.19).

SSJID maintains 28 agricultural wells located in and around the City of Manteca to augment their surface water supply. Any remaining agricultural demand in the district is met by element pumping estimated by ESJWRM.

The Nick C. DeGroot Water Treatment Plant located at Woodward Reservoir was constructed as part of the South County Water Supply Project through the collaboration of SSJID and the cities of Escalon, Lathrop, Manteca, and Tracy. Beginning in water year 2005, surface water deliveries from the treatment plant began to Lathrop, Manteca, and Tracy with Escalon deliveries to begin in the future (currently

Escalon's allotment is sold to Tracy). Ripon potentially may be added to the project at a later point. These deliveries are simulated in ESJWRM as Diversion #20 (Manteca), #21 (Escalon), #22 (Lathrop), and #23 (Ripon). Urban demand in these areas in discussed further in the relevant sections below. Any private residential demand estimated by ESJWRM in SSJID is met by element pumping.

3.4.12 City of Lathrop

Lathrop has 6 municipal pumping wells, one of which was inactive for the entire simulation period but may come back online for future use. The city began receiving surface water from the South County Water Supply Project in water year 2005 (Diversion #22) and will receive a higher allotment in future phases of the project.

Since Lathrop began receiving surface water and normalized for the drought, its supply mix has steadily decreased its reliance on groundwater, from 100% of the urban demand in water year 2004 to an average of 74% of the demand after the South County Water Supply Project began (ranging from 53% to 92% at the peak of the drought).

The small amount of agricultural demand in the vicinity of Lathrop is supplied by element pumping in ESJWRM. Recycled water is utilized for some fodder crop irrigation and will be incorporated in baseline runs of the model.

3.4.13 City of Manteca

Manteca has 15 active municipal wells that provide water for urban use and 31 active agricultural wells used to irrigate city landscaping. Agricultural land near the city is irrigated by SSJID's diversion from Stanislaus River (Diversion #17). Starting in water year 2005, Manteca began receiving water from the South County Water Supply Project (Diversion #20). Additional agricultural and urban demand not met by the mix of groundwater pumping and surface water supply is estimated in the model as element pumping.

Since Manteca began receiving surface water, its supply mix has steadily decreased its reliance on groundwater, from 100% of the urban demand before water year 2005 to an average of 62% of the demand after.

3.4.14 City of Ripon

Ripon has 9 municipal pumping wells, at least 5 of which remain active at the end of the historical simulation. In addition, Ripon has 3 agricultural wells used for the city's non-potable system and 6 non-potable wells owned by Nestle. The groundwater pumping is augmented by SSJID's diversion from Stanislaus River (Diversion #17) used for agricultural land surrounding the city. The city is currently not receiving surface water for municipal use from the South County Water Supply project, but may pursue that possibility in the future (Diversion #23). Currently, all the urban demand is met by groundwater pumping.

Adjacent to the Stanislaus River, some elements are receiving water for agricultural purposes from the Stanislaus River riparian diversion (Diversion #30) as discussed in Section 3.4.19.

3.4.15 City of Escalon

Escalon has 4 municipal pumping wells, at least 3 of which remain active at the end of the simulation. Starting in water year 2005, the city was eligible to receive water from the South County Water Supply Project (Diversion #21), but has yet to build the pipeline necessary to take advantage of the allotted surface water. Currently, Escalon sells its allotment to the City of Tracy (located in San Joaquin County but outside of the ESJ Subbasin).

Agricultural land near the city is irrigated by SSJID's diversion from Stanislaus River (Diversion #17) as discussed in Section 3.4.19. Any remaining agricultural demand is supplied using ESJWRM's element pumping estimates.

3.4.16 Oakdale Irrigation District

OID takes surface water from Stanislaus River at Goodwin Dam that splits from SSJID's water to go into OID's distribution system to supply to agricultural users (Diversion #18). The district's delivery area is spread between elements in ESJWRM Subregions 13, 18, and 20. Additional agricultural water comes from OID's 24 wells spread around the district's area.

3.4.17 Cosumnes Subbasin

As it is outside of the model focus area of ESJ Subbasin, the only diversions simulated in the Cosumnes Subbasin in ESJWRM are the riparian diversions from Cosumnes River (Diversion #26) and Dry Creek (Diversion #27) (see Section 3.4.19). Any additional agricultural or urban demands are met in the model by element pumping.

3.4.18 Modesto Subbasin

Three riparian diversions extend to elements in the Modesto Subbasin—Stanislaus River (Diversion #30), Tuolumne River (Diversion #31), and San Joaquin River (Diversion #32) (see Section 3.4.19). Additional agricultural surface water comes from the Tuolumne River to Modesto Irrigation District using data in C2VSim (Diversion #24). OID's delivery area extends into the Modesto Subbasin and receives a portion of OID's diversion off Stanislaus River (Diversion #18). Any remaining agricultural demand is supplied by ESJWRM-calculated element pumping.

Urban demand in the Modesto Subbasin is largely met using element pumping, except in the area of the City of Modesto, which receives surface water from Tuolumne River (via Modesto Irrigation District) in Diversion #25, with data from C2VSim.

3.4.19 Riparian Diverters

C2VSim includes surface water diversions to non-district riparian water users along simulated streams. This information (diversion volumes, locations, and delivery areas) was pulled from C2VSim and used to simulate riparian diversions in ESJWRM. These diversions are from Cosumnes River (Diversion #26), Dry Creek (Diversion #27), Mokelumne River (Diversion #28), Calaveras River (Diversion #29), Stanislaus River (Diversion #30), Tuolumne River (Diversion #31), and San Joaquin River (Diversion #32). The riparian lands receiving these diversions are shown in Figure 36.

4. MODEL CALIBRATION

The goals of model calibration are (1) to achieve a reasonable water budget for each component of the hydrologic cycle modeled (i.e., land and water use, soil moisture, stream flow, and groundwater) and (2) to maximize the agreement between simulated and observed groundwater levels at selected well locations and simulated and observed streamflow hydrographs at selected gauging stations. These objectives are achieved through verification of the model input data and adjustment of model parameters.

4.1 Model Calibration

Model calibration begins after data analysis and input data file development is completed. The calibration effort can be broken down into subsets that align with packages within the IWFM platform. As an integrated groundwater model, the results of each part of the simulation are dependent on one another. The model calibration can be considered a systematic process that includes the following activities:

- Calibrate hydrologic demand
- Calibrate surface water features
- Calibrate overall water budgets for the model area
- Calibrate simulated groundwater levels to observed groundwater levels
- Compare calibration performance with the calibration targets
- Conduct additional refinements to model as necessary

ESJWRM was calibrated to local data and knowledge, surface water flows, groundwater hydrographs, and groundwater contours. The sources used to check model results include local knowledge (mainly gathered during Technical Review Committee meetings), AWMPs, UWMPs, other local planning efforts, measured groundwater levels and contours, and observed streamflow data.

Due to uncertainty in the initial conditions, a one year “ramp up” period is included to allow groundwater levels to stabilize. Thus, the model calibration period for the ESJWRM is October 1995 through September 2015 or water years 1996 through 2015 (20 years).

4.2 Calibration of the IDC and Root-Zone Parameters

The goal of the IDC calibration process is to determine reasonable urban and agricultural demand and develop the components of a balanced root zone budget. IDC calibration serves as the foundation of the IWFM calibration as demand estimated translates directly to groundwater pumping, which is the primary stress on the groundwater system. This part of the calibration effort focused primarily on refining individual budget items while maintaining reasonable root zone parameters.

The calibrated IDC was used to estimate monthly agricultural water demand at each model element during the model hydrologic period. To adjust agricultural demand, elemental root zone parameters, particularly the soil hydraulic conductivity and the pore size distribution index, were adjusted in accordance with the hydrologic soil group and subregion. Spatial representation of these calibrated parameters is shown in Figure 37 though Figure 41. The IDC model was calibrated to agricultural water use values reported by irrigation districts in their AWMPs and then checked against local data with input from irrigation district representatives and consultants (pers. comm. Doug Heberle from WID, Jennifer Spaletta representing

NSJWCD, Tom Flinn from NSJWCD, Peter Martin from CCWD, Cathy Lee from SEWD, Manuel Verduzco from SEWD, Sam Bologna from SSJID, Peter Rietkerk from SSJID, Bryan Thoreson representing SSJID, Emily Sheldon from OID, Eric Thorburn from OID, and Byron Clark representing OID). Figure 42a-42n show the agricultural water demand, unit agricultural water use, and unit evapotranspiration of applied water (ETAW) estimates by the total ESJ Subbasin area and major subareas. Differences in the charts between the subregion and subareas is due the differences in cropping patterns and evapotranspiration rates, which drive the estimation of agricultural demand. The difference between the two unit water use columns provide an indication of the efficiency of agricultural practices in the subregion or subarea. Overall, the estimated agricultural demand reflects the same variability seen in irrigation practices and major crops from area to area within the ESJ Subbasin.

Figure 43a-43g show the model estimated annual urban demand for the total ESJ Subbasin area and subareas. Urban demand reflects the population and per capita water use defined for each urban area and estimated for the remaining rural residential areas.

4.3 Calibration of Surface Water Features

The ESJWRM simulates streamflow in 39 small watersheds and several major rivers and creeks across the model domain.

As discussed in Section 2.10, small watersheds are used to simulate inflows into the model from ungauged watersheds. The small watershed contributions are split between surface water runoff that enters the stream system, percolation that occurs during transport to the streams, and baseflow entering the groundwater system at the model boundary. Groundwater level hydrographs along the model boundary selected for groundwater level calibration (Section 4.5) were referenced to confirm and edit, as necessary, the various parameters of the small watersheds.

Streamflow calibration is primarily performed by comparing the simulated streamflow with local data from 11 stream gauges (Table 9 and Figure 44). Data for these gauges came from USGS or the California Data Exchange Center (CDEC). Two of these stream gauges (Mokelumne River below Camanche Dam and San Joaquin River near Vernalis) are duplicates of gauges used to estimate stream inflow into the model area and were not referenced for streamflow calibration and only verification of model setup.

Table 9: Summary of ESJWRM Stream Calibration Gauges

Stream	Stream Node	Agency	Gauge Name	Period of Record
Cosumnes River	98	USGS	USGS 11336000: Cosumnes River at McConnell, CA	October 1941 to October 1982
Dry Creek	222	USGS	USGS 11329500: Dry Creek near Galt, CA	October 1926 to December 1997
Mokelumne River*	290	USGS	USGS 11323500: Mokelumne River below Camanche Dam, CA	October 1904 to present/ongoing
Mokelumne River	382	USGS	USGS 11325500: Mokelumne River at Woodbridge, CA	June 1924 to present/ongoing
Mokelumne River	501	USGS	USGS 11336930: Mokelumne River at Andrus Island near Terminous, CA	July 2006 to present/ongoing

Stream	Stream Node	Agency	Gauge Name	Period of Record
Mormon Slough	876	USACE	CDEC MRS: Mormon Slough at Bellota	December 1997 to present/ongoing
Stanislaus River	1067	DWR	CDEC OBB: Stanislaus River at Orange Blossom Bridge	January 1993 to present/ongoing
Stanislaus River	1186	USGS	USGS 11303000: Stanislaus River at Ripon, CA	October 1940 to present/ongoing
Tuolumne River	1382	USGS	USGS 11290000: Tuolumne River at Modesto, CA	April 1940 to present/ongoing
San Joaquin River*	1497	USGS	USGS 11303500: San Joaquin River near Vernalis, CA	October 1923 to present/ongoing
San Joaquin River	1597	USGS	USGS 11304810: San Joaquin River below Garwood Bridge at Stockton, CA	December 1995 to present/ongoing

*Same as stream inflow gauge, so not used for calibration and included as verification of model setup

Stream flow calibration included refinement of the stream bed hydraulic conductivity originally from C2VSim (Figure 45). Simulated stream flows were compared with observed records and exceedance charts were also used to check the model performance when simulating high and low flows at each gauge location. Calibration results for select stream gauges are included in Figure 46a-46j.

4.4 Calibration of Water Budgets

The aim of the calibration process is to ensure the accurate representation of the hydrologic characteristics of the groundwater basin, confirmed through the analysis of the resulting water budgets. A water budget balances all supplies, demands, and any subsequent change in storage occurring within that specific portion of the hydrologic cycle. IWFM automatically outputs budgets at the subregion scale for processes involving groundwater, the surface layer, streams, the root zone, small watersheds, and the unsaturated zone. IWFM can output select budgets down to a single element or any specific grouping of elements.

During this step of the calibration process, model results are reviewed and summarized into monthly and annual (by water year) budgets. The most important budgets reviewed for calibration are the groundwater budget and the land and water use budget. After extensive budget analysis, key model datasets and parameters are adjusted, particularly groundwater aquifer parameters, to better match local budgets from AWMPs or other planning efforts. The ESJWRM water budget results are summarized in the following sections.

4.4.1 Land and Water Use Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the IDC-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
    - Demand (either agricultural or urban)
    - Surplus (if applicable)

- Outflows:
  - Groundwater pumping
  - Surface water deliveries
  - Shortage (if applicable)

The average annual water demand for the subbasin within the calibration period was 1.2 million acre-feet (MAF), consisting of approximately 1.1 MAF agricultural demand and 0.1 MAF urban demand. This demand was met by approximately an average annual of 0.50 MAF of surface water deliveries (0.45 MAF of agricultural and 0.05 MAF of urban deliveries) and was supplemented by approximately 0.69 MAF of groundwater production (0.62 MAF of agricultural and 0.07 MAF of urban pumping). The annual estimated land and water use budgets for the calibration period are presented in Figure 47a-47g and Figure 48a-48g, showing the agricultural and urban, respectively, demands and water supplies in the ESJ Subbasin and its component subareas. Due to uncertainties in the reported and estimated values of agricultural and urban water supplies, as well as respective estimates of the demands, there are some imbalances between the demand and supply values. These imbalances are shown as surplus or shortage and are typically less than 10% of the reported supplies, and within the margin of errors of the analysis.

4.4.2 Groundwater Budget

The primary components of the groundwater budget, corresponding to the major hydrologic processes affecting groundwater flow in the model area, are:

- Inflows:
  - Deep percolation (from rainfall and excess irrigation applied water)
  - Gain from stream (or recharge due to stream seepage)
  - Recharge (from other sources such as irrigation canal seepage and recharge ponds)
  - Boundary inflow (from outside the model area)
  - Subsurface inflow (from adjacent subregions)
- Outflows:
  - Groundwater pumping
  - Loss to stream (or outflow to streams and rivers)
  - Boundary outflow (to outside the model area)
  - Subsurface outflow (to adjacent subregions)
- Change in groundwater storage (either an inflow or outflow)

The groundwater budget consists of inflows to and outflows from the groundwater system. Figure 49a-49g show the annual components of the groundwater budget, including cumulative change in groundwater storage for ESJ Subbasin. Primary components of the groundwater budget are as follows: average annual groundwater pumping is estimated to be 0.70 MAF, which is offset by approximately 0.22 MAF of deep percolation from rainfall and applied water, net gain from stream of 0.15 MAF, recharge from conveyance and unlined canals of approximately 0.12 MAF, and a total net subsurface inflow of approximately 0.16 MAF from neighboring subbasins and foothills. The cumulative change in groundwater storage is calculated from the change in groundwater storage. Due to inherent uncertainties in data and assumptions used in the model, approximations used in representing physical features in the aquifer system, and uncertainties in the model calibration, all budget components have some degree of uncertainty. A sensitivity analysis was performed to estimate the sensitivity of the model results to the changes in each of the key model parameters. Given the overall range of uncertainties, the long-term average annual depletion in groundwater storage in ESJ Subbasin during the model historical period is estimated to range between 24 to 70 TAF, with an average of approximately 47 TAF per year.

4.5 Groundwater Level Calibration

Like streamflow calibration, the goal of groundwater level calibration is to achieve reasonable agreement between the simulated and observed values (in this case, groundwater levels at calibration wells). Within the ESJWRM, over 3,000 wells were evaluated for developing groundwater observation locations to track ESJWRM's calibration at both a regional and local scale. The records for these wells were obtained from San Joaquin County's monitoring database, DWR's CASGEM program, and local monitoring wells from the City of Lodi and Oakdale Irrigation District. The calibration wells were selected based on their period of record, spatial distribution across the model, representativeness of good indicators of model responses to the various stresses, availability of observation data, and trends of nearby wells. Though a working set of 160 wells was tentatively selected initially, this was narrowed to an ultimate set of 70 wells that are representative of the long-term conditions of groundwater levels both at a local and regional scale in ESJWRM. These 70 calibration wells are shown in Figure 50 with information tabulated in Appendix C.

Simulated groundwater levels are calibrated to observed levels through adjustments to hydrogeologic parameters or aquifer parameters including hydraulic conductivity, specific storage, and specific yield (discussed in Section 4.7). The goal of groundwater level calibration is to achieve the maximum agreement between simulated and observed groundwater elevations at calibration wells while maintaining reasonable values for aquifer parameters. The groundwater level calibration is performed in two stages:

- The initial calibration effort is focused on the regional scale to verify hydrogeological assumptions made during data development and confirm the accuracy of general groundwater flow vectors. During this iteration, simulated groundwater elevation trends, flow directions, and groundwater gradients are compared to measured data. DWR's groundwater level contours for spring and fall many years starting in the 2010s were used to evaluate ESJWRM's groundwater contours from matching time periods. Figure 51a-51d show the resulting ESJWRM groundwater level elevations (average of the top 2 layers of the model where most of the pumping in the subbasin occurs) compared to DWR contours for 4 different seasons and years: Spring 2011, Fall 2013, Spring 2015, and Fall 2015. Fall 2015 also represents the end of simulation groundwater levels.
- The second stage of calibration of groundwater levels is to compare the simulated and observed groundwater level at each calibration well. This comparison provides information on the overall model performance during the simulation period. The simulated groundwater elevations at the 70 calibration wells were compared with corresponding observed values for concurrence in long-term trends as well as seasonal fluctuations.

Discussed further in the next section (Section 4.6), the results of the groundwater level calibration indicate that the ESJWRM reasonably simulates the long-term hydrologic responses under various hydrologic conditions. Figure 52a-52r show a selection of calibration wells (1 representing each ESJ Subbasin model subregion or 18 wells) with their resulting groundwater level hydrographs. All 70 calibration well hydrographs are included in Appendix C.

4.6 Measurement of Calibration Status

The ESJWRM calibration status was measured using two metrics: the groundwater level trend and the relationship between simulated and observed groundwater levels. The statistics were evaluated to meet the American Standard Testing Method (ASTM) standard. In addition to quantifiable metrics, the ESJWRM calibration was evaluated by generating reasonable regional groundwater flow directions and producing realistic water budgets.

The "Standard Guide for Calibrating a Groundwater Flow Model Application" (ASTM D5981) states that "the acceptable residual should be a small fraction of the head difference between the highest and lowest heads across the site." The residual is defined as the simulated head minus the observed head. An analysis of all calibration water levels within the model indicated the presence of 200+ feet of water level changes. Using 10 percent as the "small fraction", the acceptable residual level would be 20 feet. Calibration goals for the groundwater level residuals were set such that no more than 10 percent of the observed groundwater levels would exceed the acceptable residual level of 20 feet.

- 75% of observed groundwater levels are within +/- 10 feet of its respective simulated values
- 97% of observed groundwater levels are within +/- 20 feet of its respective simulated values
- 99% of observed groundwater levels are within +/- 30 feet of its respective simulated values

The residual histogram for the ESJ Subbasin is shown in Figure 53. Additionally, a scatter plot of simulated versus observed values is shown in Figure 54.

4.7 Final Calibration Parameters

The initial aquifer parameters for the ESJWRM came from DWR's texture model values extracted to C2VSim coarse grid nodes. These coarse grid nodes formed a parametric grid covering the model area and reflected the scale at which parameters were adjusted throughout the calibration process. The grid was slightly modified to cover the entire ESJWRM model along the boundaries and additional nodes were added or moved within areas of the model to provide better control (Figure 55). The parameters resulting from the calibration process are listed in Table 10.

Table 10: Range of Aquifer Parameter Values

Stream	Layer 1	Layer 2	Layer 3	Layer 4
Horizontal Hydraulic Conductivity (ft/day)	11.5 – 72.7	6.4 – 44.8	1.1 – 4.6	1.8 – 5.2
Vertical Hydraulic Conductivity (ft/day)	0.005 – 0.14	0.004 – 0.07	0.004 – 0.05	0.004 – 0.15
Corcoran Clay Vertical Hydraulic Conductivity (ft/day)	3.6×10^{-4} – 1.5×10^{-3}	3.6×10^{-4} – 1.5×10^{-3}	3.6×10^{-4} – 1.5×10^{-3}	3.6×10^{-4} – 1.5×10^{-3}
Specific Storage (unitless)	8.55×10^{-5} – 1.57×10^{-4}	4.18×10^{-6} – 1.97×10^{-4}	4.21×10^{-6} – 2.05×10^{-4}	2.53×10^{-5} – 1.75×10^{-4}
Specific Yield (unitless)	0.04 - 0.10	0.04 – 0.09	0.04 – 0.09	0.05 – 0.09

Horizontal Hydraulic Conductivity – The hydraulic conductivity (KH) in the ESJWRM varies across the horizontal direction and across model layers. The fully calibrated values remain descriptive of the initial hydrogeologic analysis, range from 1.1 ft/day to 72.7 ft/day, and the spatial distribution is represented in Figure 56 through Figure 58.

Vertical Hydraulic Conductivity – Primarily a constraining factor across the Corcoran Clay in the small portion of the model underlain by it, the Vertical Hydraulic Conductivity (KV) facilitates the separation between the unconfined and confined aquifers within the ESJWRM. The KV values of the Corcoran aquitard is found to be less than one one-thousandth of the horizontal conductivity of the surrounding aquifer systems. For those parts of ESJWRM without Corcoran Clay, the KV controls the flow of groundwater between the materials making up the different modeled aquifer layers.

Specific Storage – Specific Storage (SS) is used to represent the available storage at nodes in a confined aquifer, where the hydraulic head is above the top of the aquifer. Specific Storage is the unit volume of water released or taken into storage per unit change in head. Calibrated specific storage values range from 4.18×10^{-6} to 2.05×10^{-4}, as shown in Figure 59 through Figure 61.

Specific Yield – Specific Yield (SY) is representative of the available storage in an unconfined aquifer and defined as the unit volume of volume released from the aquifer per unit change in head due to gravity. Calibrated specific storage values range from 0.04 to 0.10 and are shown in Figure 62 through Figure 64.

4.8 Sensitivity Analysis

Sensitivity analysis is an important step in the model development process. It is defined as “the study of distribution of dependent variables (e.g., groundwater elevations in a groundwater model) in response to changes in the distribution of independent variables, initial conditions, boundary conditions, and physical parameters” (AWWA, 2001). In general, a sensitivity analysis of an integrated groundwater and surface water model is performed for the following purposes:

- To test the robustness and stability of the model by establishing tolerance within which the model parameters can vary without significantly changing the model results;
- To understand the impact of inaccuracies in input data on model results (e.g., how model results can change because of a 10% error in the estimation of agricultural pumping); and
- To develop an understanding of the relative sensitivity of the components of the hydrologic cycle and data, so that an effective data collection and monitoring plan can be developed.

A sensitivity analysis was performed using the ESJWRM to assess the sensitivity of model results to specific model parameters and input data. Two different metrics were selected to measure the sensitivity of the ESJWRM. A sensitivity metric is a single number derived from the ESJWRM results and has a unique value for each model run corresponding to a given set of data or parameter value. The sensitivity metrics used here:

- Average groundwater elevation in the study areas, and
- Average root mean square (RMS) error aggregated from selected calibration wells.

Average groundwater elevation in the study areas is defined as a three-way average of simulated groundwater elevations at model nodes. The average is taken over the model layers, model nodes, and time.

This can be mathematically expressed by:

$$\overline{H} = \frac{1}{M}\sum_{K=1}^{M} H_k$$

Such that,

$$H_k = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{1}{L}\sum_{j=1}^{L} h_j\right]_i^k$$

Where,

M total number of simulation time steps,

H_k average head in the model area at k-th time step,

N number of model nodes,

L number of model layers in aquifer,

H_j groundwater elevation at layer j, and

i, j, k are indices for node, layer, and time, respectively.

The average RMS error at selected calibration wells is defined as the average of individual RMS error at each calibration well. The RMS error at a calibration well is defined as follows:

$$RMS_w = \sqrt{\left\{\frac{1}{N}\sum_{k=1}^{N_0}\left[h_{k,w}^0 - h_{k,w}^s\right]^2\right\}}$$

where,

N_0 is the number of observations at well k,

$h_{k,w}^0$ is the observed groundwater elevation at time step k, at well w,

$h_{k,w}^s$ is the simulated groundwater elevation at time step k, at well w.

4.8.1 Sensitivity Analysis Results

Adjustments of aquifer parameters, and the analysis the resulting groundwater head, was performed at all groundwater nodes within the model domain. Similarly, streambed conductance was analyzed at all model stream nodes. Sensitivity analyses were performed for the ESJWRM for the following parameters with results discussed below.

Horizontal Hydraulic Conductivity – The sensitivity of the ESJWRM to changes in hydraulic conductivity are presented in Figure 65 and Figure 66. Reduction of hydraulic conductivity to one-fourth of the calibrated value results in 10.13 feet higher groundwater levels in the model, whereas increases to hydraulic conductivity decrease the average groundwater levels by 2.05 feet. Changes to horizontal hydraulic conductivity have small impacts to RMS values.

Vertical Hydraulic Conductivity – The sensitivity of the ESJWRM to changes in vertical hydraulic conductivity are presented in Figure 67 and Figure 68. Reduction of this parameter to one-fourth of the calibrated value results in 10.34 feet higher groundwater levels in the model, whereas increases to the vertical hydraulic conductivity decrease the average groundwater levels by 4.80 feet. Changes to vertical hydraulic conductivity have very little impact on RMS values.

Specific Storage – The sensitivity of the ESJWRM to changes in specific storage are presented in Figure 69 and Figure 70. Reduction of specific storage to one-fourth of the calibrated value results in approximately 12.64 feet higher groundwater levels in the model, whereas increases to specific storage decrease the average groundwater levels by 1.49 feet. Changes to specific storage have very little impact on RMS values.

Specific Yield – The sensitivity of the ESJWRM to changes in specific yield are presented in Figure 71 and Figure 72. Reduction of specific yield to one-fourth of the calibrated value results in 11.67 feet higher groundwater levels in the model and increases to specific yield increase the average groundwater levels by 1.82 feet. Changes to specific yield have slight impacts to RMS values.

Streambed Conductance – The sensitivity of the ESJWRM to changes in streambed conductance are presented in Figure 73 and Figure 74. Reduction of conductance to one-fourth of the calibrated value results in 8.09 feet higher groundwater levels in the model, whereas increases to conductance decrease the average groundwater levels by 5.09 feet. Changes to streambed conductance have slight impacts to RMS values.

The results of the sensitivity analysis for the ESJWRM indicate that the model is a stable model and the system responds in the expected manner because of changes in aquifer parameters and other input data.

5. CONCLUSIONS AND RECOMMENDATIONS

The ESJWRM, in its current state, is a robust, comprehensive, defensible and well-established model for assessing the water resources in the ESJ Subbasin under historical and projected conditions. The following recommendations are to be considered for further refinements and enhancements of the model:

- **Continue engagement with local groundwater users and managers**. Continue working with local agencies and groundwater users in ESJ Subbasin to further understand the local operations of the groundwater system and improve representation of groundwater users in the ESJWRM.
- **Refinement of boundary flows**. The current boundary flows at the northern, western, and southern boundaries of the model area are based on an older version of the C2VSim with adjustments made based on initial groundwater levels assumed for the beginning of the model (October 1994). DWR is currently in the process of updating the C2VSIm model. Once the latest fine grid version (C2VSim-2015) is publicly available, boundary flows for the ESJ model area should be verified and updated, as necessary.
- **Enhance variability of potential evapotranspiration**. The current version of the IDC used for estimation of the consumptive use of crops in the ESJWRM uses monthly potential ET values that are the same for all years during the model period. Given that there may be annual variability in the potential ET data with possible effects on the annual estimation of crop water demand, it is recommended to use more detailed data with temporal variability to develop a full time series of ET values for use in the model.
- **Refine surface water deliveries in Cosumnes and Modesto Subbasins.** The surface water deliveries in the Cosumnes and Modesto Subbasins are currently at the subregion level and do not have the detailed spatial resolution of other areas within the ESJ Subbasin. This data may need to be verified and updated as modeling efforts in those subbasins progress to meet the requirements of SGMA.
- **Update C2VSim based on ESJWRM**. The fine grid version of C2VSim was developed by the DWR to evaluate the integrated surface water and groundwater conditions at a regional scale; whereas, the ESJWRM is capable of evaluation at the local scale. To increase the accuracy of regional groundwater conditions in the fine grid C2VSim, the County is encouraged to work with DWR to provide data and information for further refinement and update of C2VSim in the ESJWRM area.
- **Develop model update schedule**. In order to keep the ESJWRM up-to-date and current for analysis of water resources and especially for supporting SGMA implementation, it is recommended that the model be updated every 3 to 5 years. A possible update schedule can be kept consistent with the GSP updates, with a lead time of 2 to 3 years relative to the GSP update schedule.

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FIGURES

Figure 1: ESJ Subbasin with County Lines

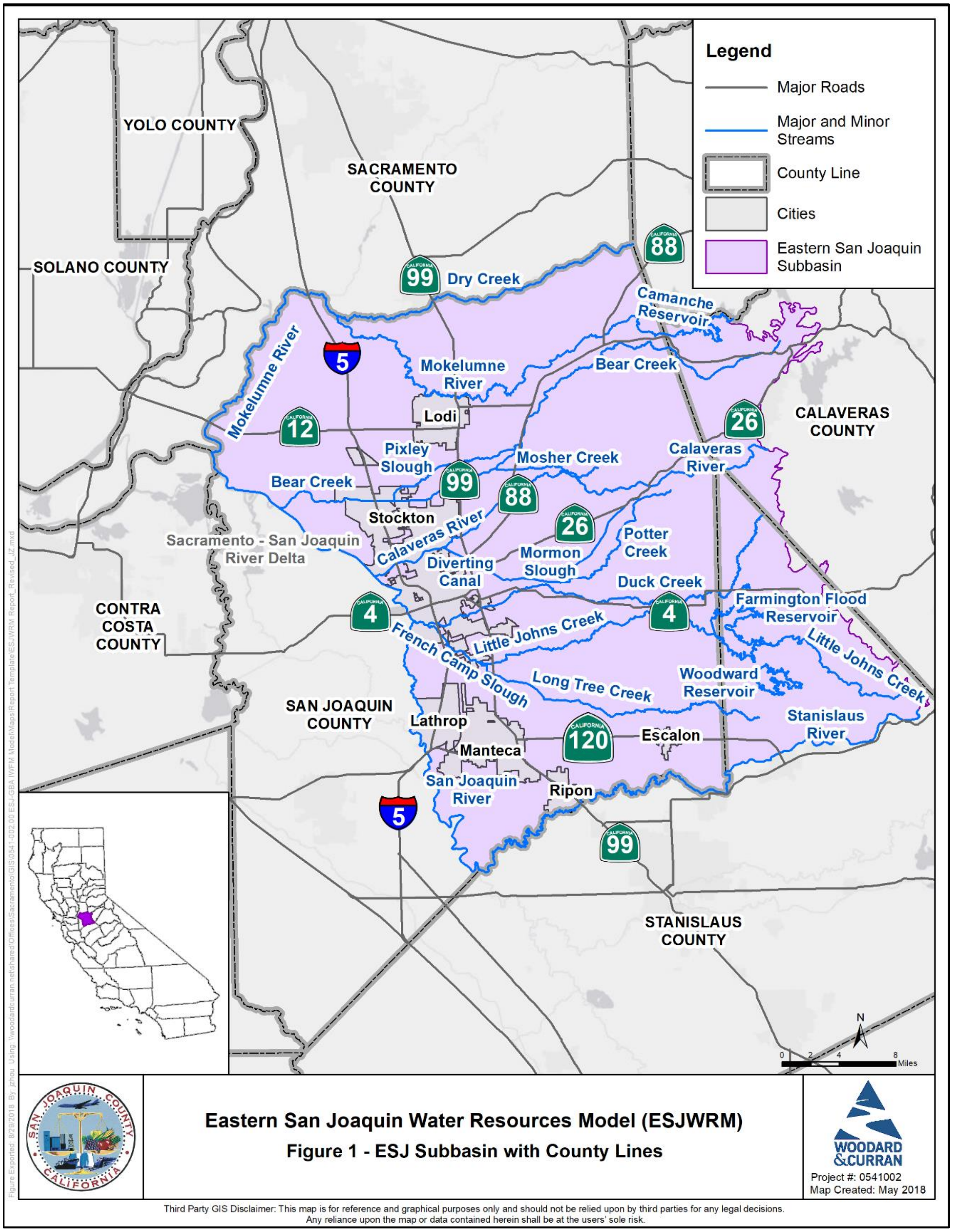

Figure 2: Groundwater Subbasins

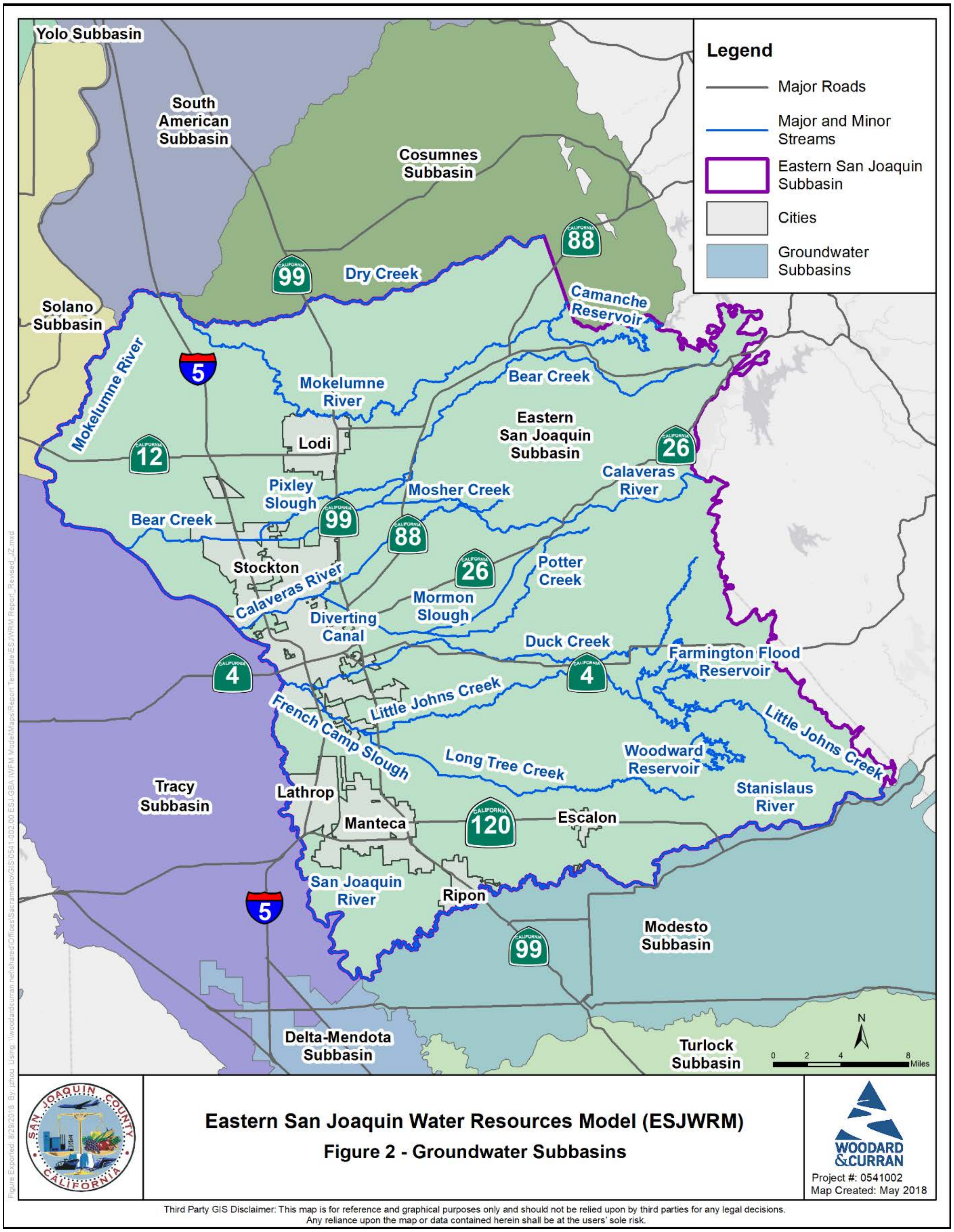

Figure 3a: ESJ Subbasin Major Water Purveyors

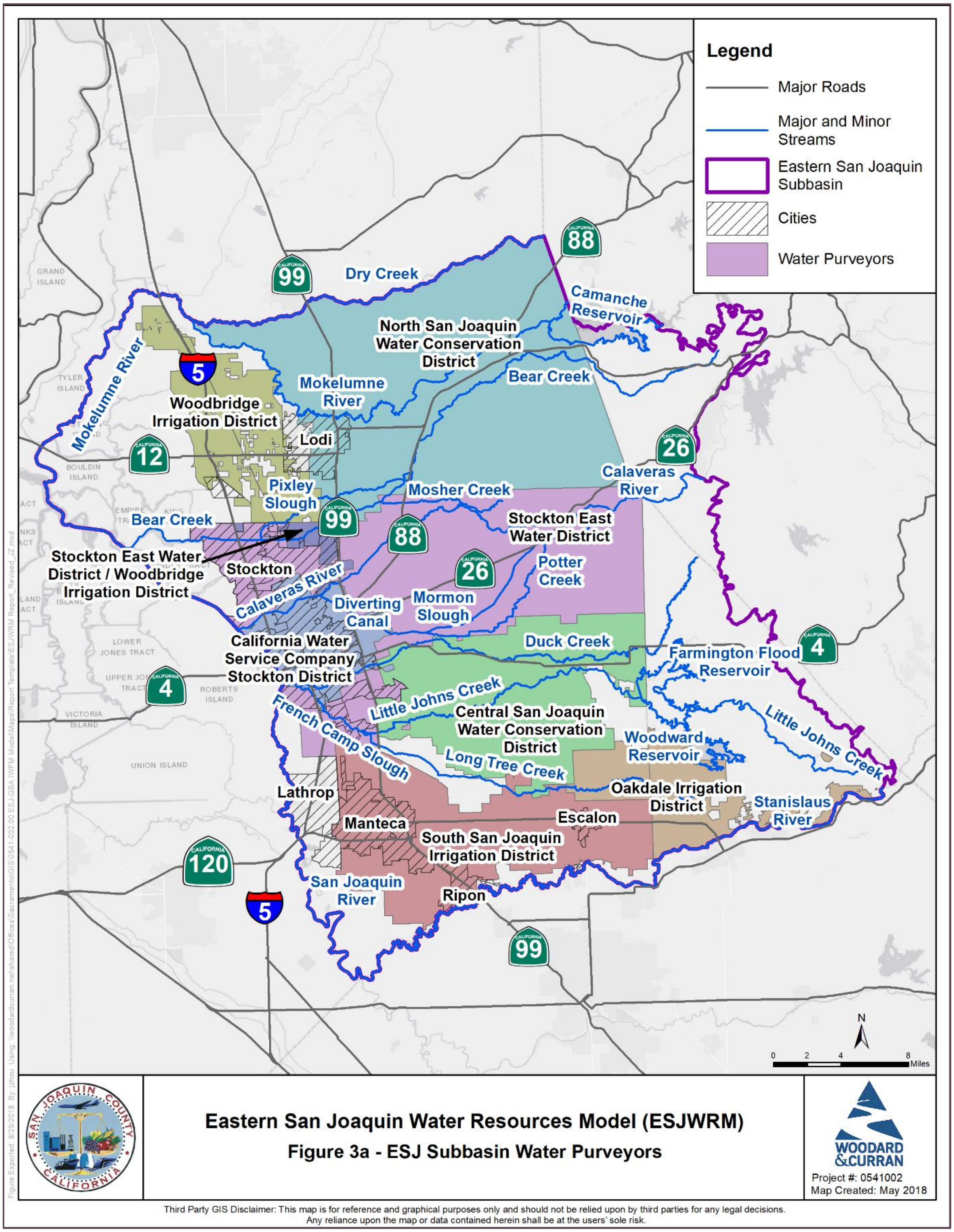

Figure 3b: ESJ Subbasin Groundwater Sustainability Agencies

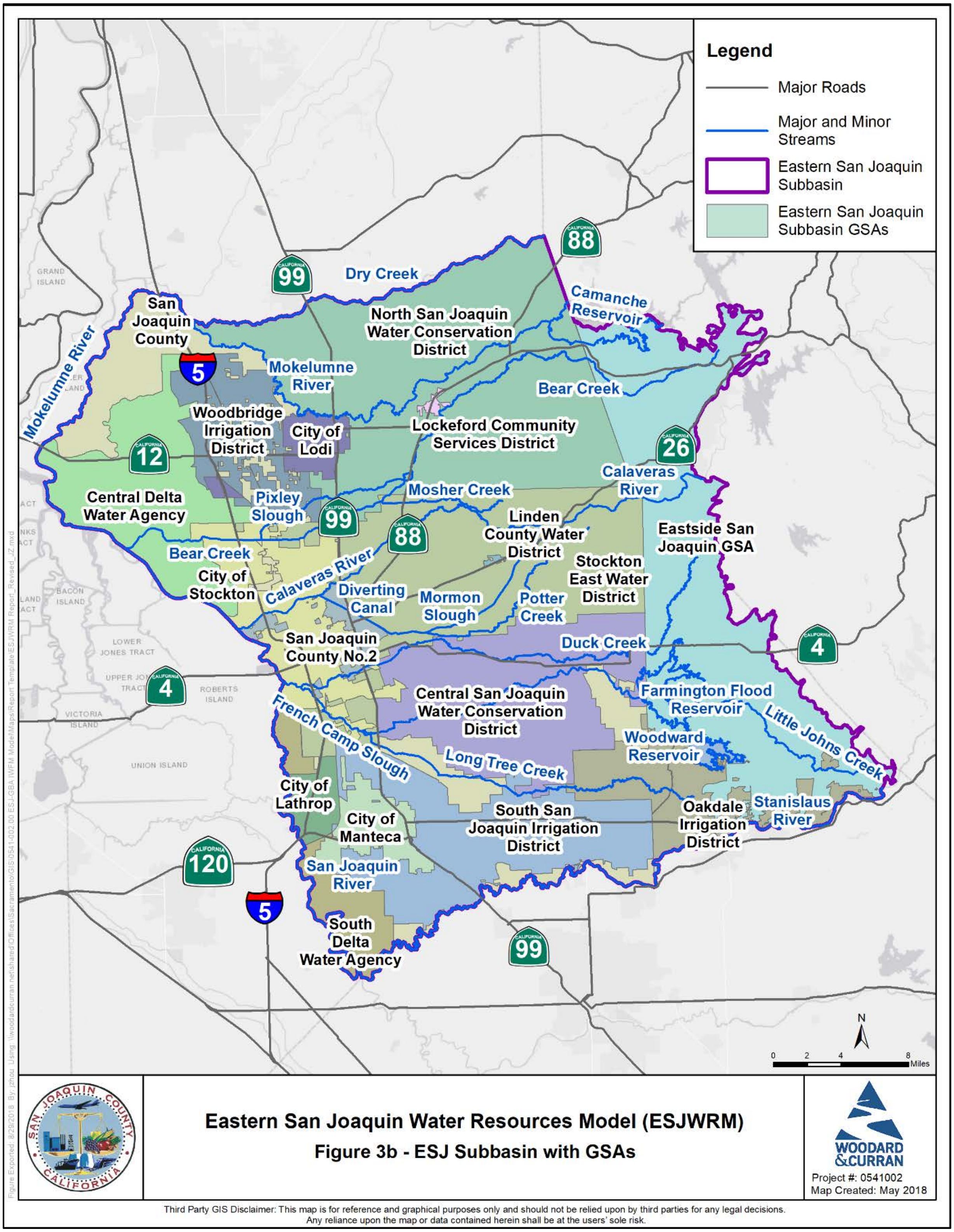

Figure 4: ESJWRM Boundaries

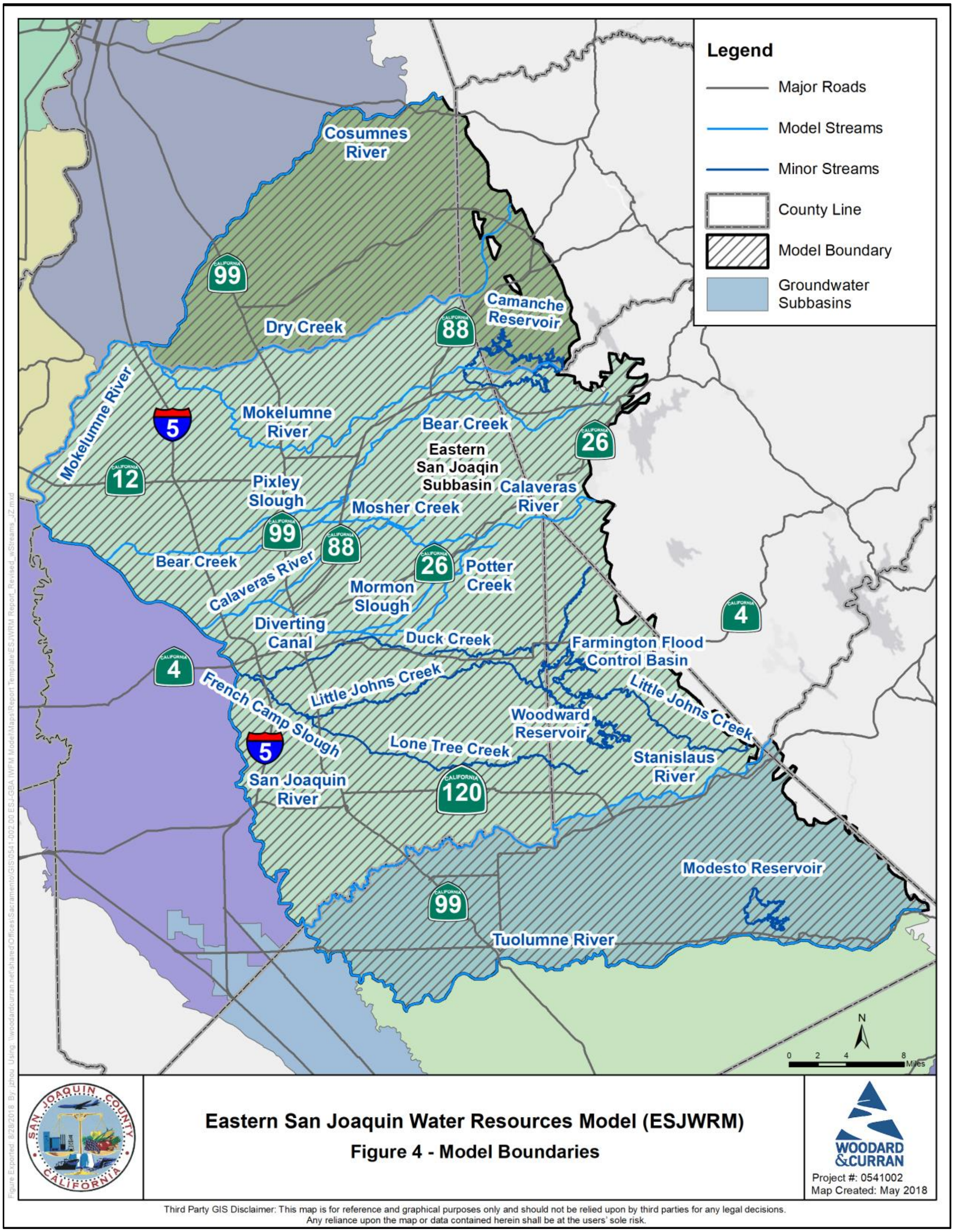

Figure 5: ESJWRM Grid Development Features

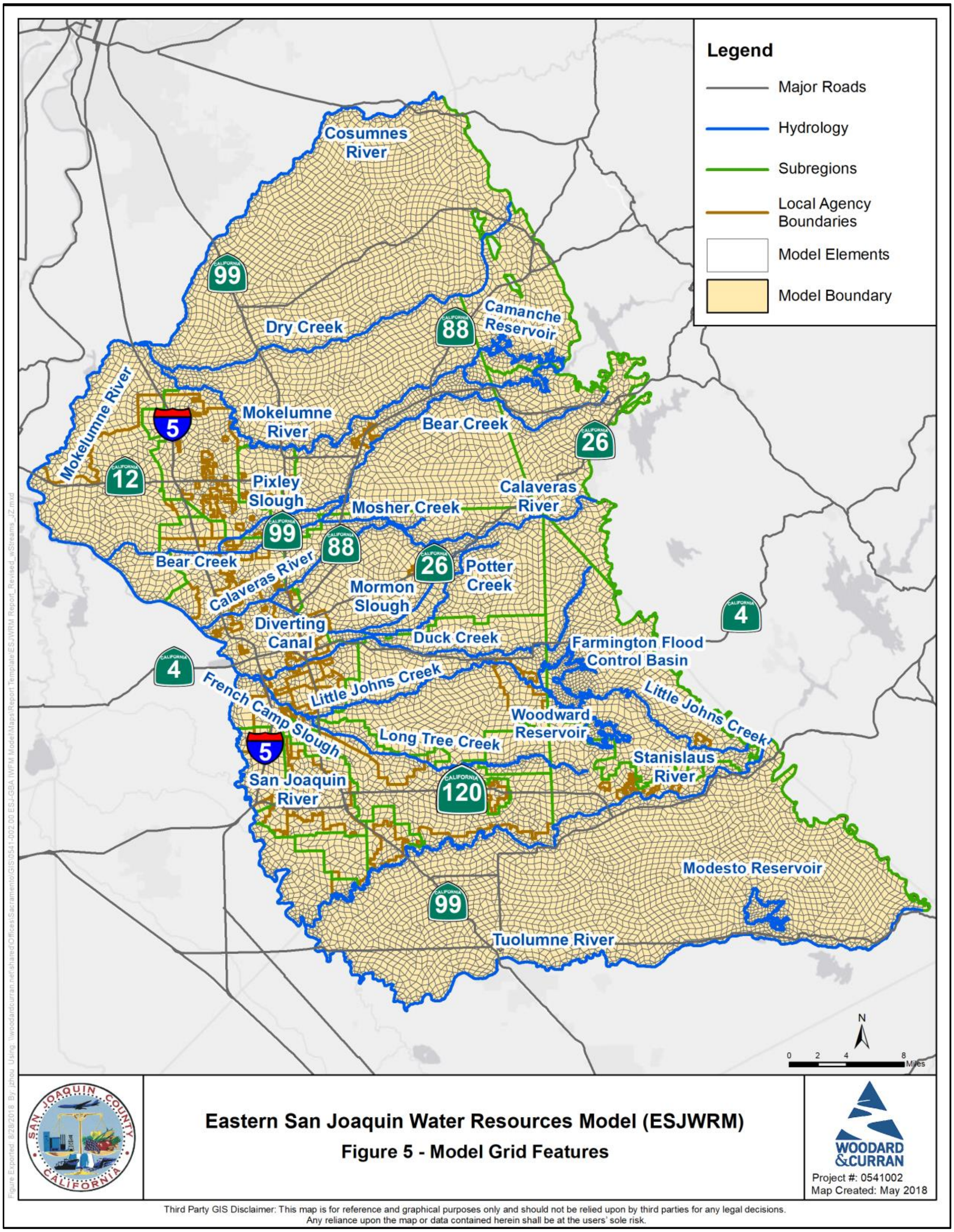

Figure 6: ESJWRM Elements

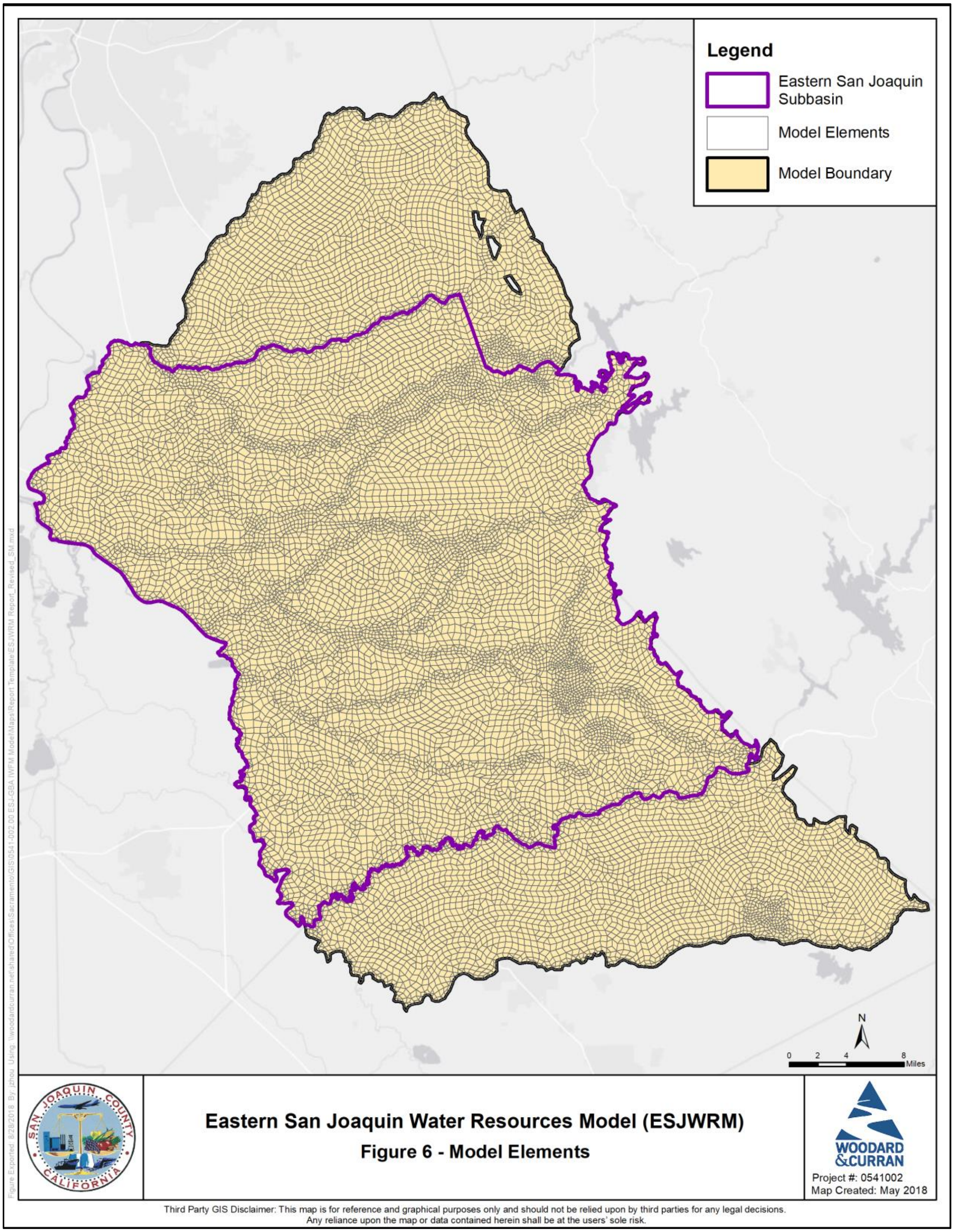

Figure 7: ESJWRM Subregions

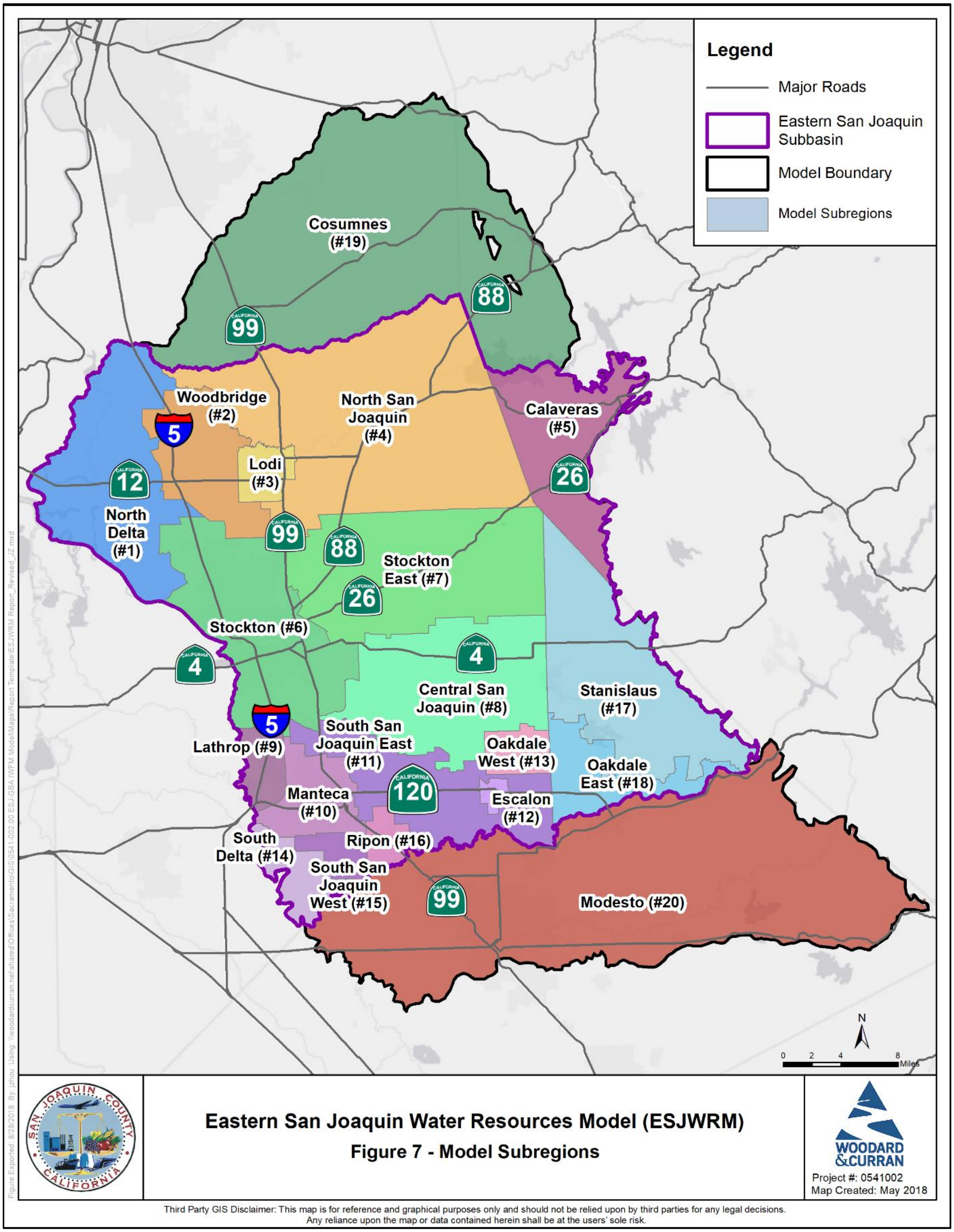

Figure 8: ESJWRM Subareas

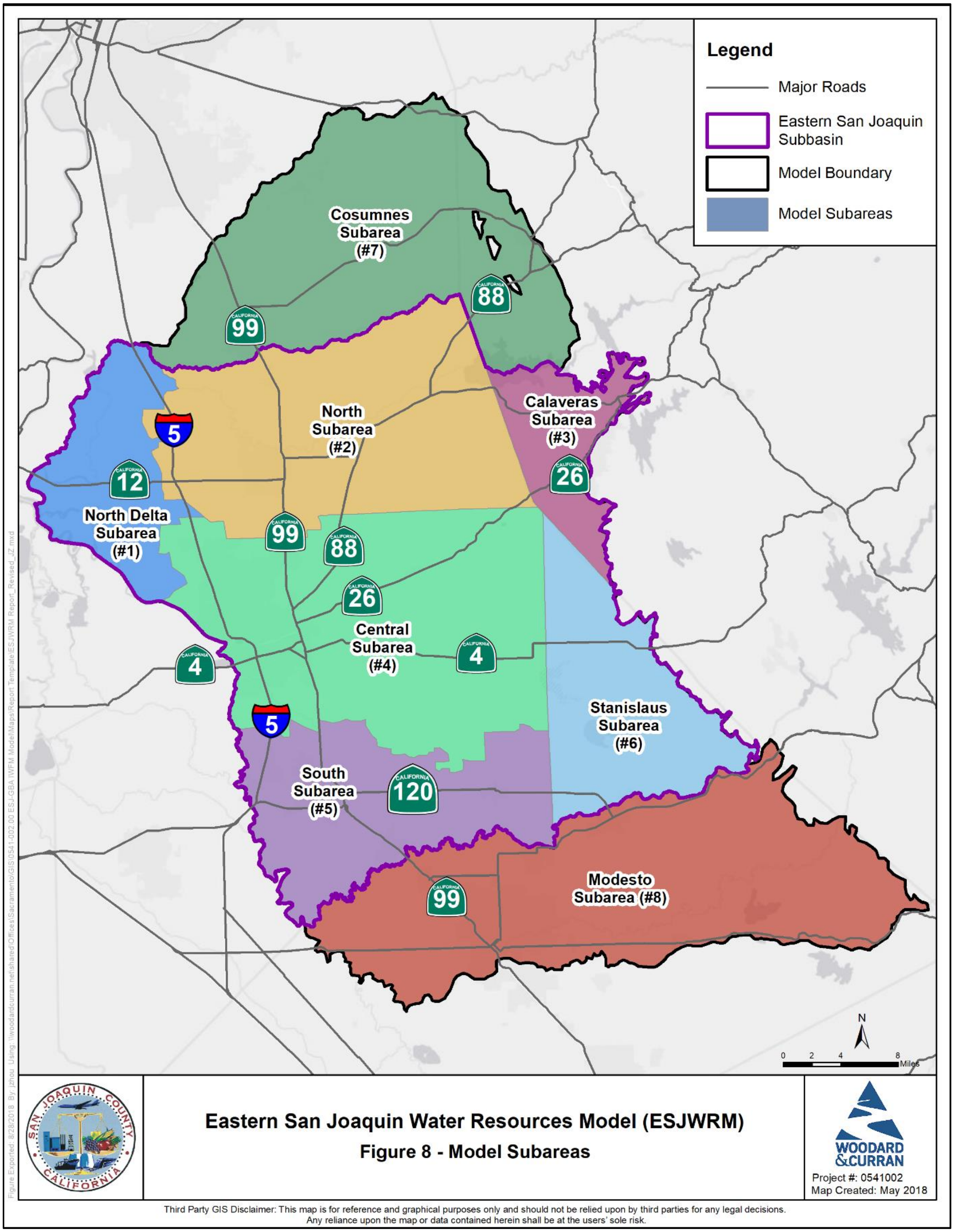

Figure 9: ESJWRM Streams and Stream Inflow Locations

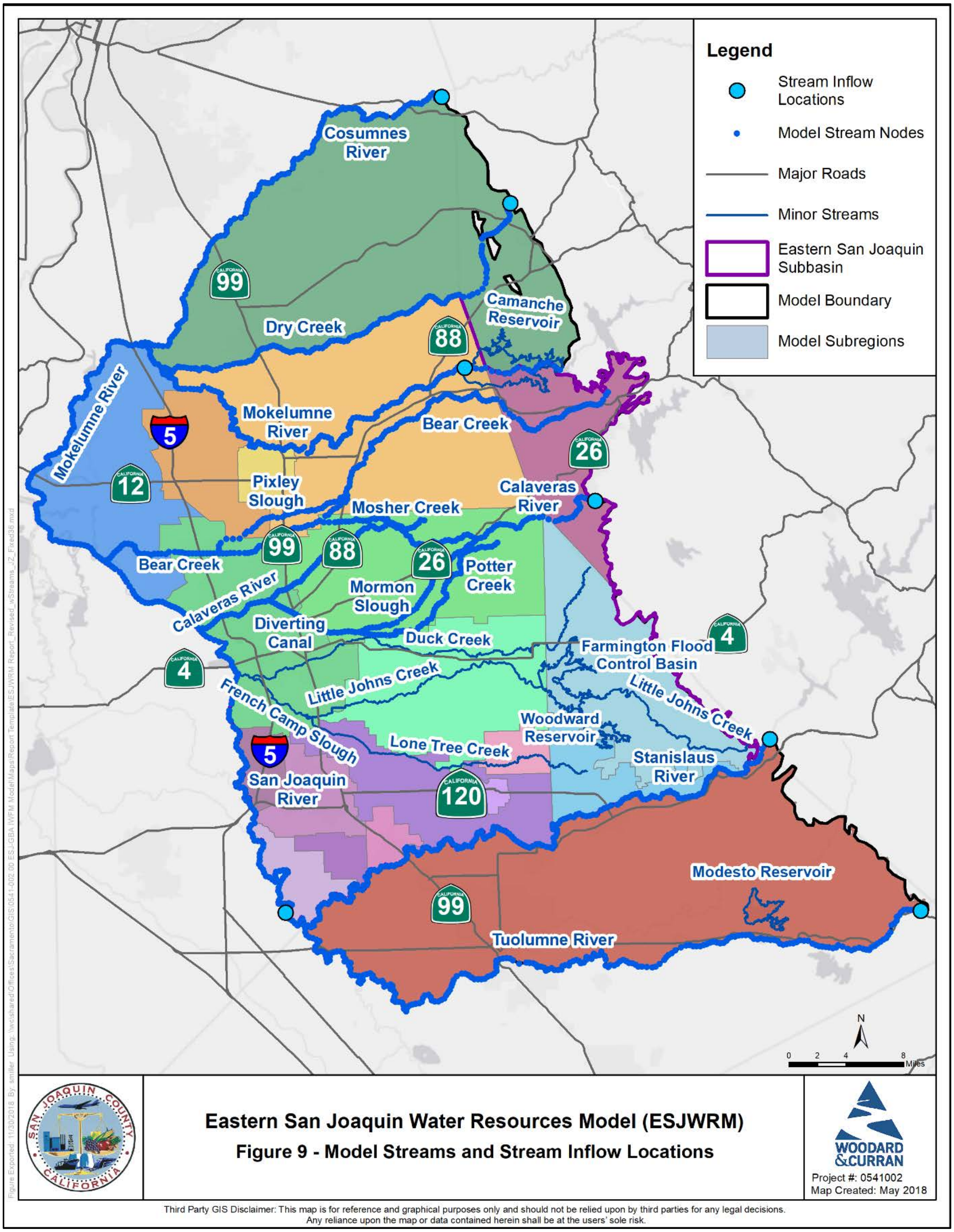

Figure 10: ESJWRM Average Annual Precipitation

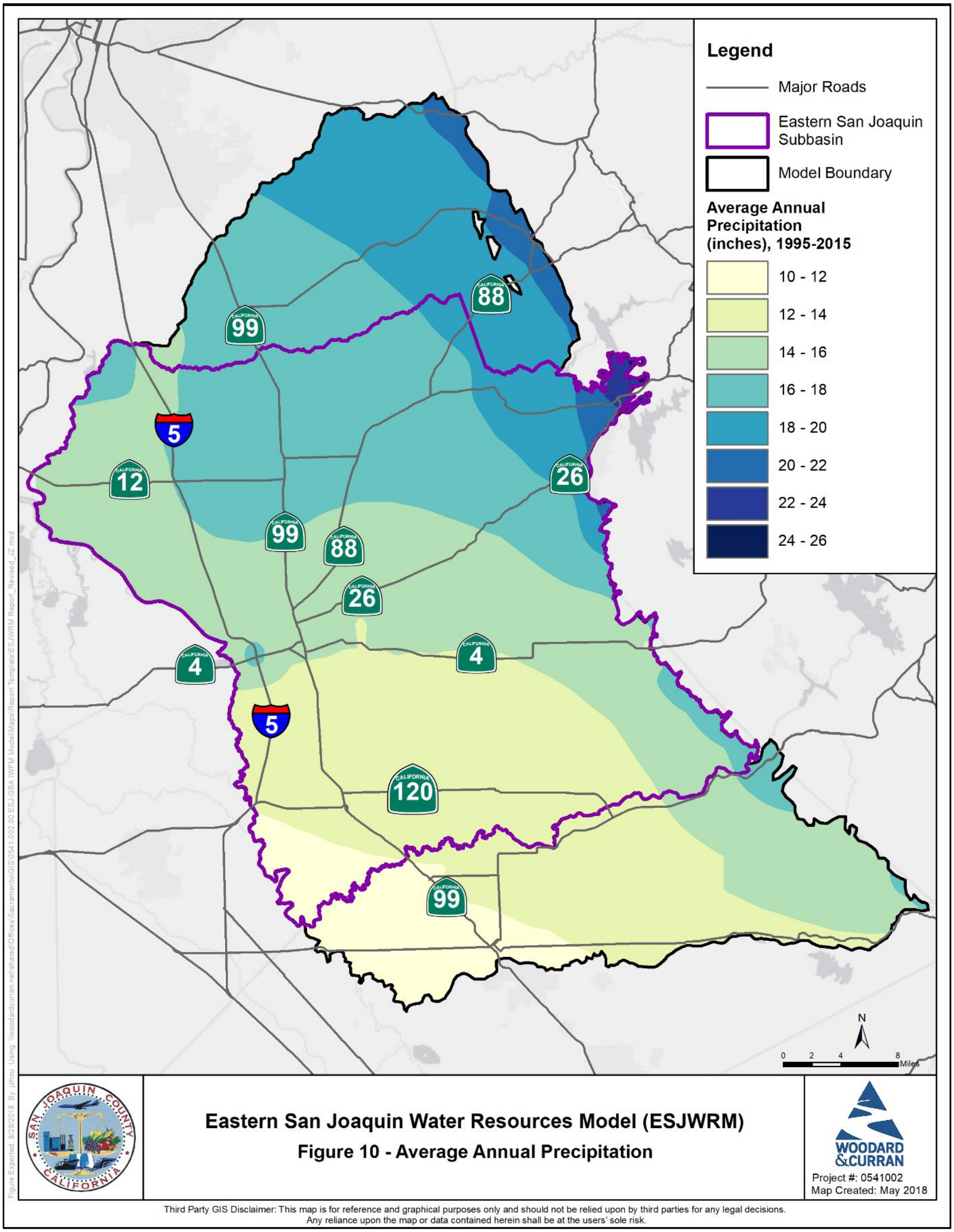

Figure 11: ESJWRM Annual Rainfall

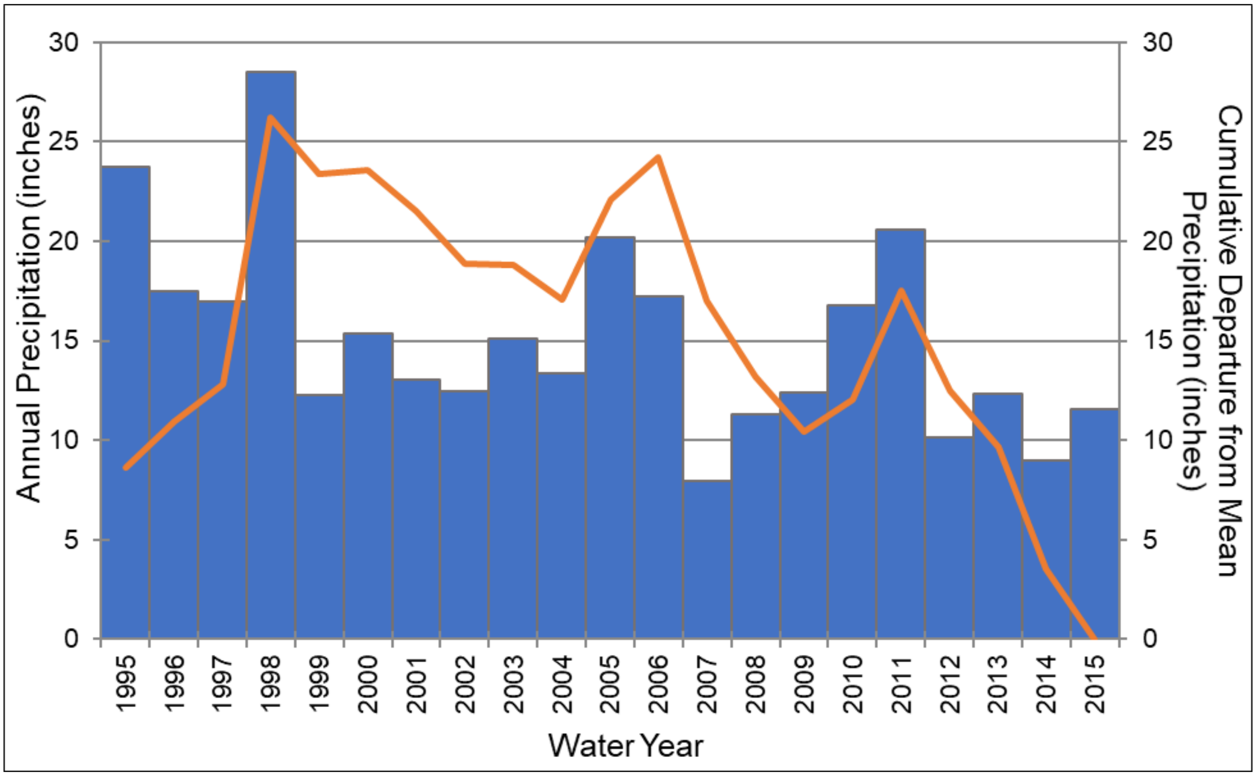

Figure 12: ESJWRM Hydrologic Soil Group

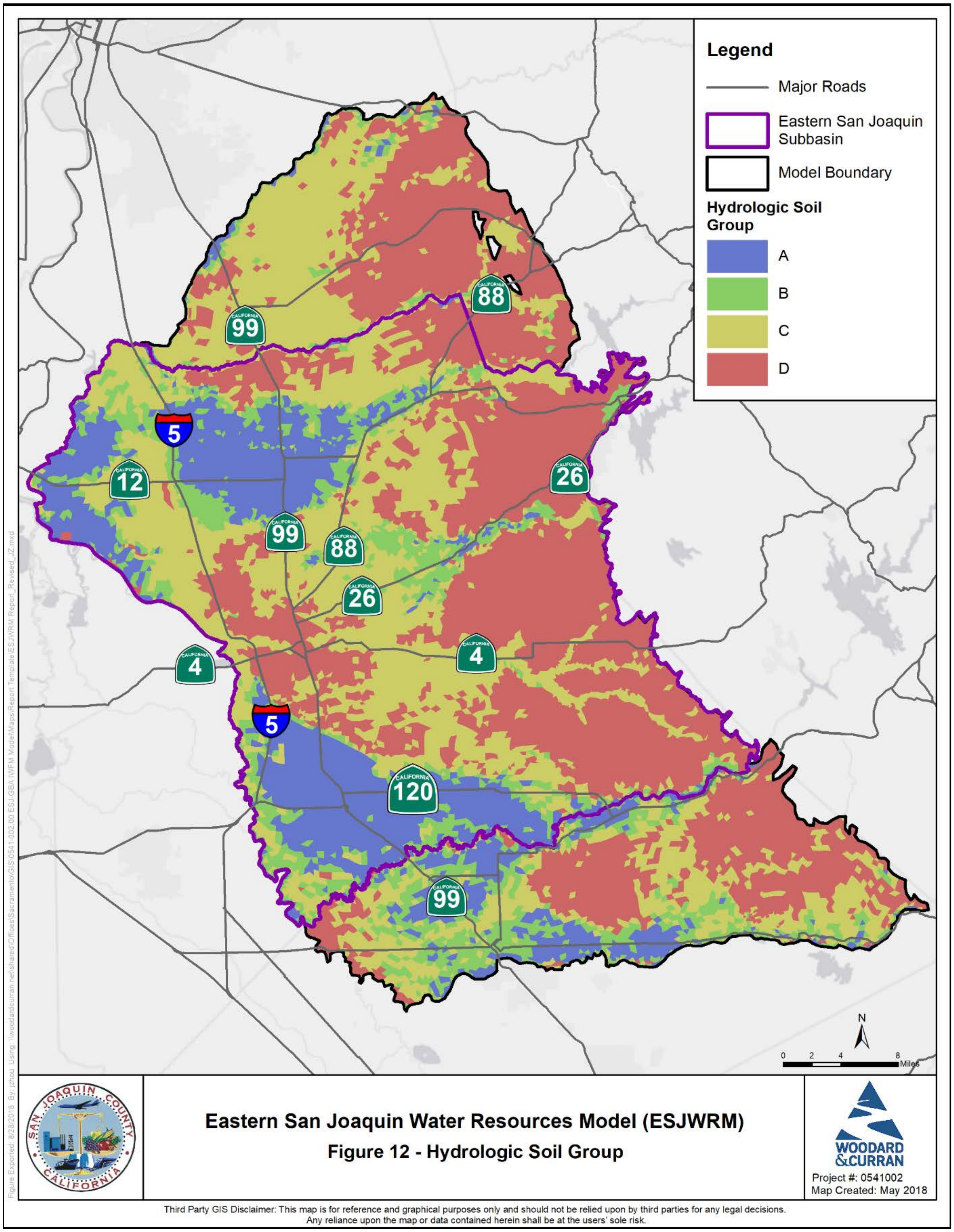

Figure 13: ESJWRM General Land Use in 1995 DWR Land Use Survey

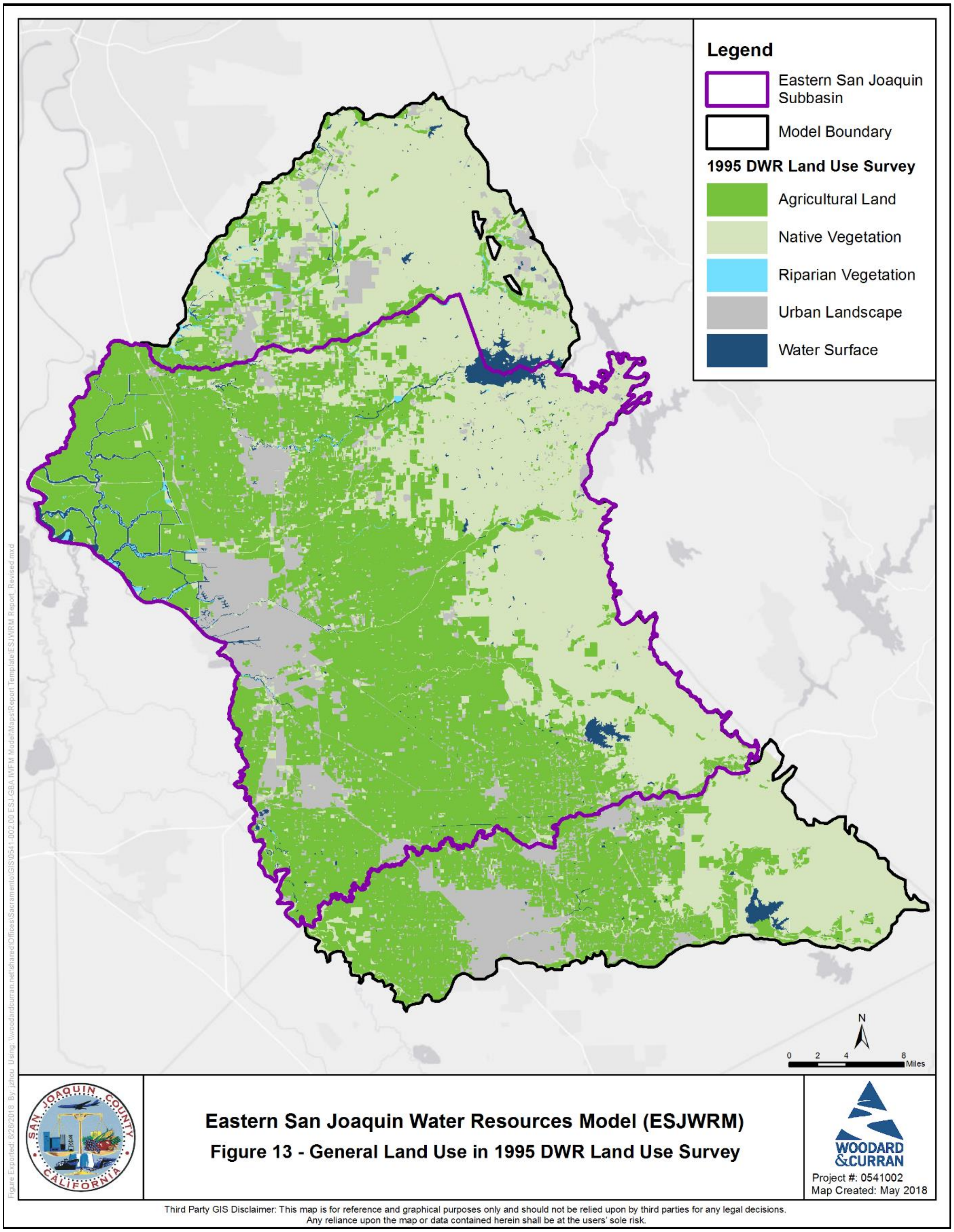

Figure 14: ESJWRM General Land Use in 2015 CropScape

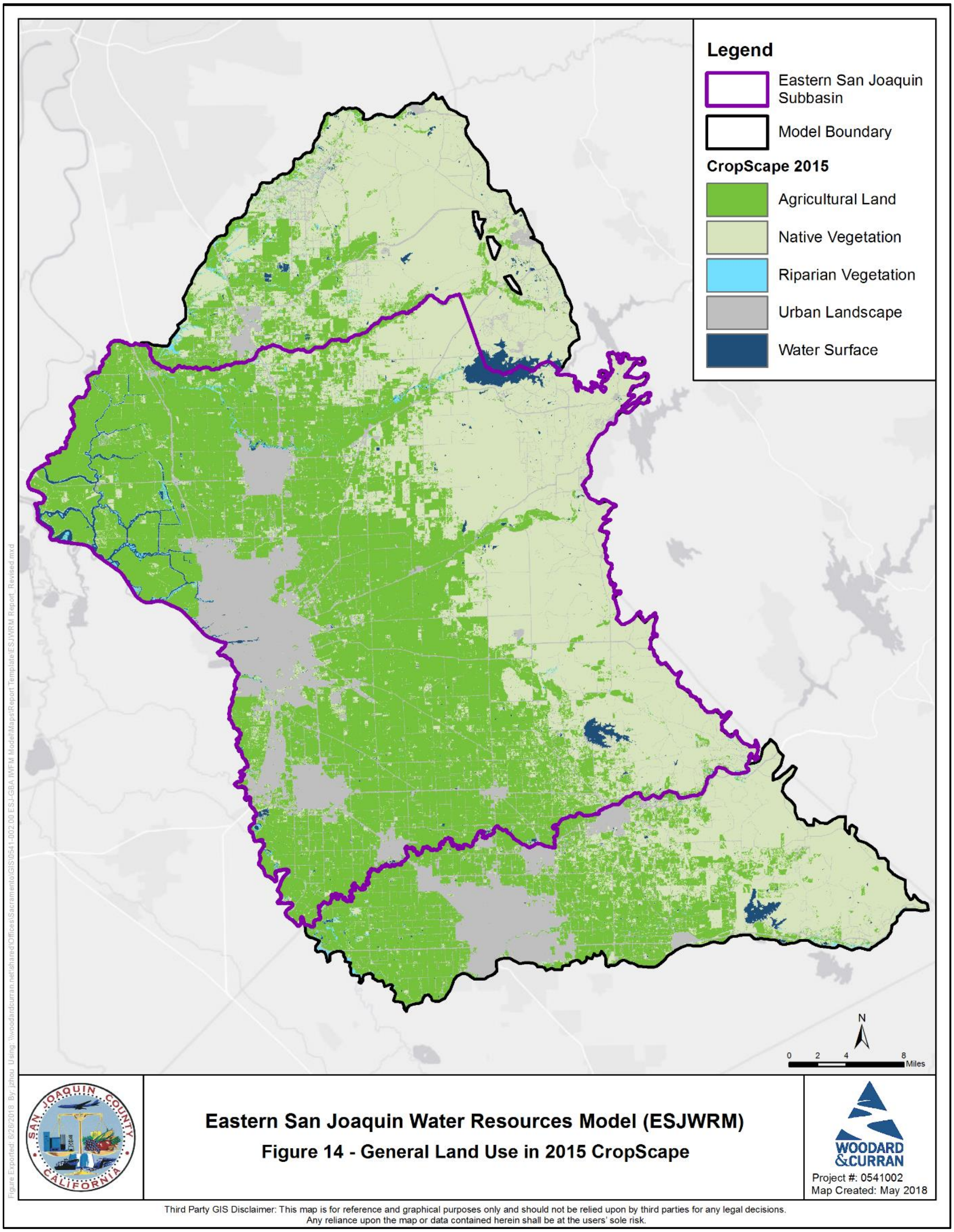

Figure 15: ESJWRM ESJ Subbasin Annual General Land Use

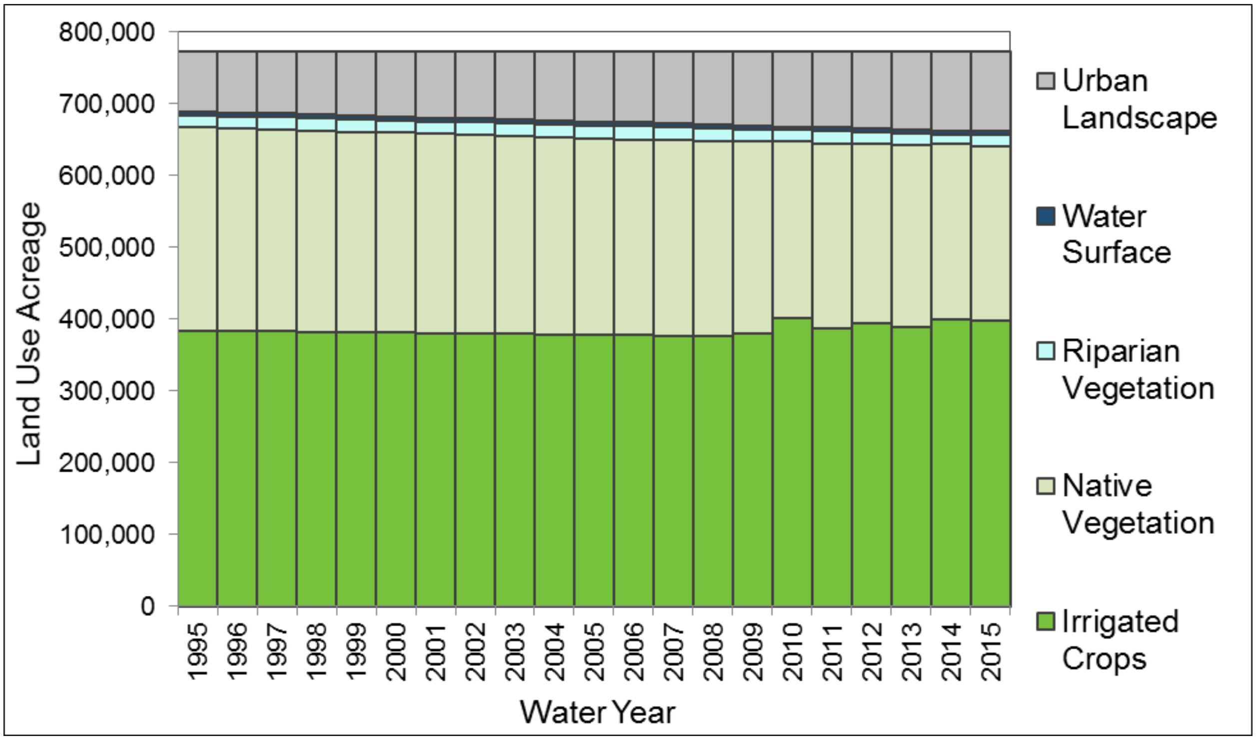

Figure 16: ESJWRM Cropping Pattern in 1995 DWR Land Use Survey

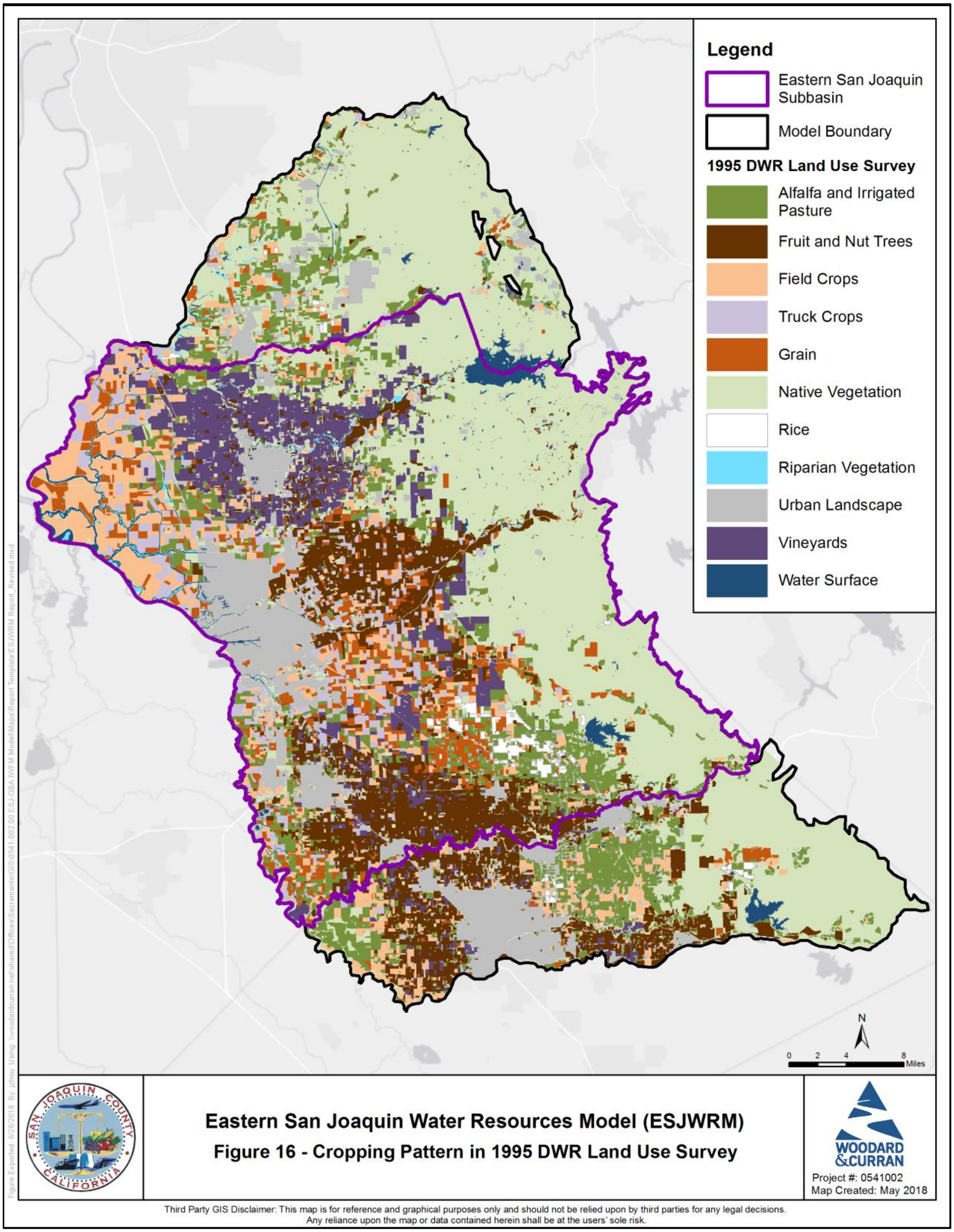

Figure 17: ESJWRM Cropping Pattern in 2014 Land IQ

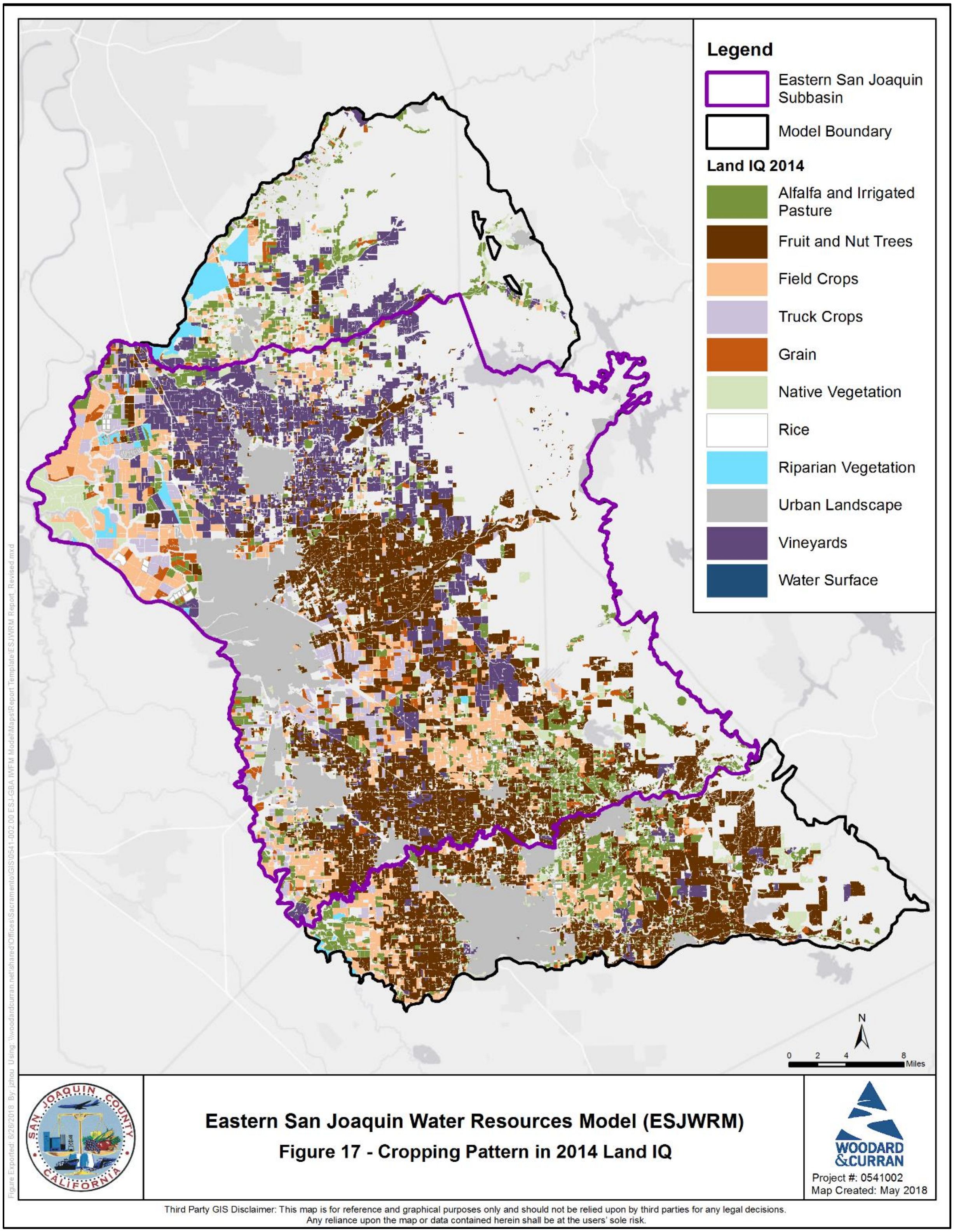

Figure 18: ESJWRM Cropping Pattern in 2015 CropScape

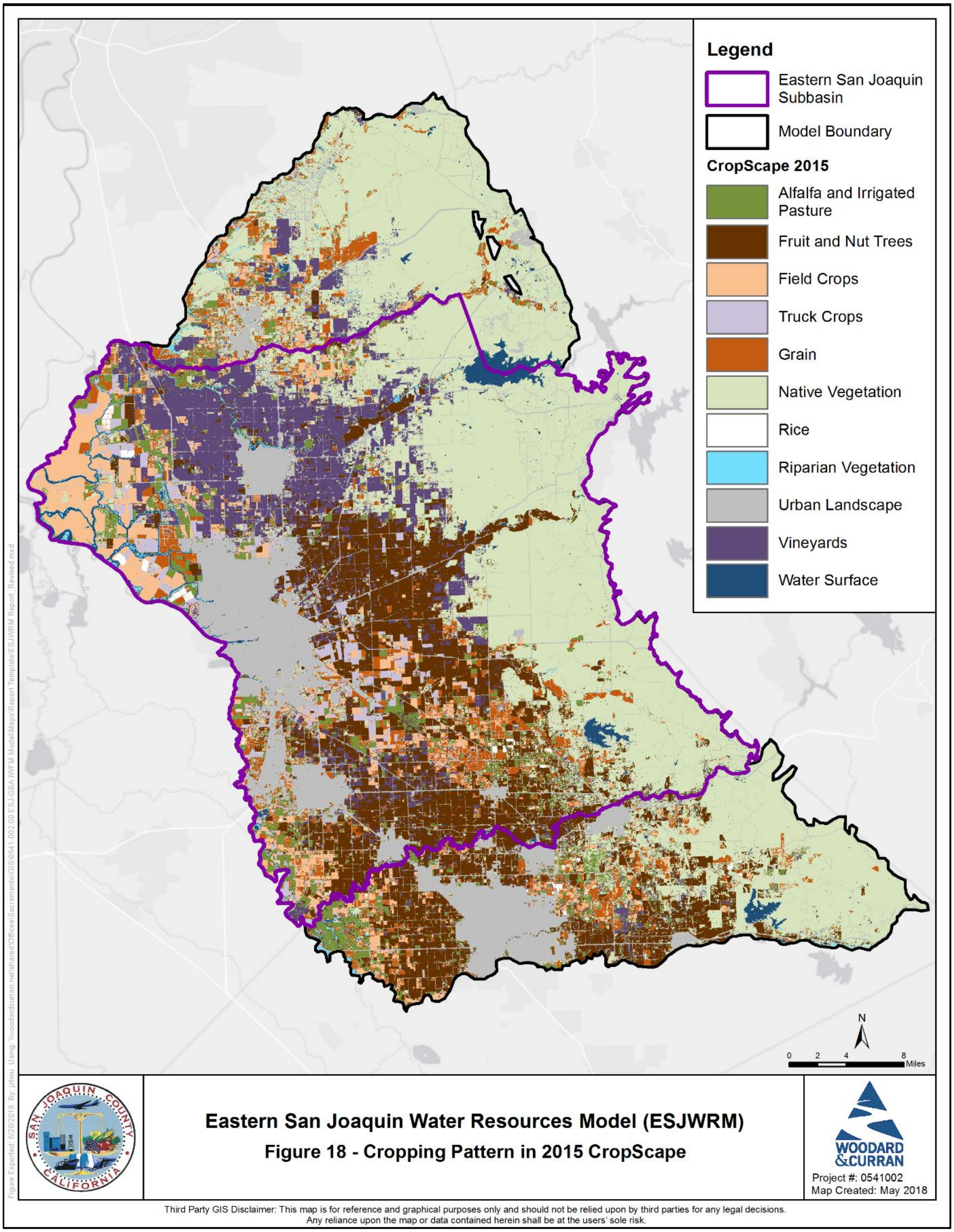

Figure 19a: ESJWRM Annual Cropping Pattern – Eastern San Joaquin Subbasin

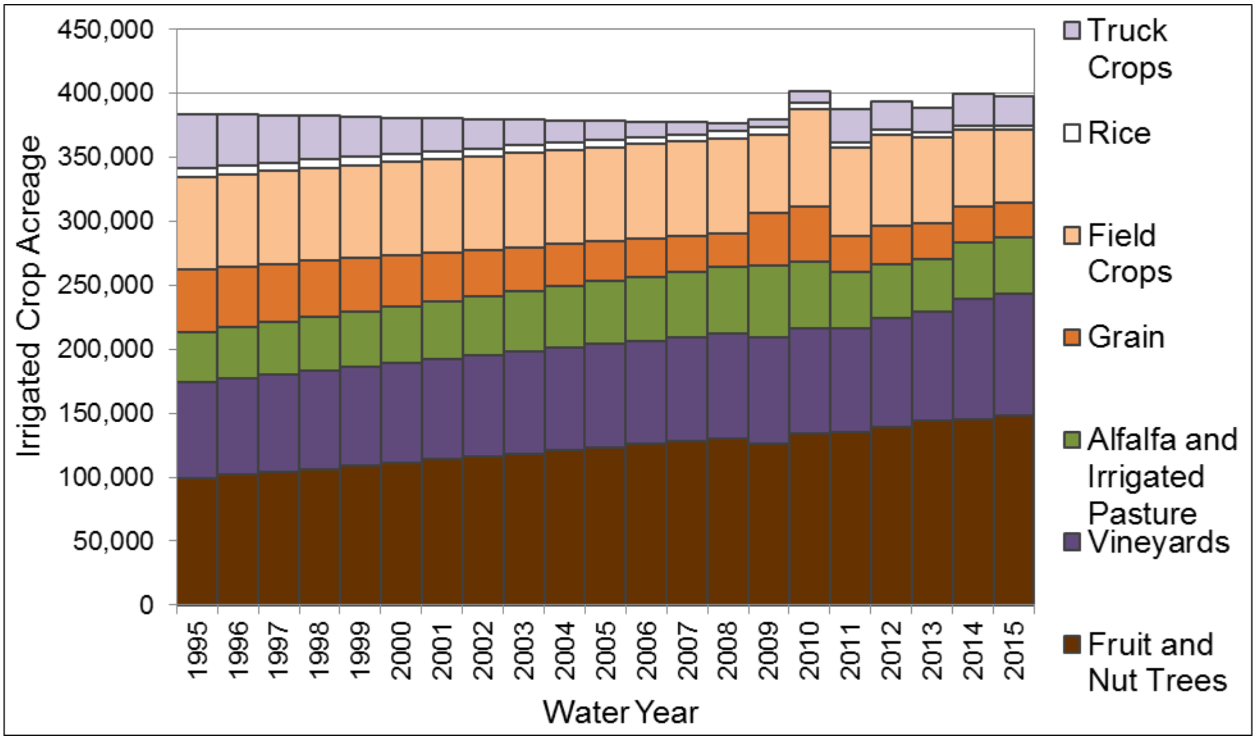

Figure 19b: ESJWRM Annual Cropping Pattern – Subarea 1 (North Delta Subarea)

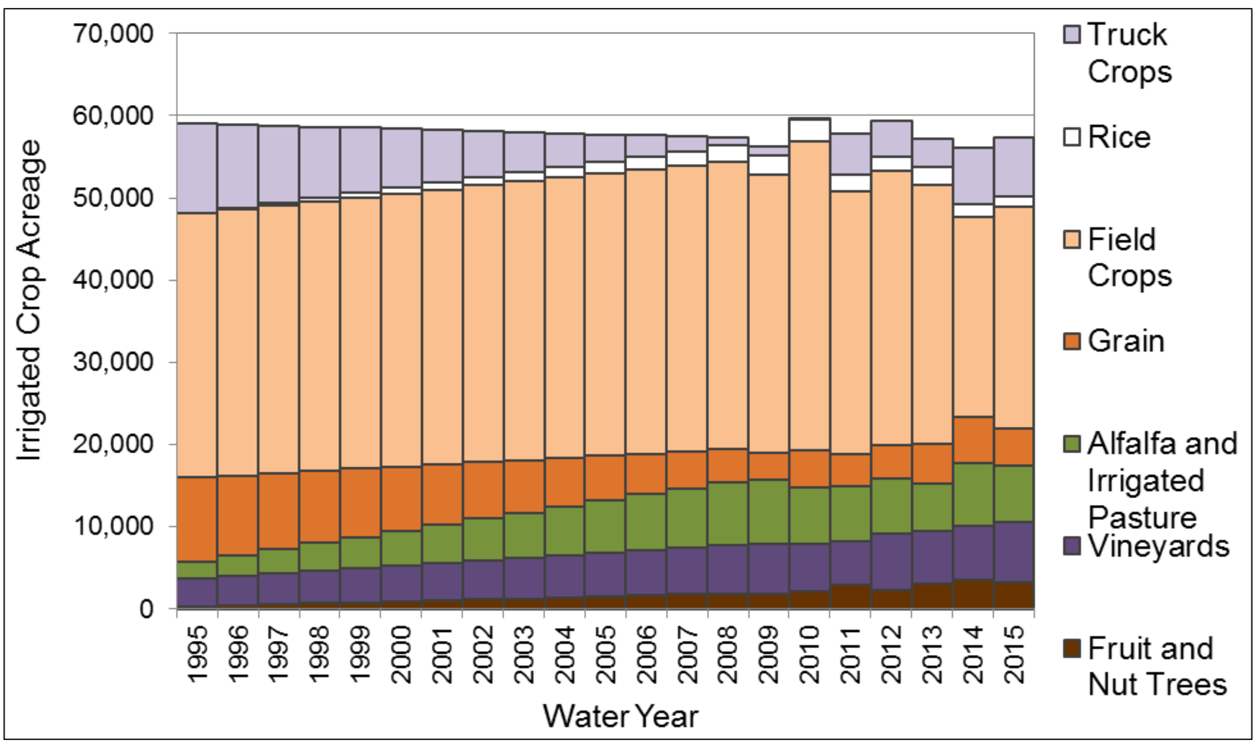

Figure 19c: ESJWRM Annual Cropping Pattern – Subarea 2 (North Subarea)

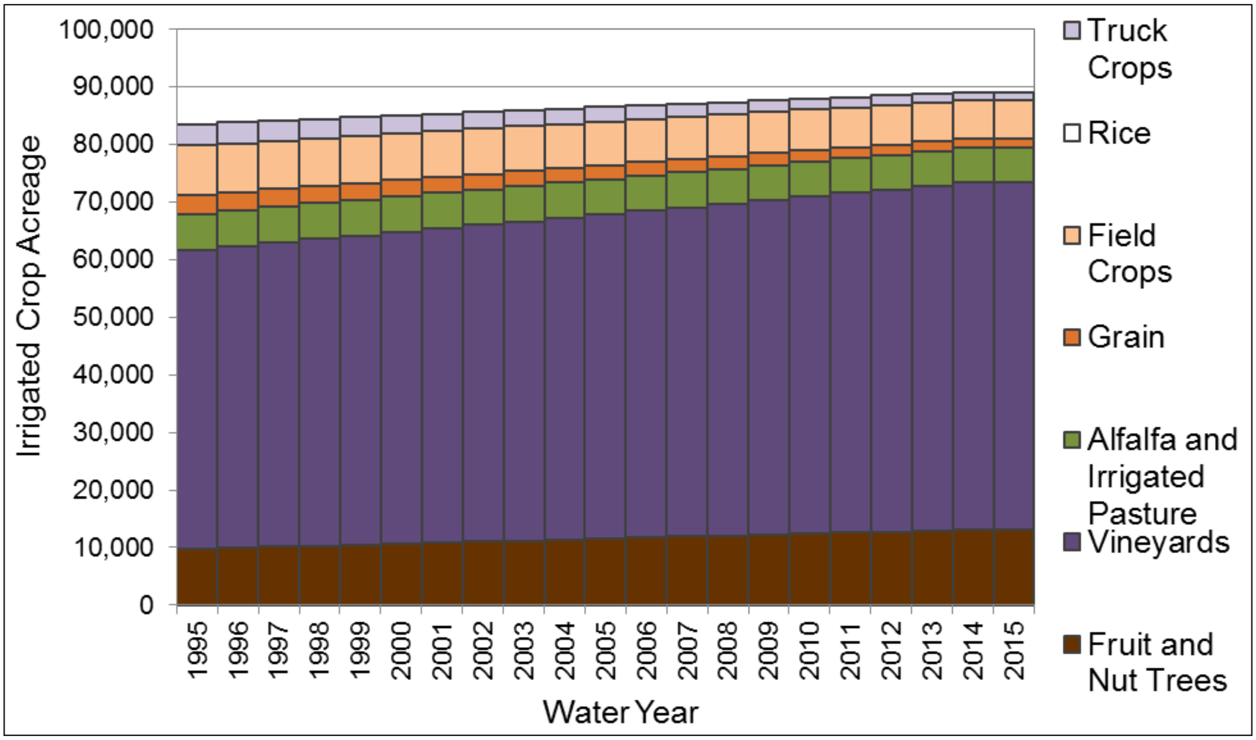

Figure 19d: ESJWRM Annual Cropping Pattern – Subarea 3 (Calaveras Subarea)

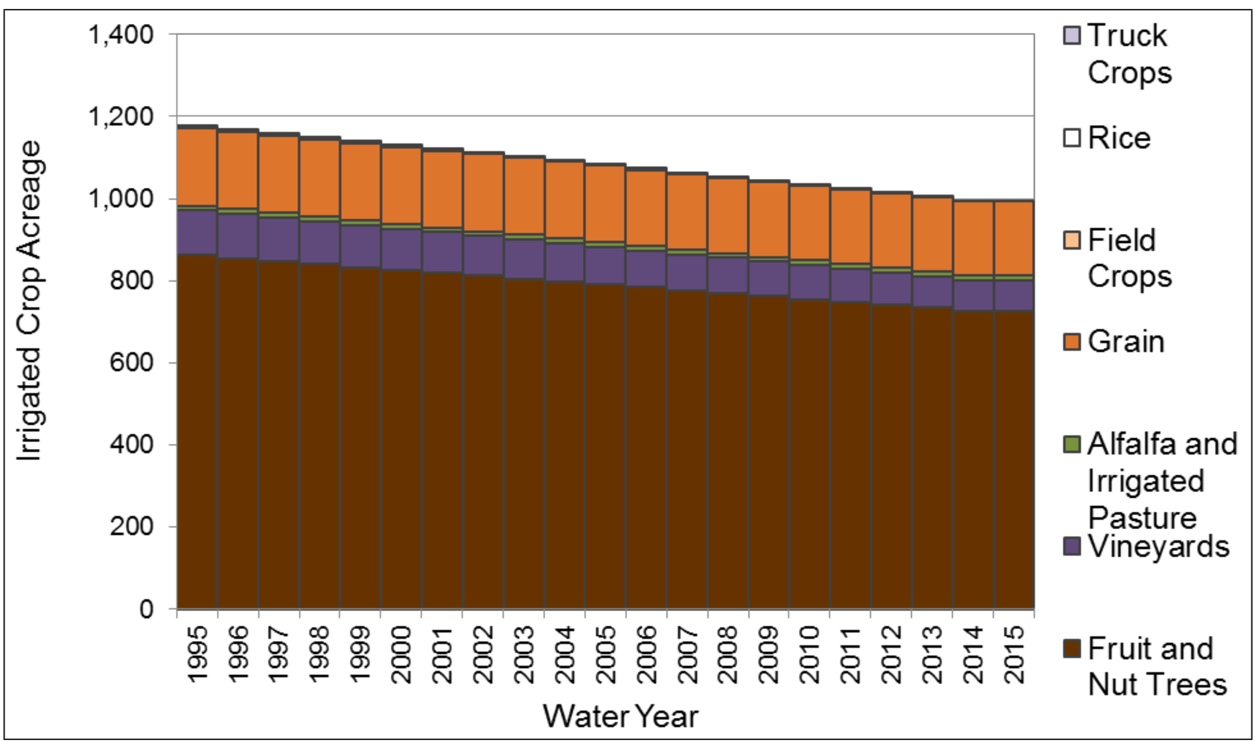

Figure 19e: ESJWRM Annual Cropping Pattern – Subarea 4 (Central Subarea)

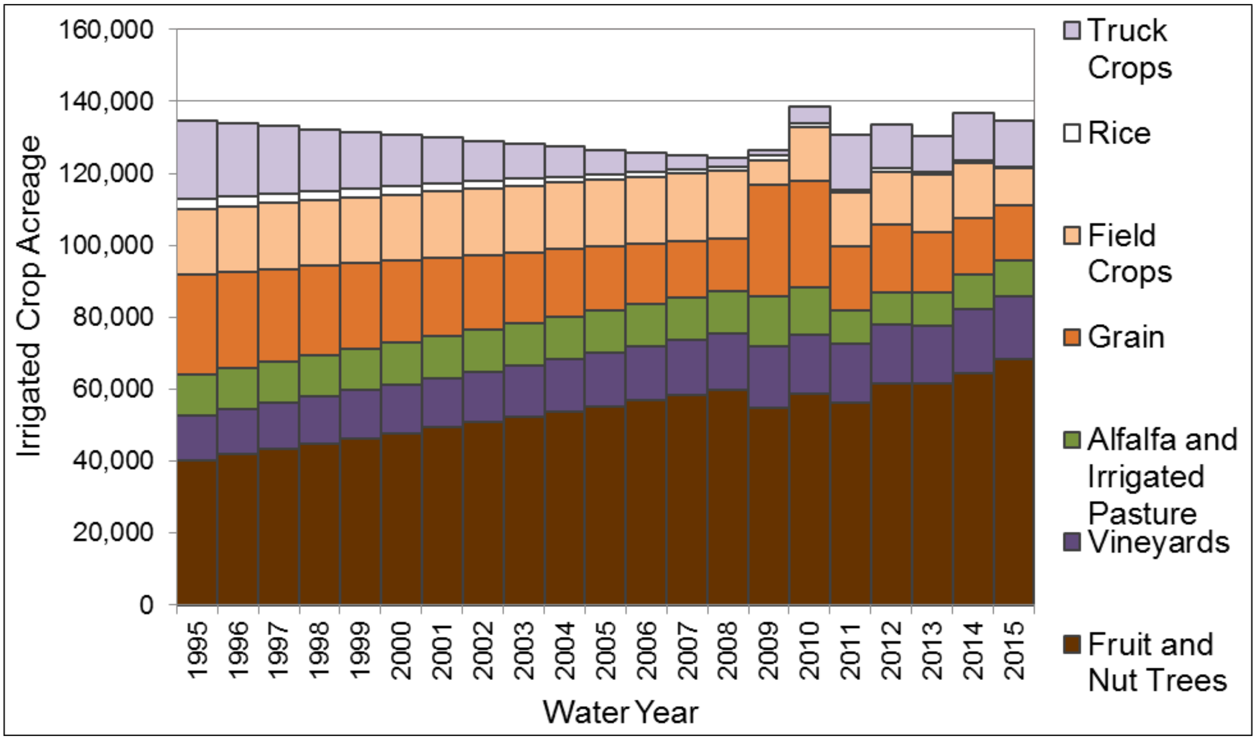

Figure 19f: ESJWRM Annual Cropping Pattern – Subarea 5 (South Subarea)

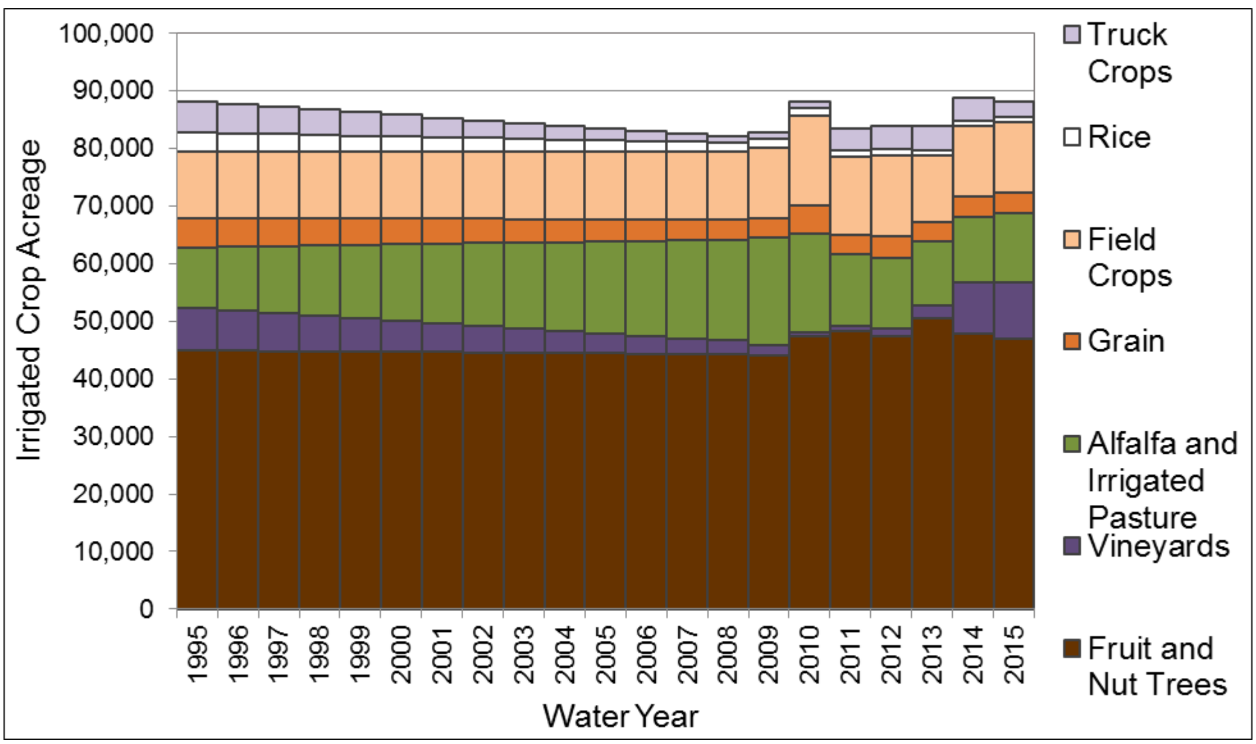

Figure 19g: ESJWRM Annual Cropping Pattern – Subarea 6 (Stanislaus Subarea)

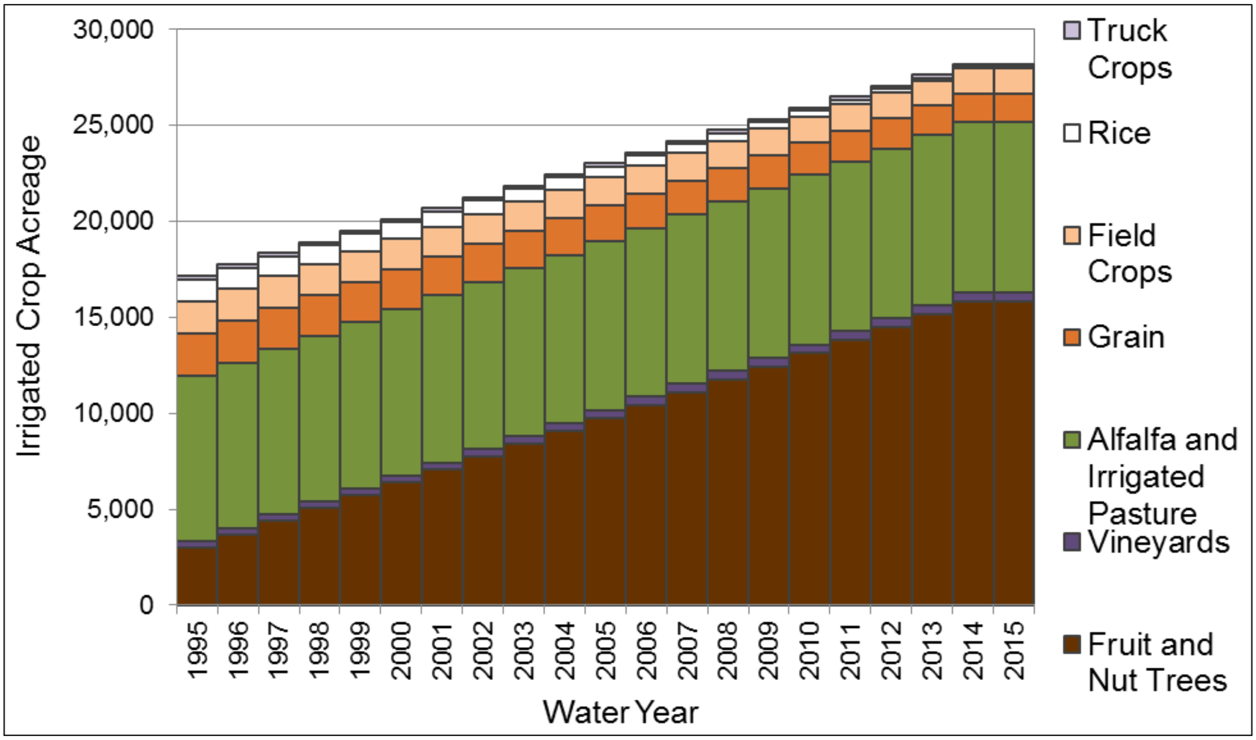

Figure 20: ESJWRM Annual Evapotranspiration

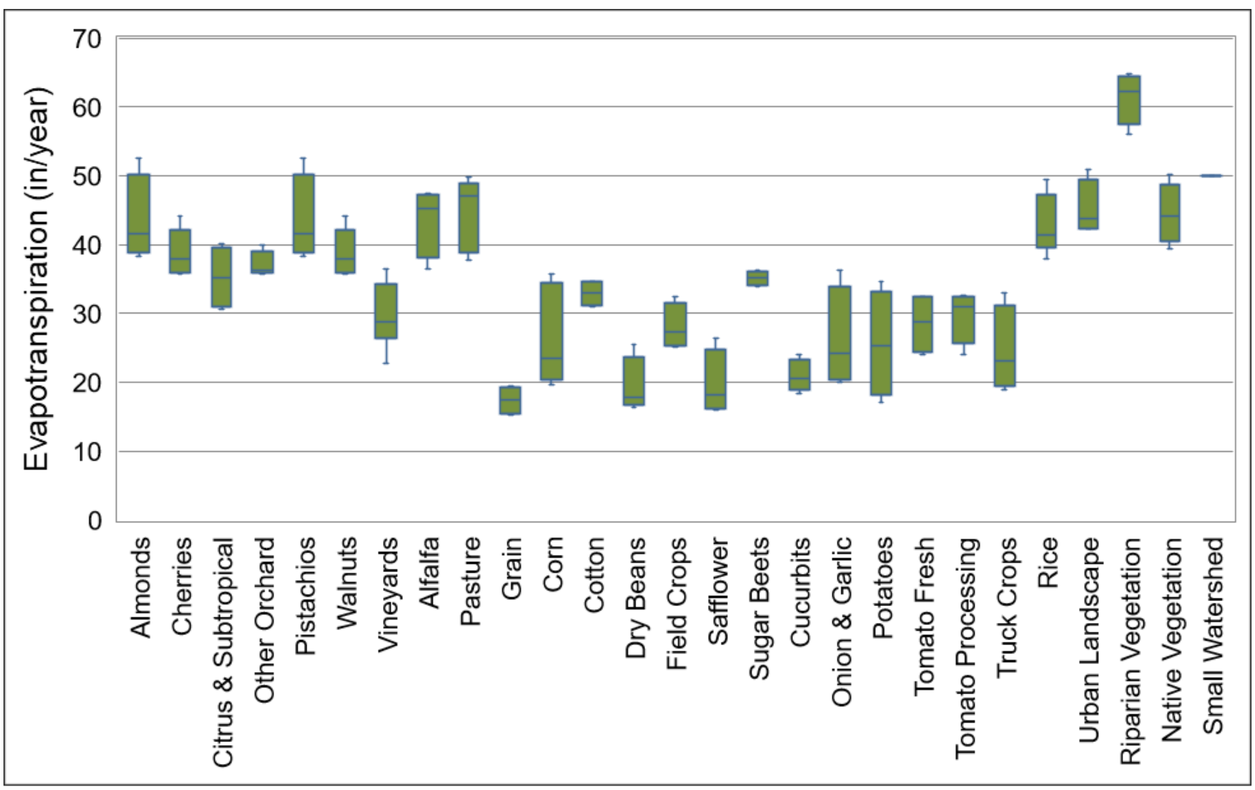

Figure 21: ESJWRM Surface Water Drainage Watersheds

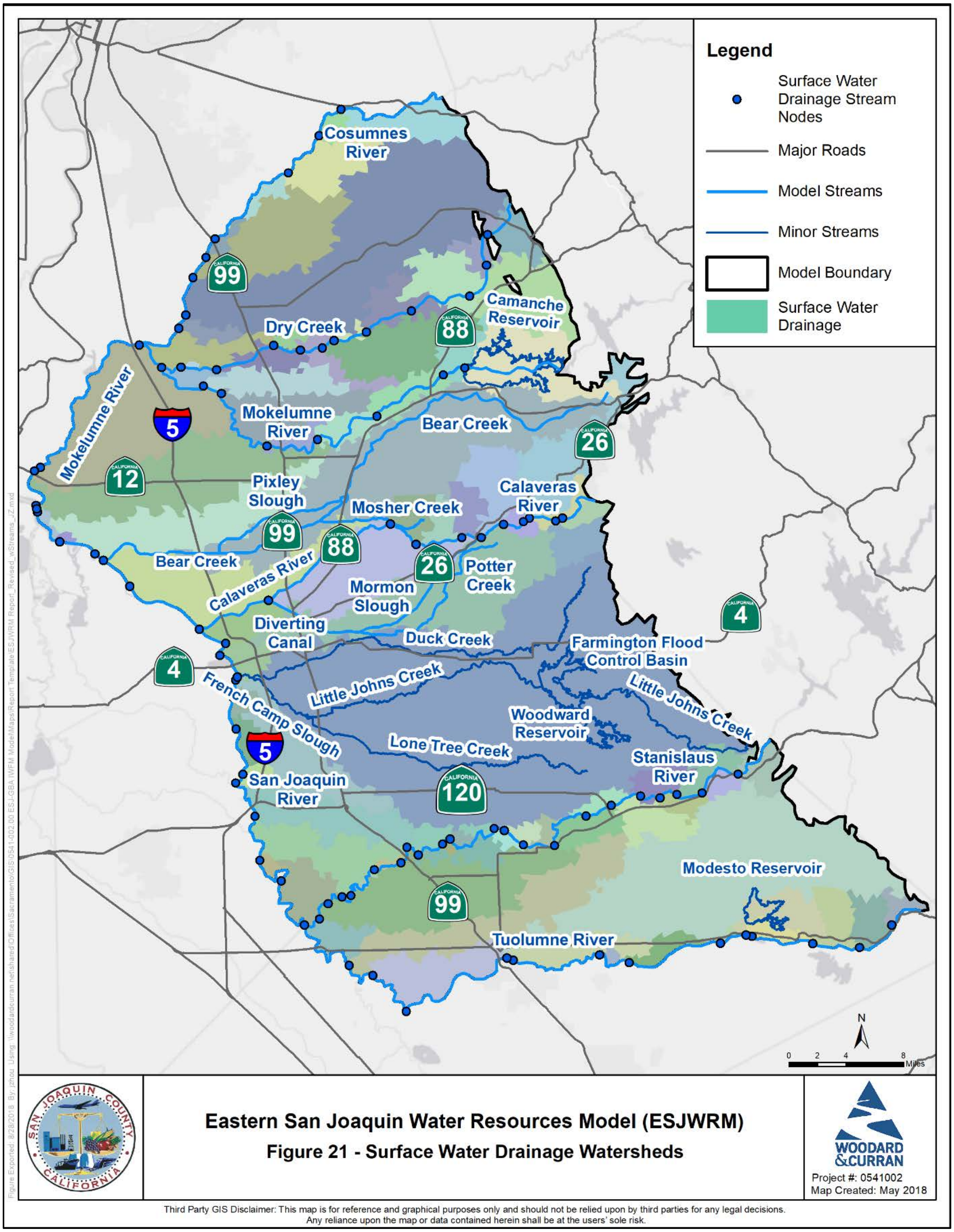

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Figure 22: ESJWRM Ground Surface Elevation

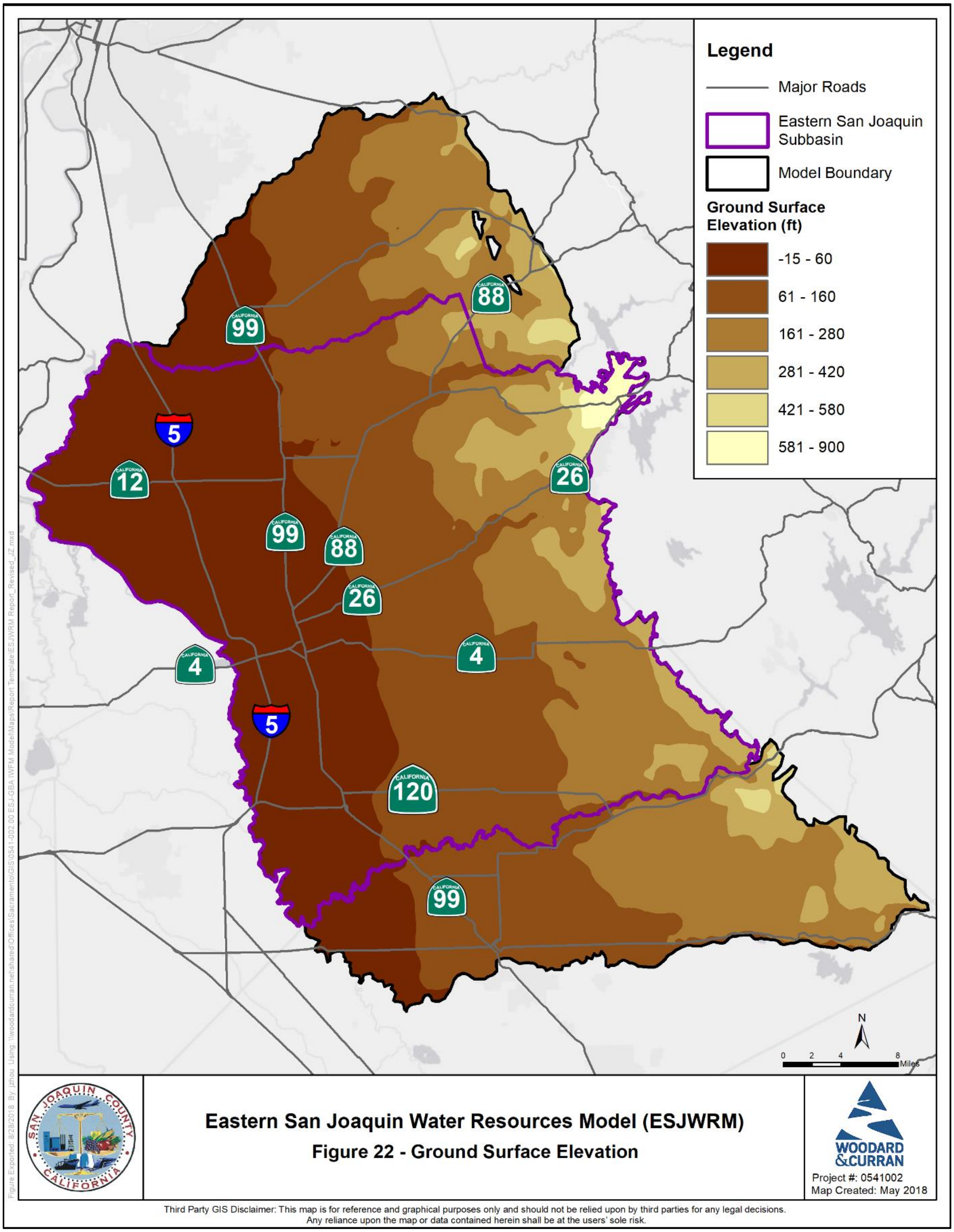

Figure 23: ESJWRM Layer 1 Thickness

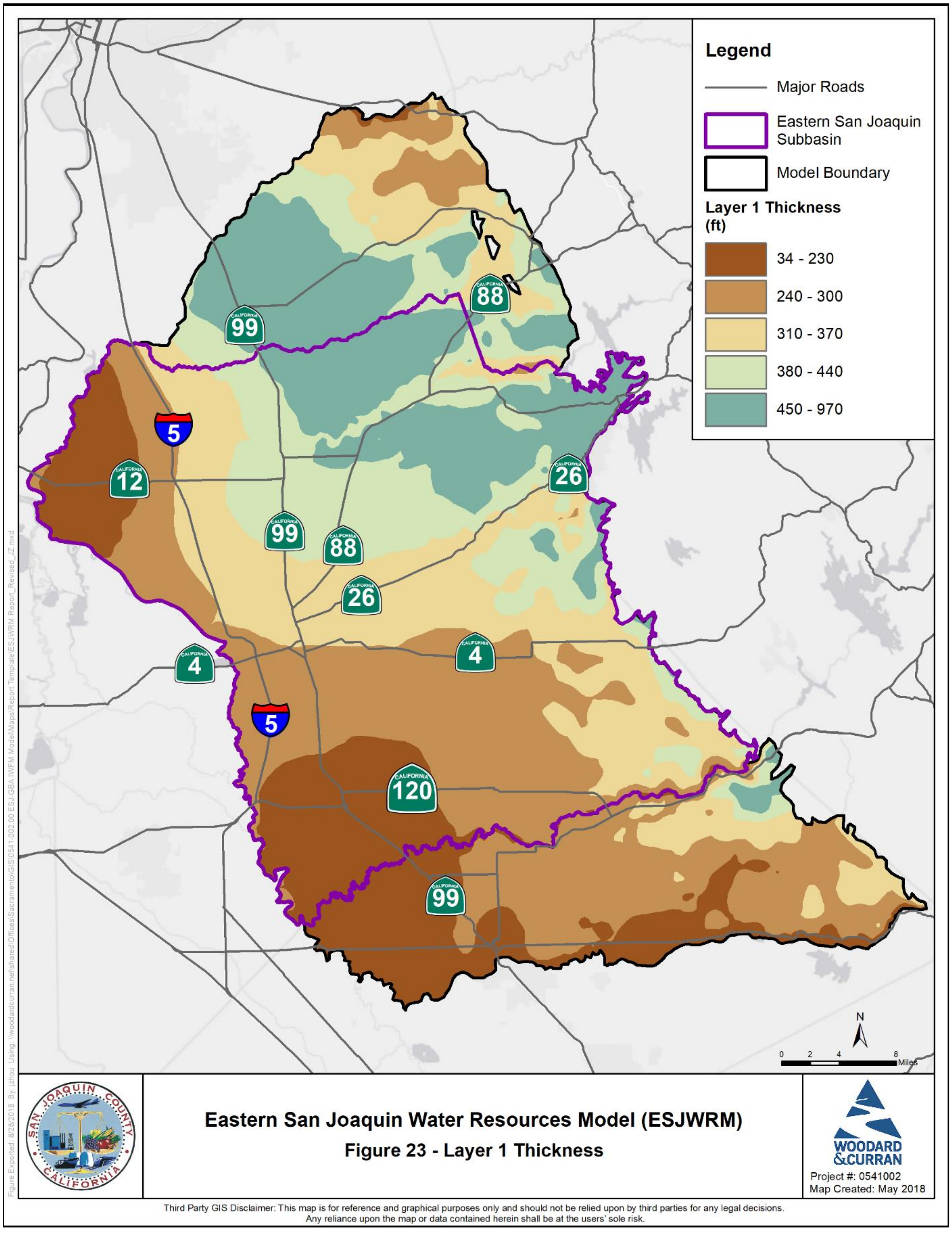

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Figure 24: ESJWRM Corcoran Clay Depth to Top

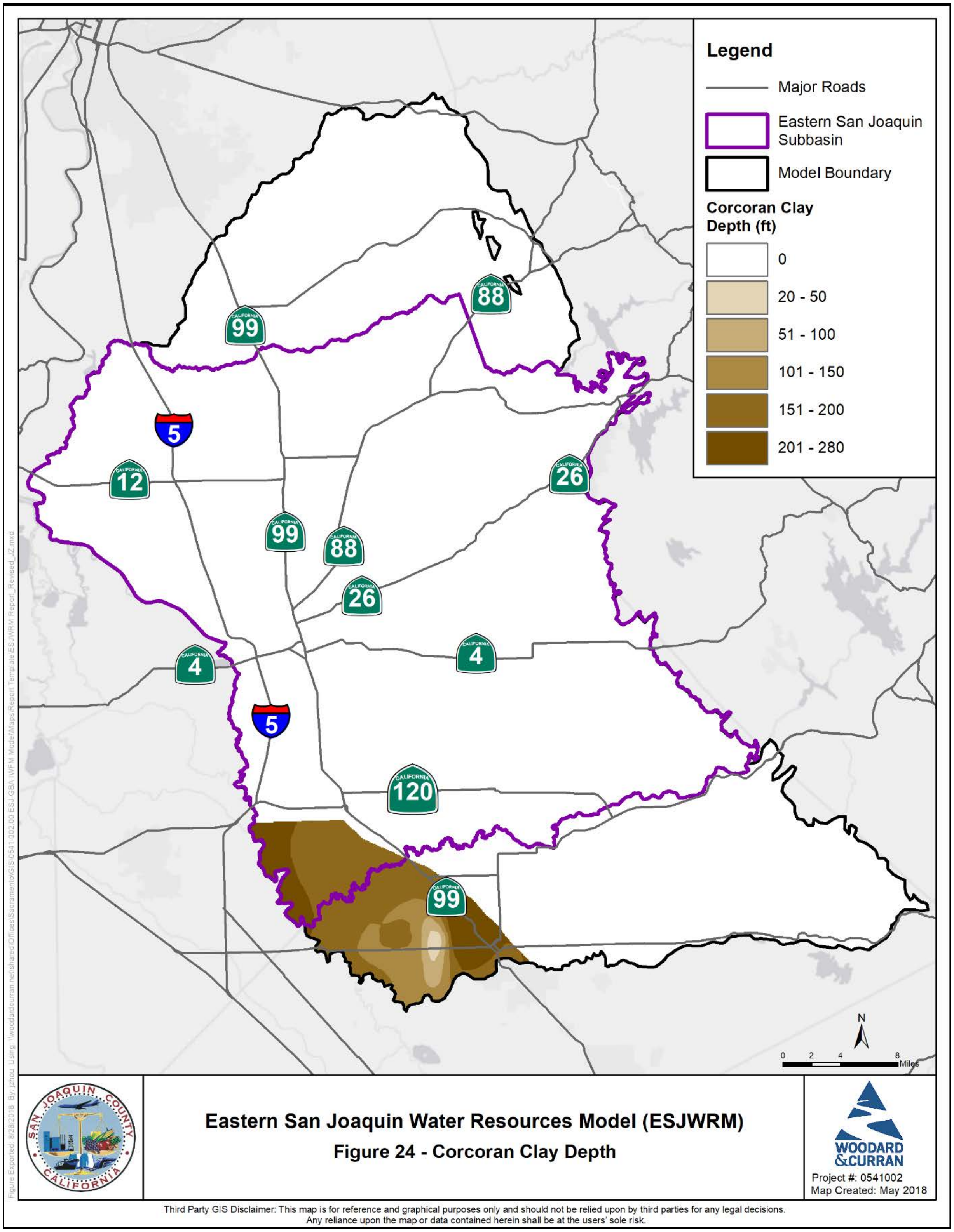

Figure 25: ESJWRM Corcoran Clay Thickness

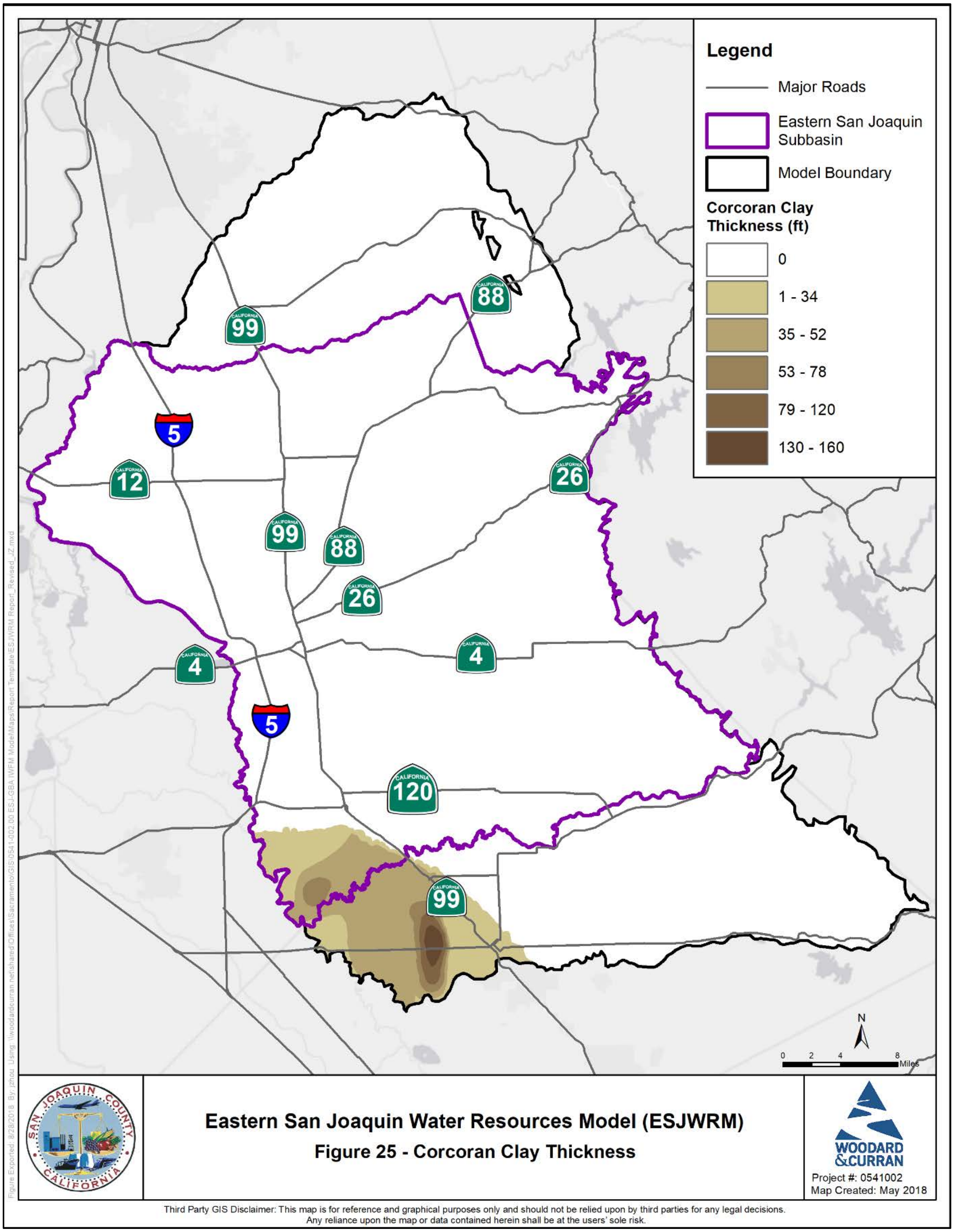

Figure 26: ESJWRM Layer 2 Thickness

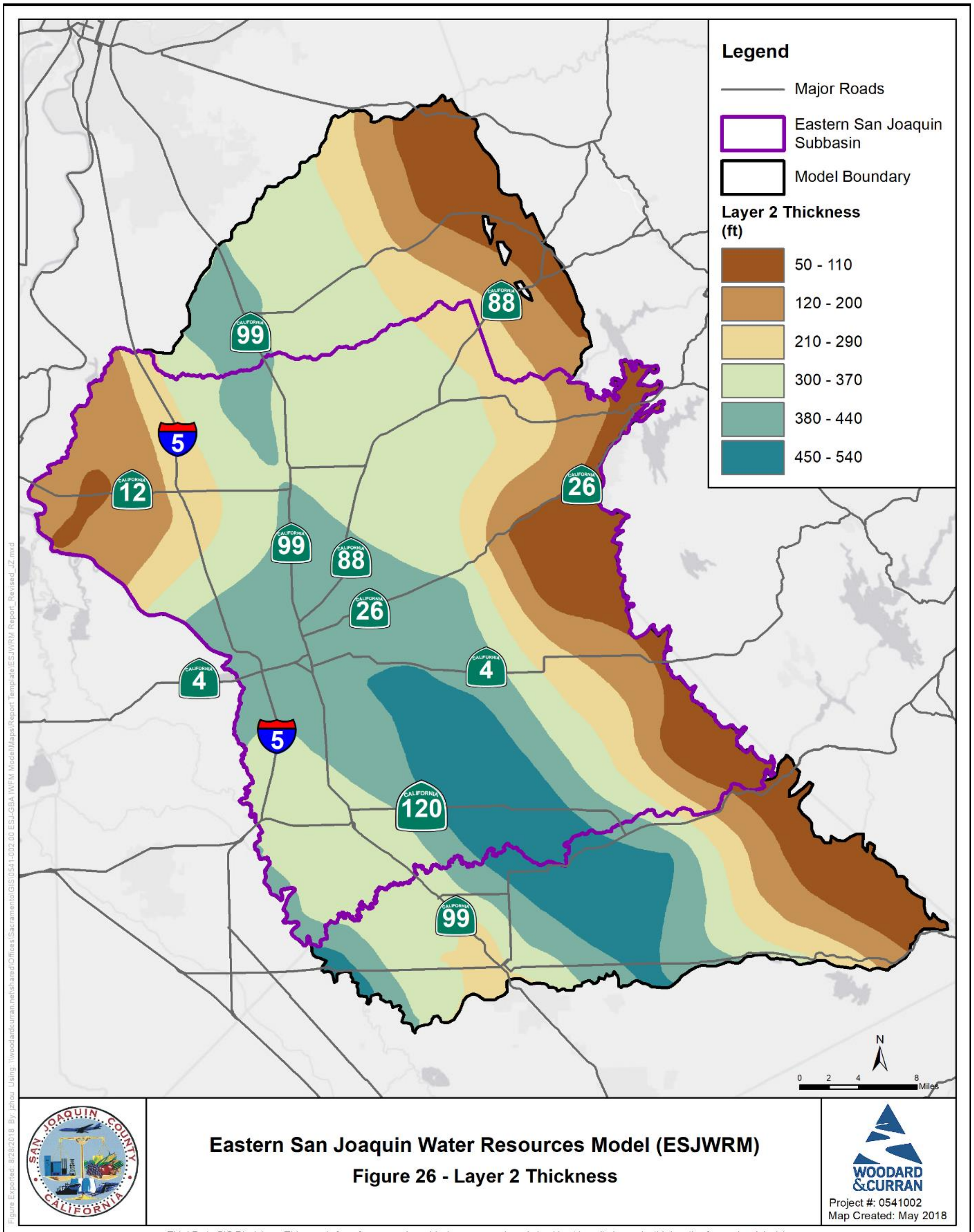

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Figure 27: ESJWRM Layer 3 Thickness

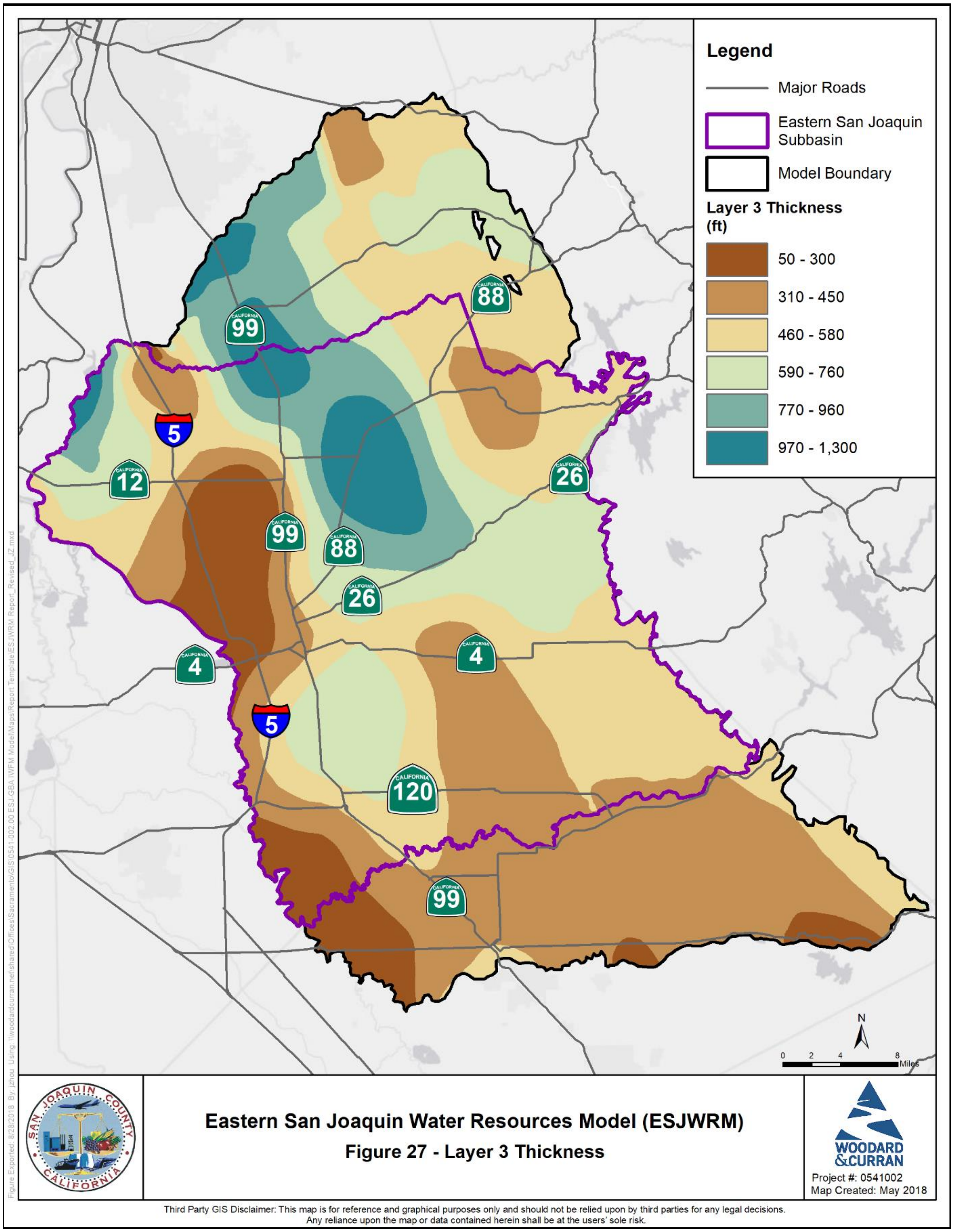

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Figure 28: ESJWRM Layer 4 Thickness

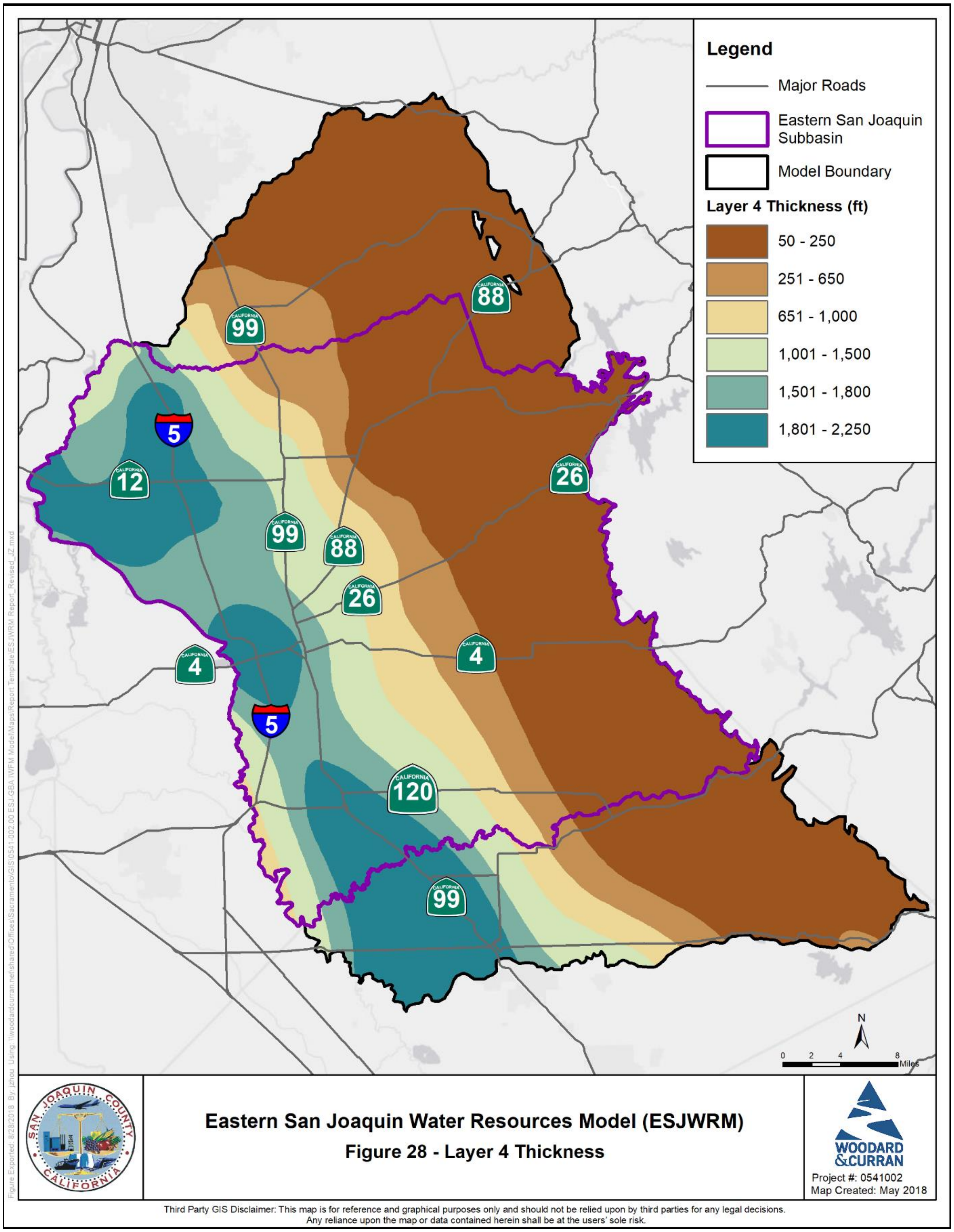


Figure 29a: ESJWRM Cross Section A - A’

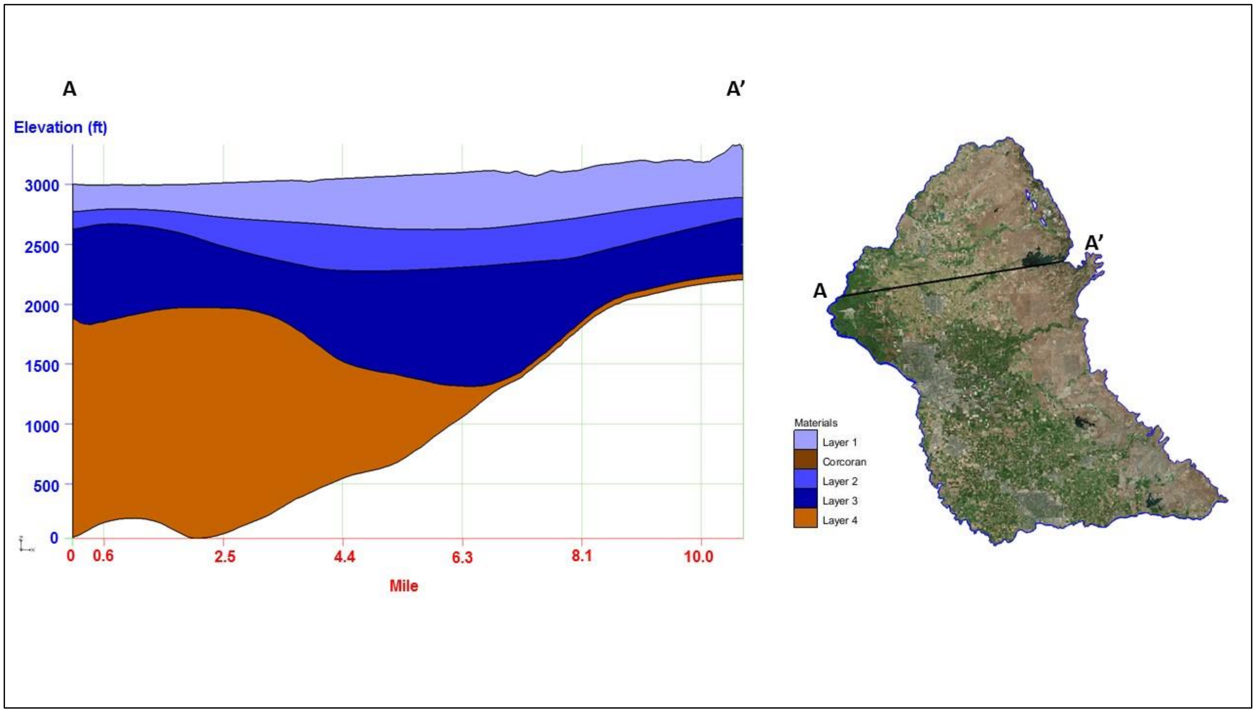


Figure 29b: ESJWRM Cross Section B - B’

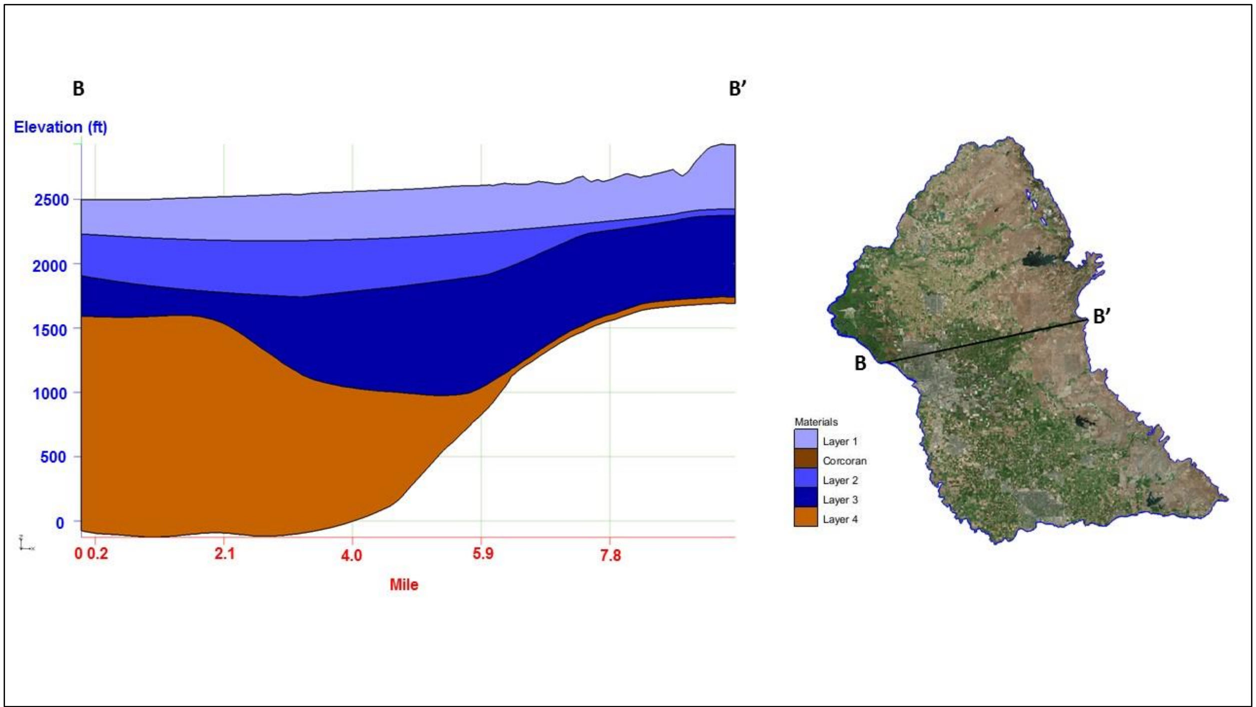


Figure 29c: ESJWRM Cross Section C - C’

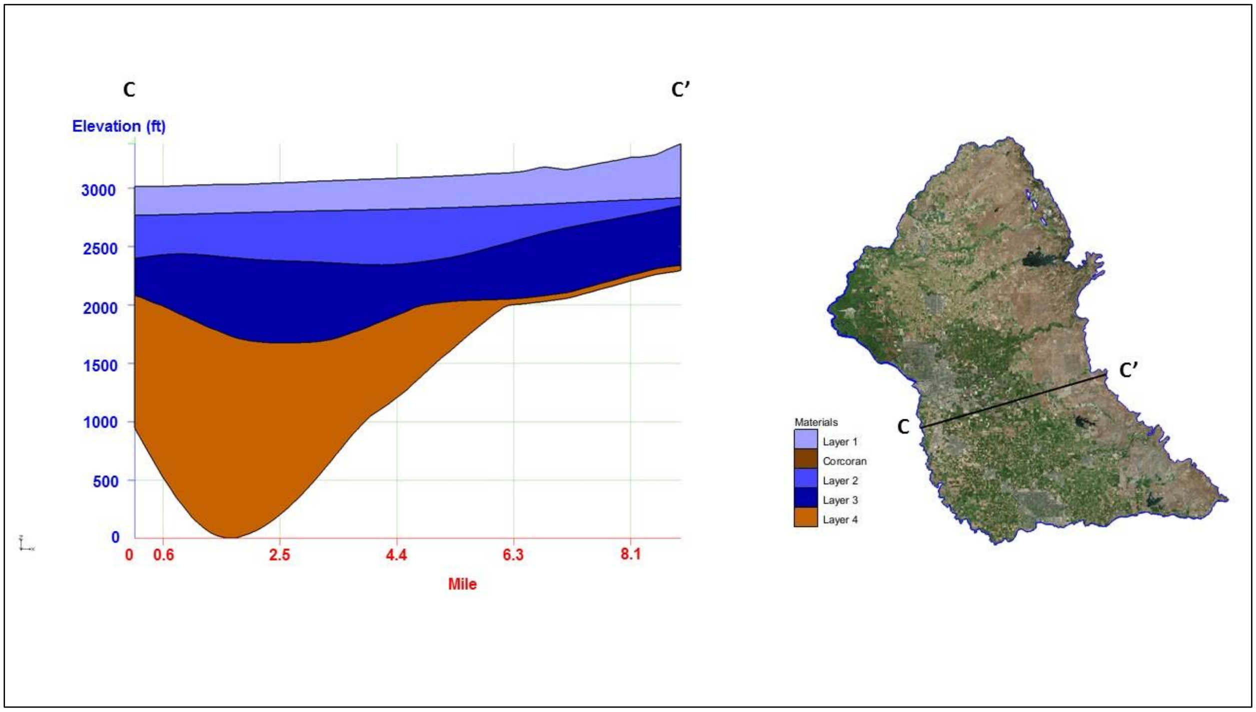


Figure 29d: ESJWRM Cross Section D - D’

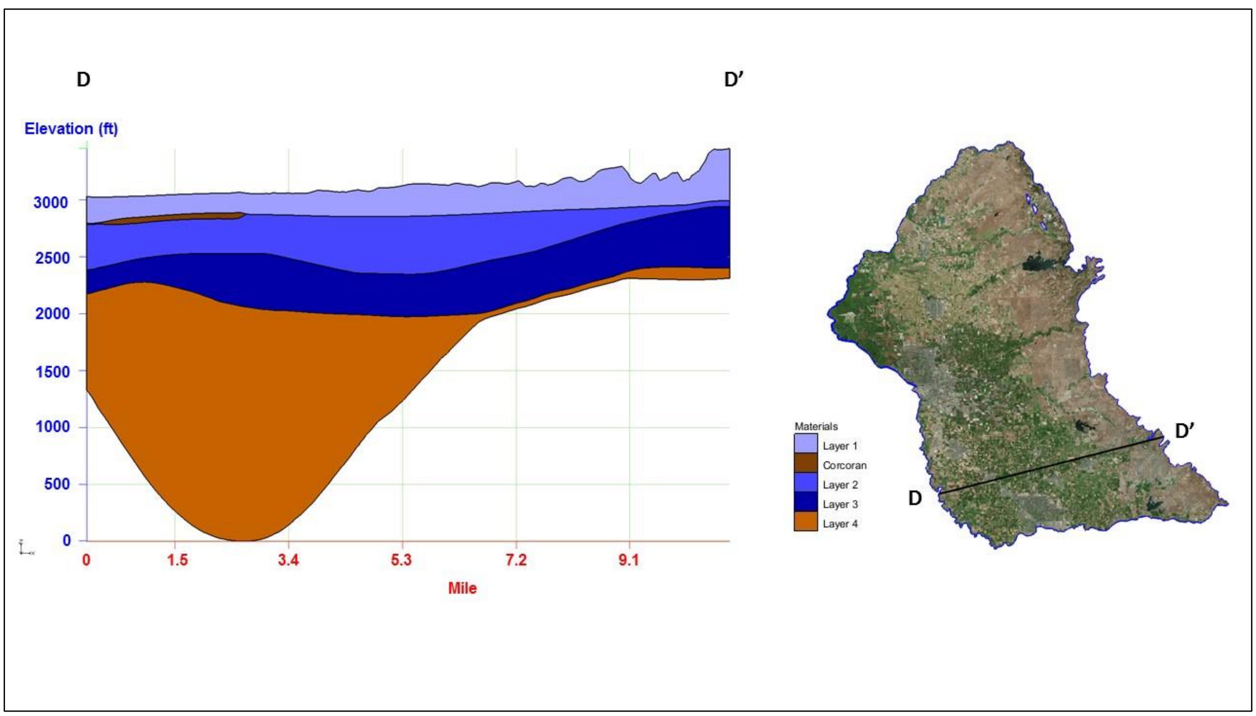


Figure 29e: ESJWRM Cross Section E - E’

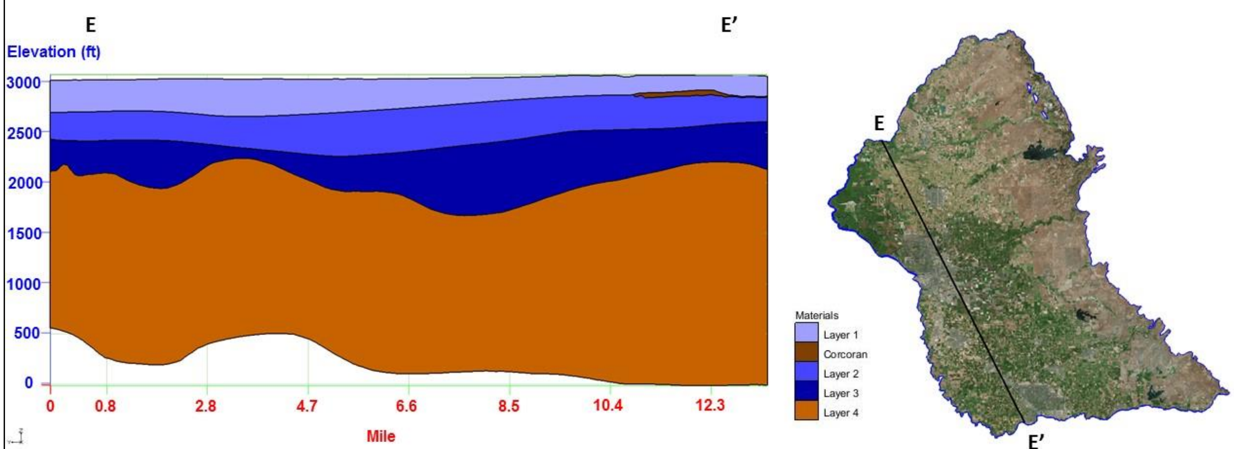


Figure 29f: ESJWRM Cross Section F - F’

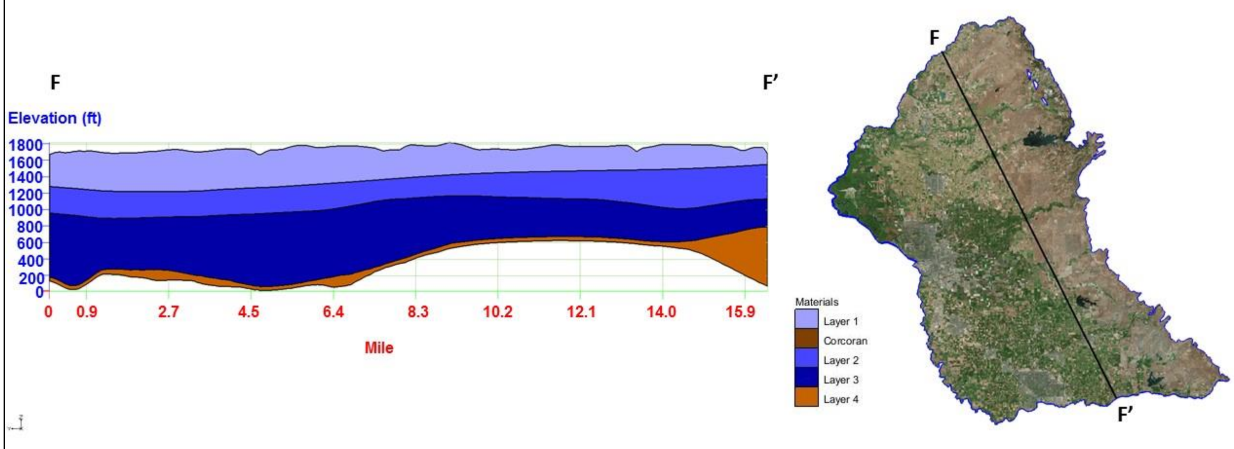


Figure 30: ESJWRM Small Watersheds

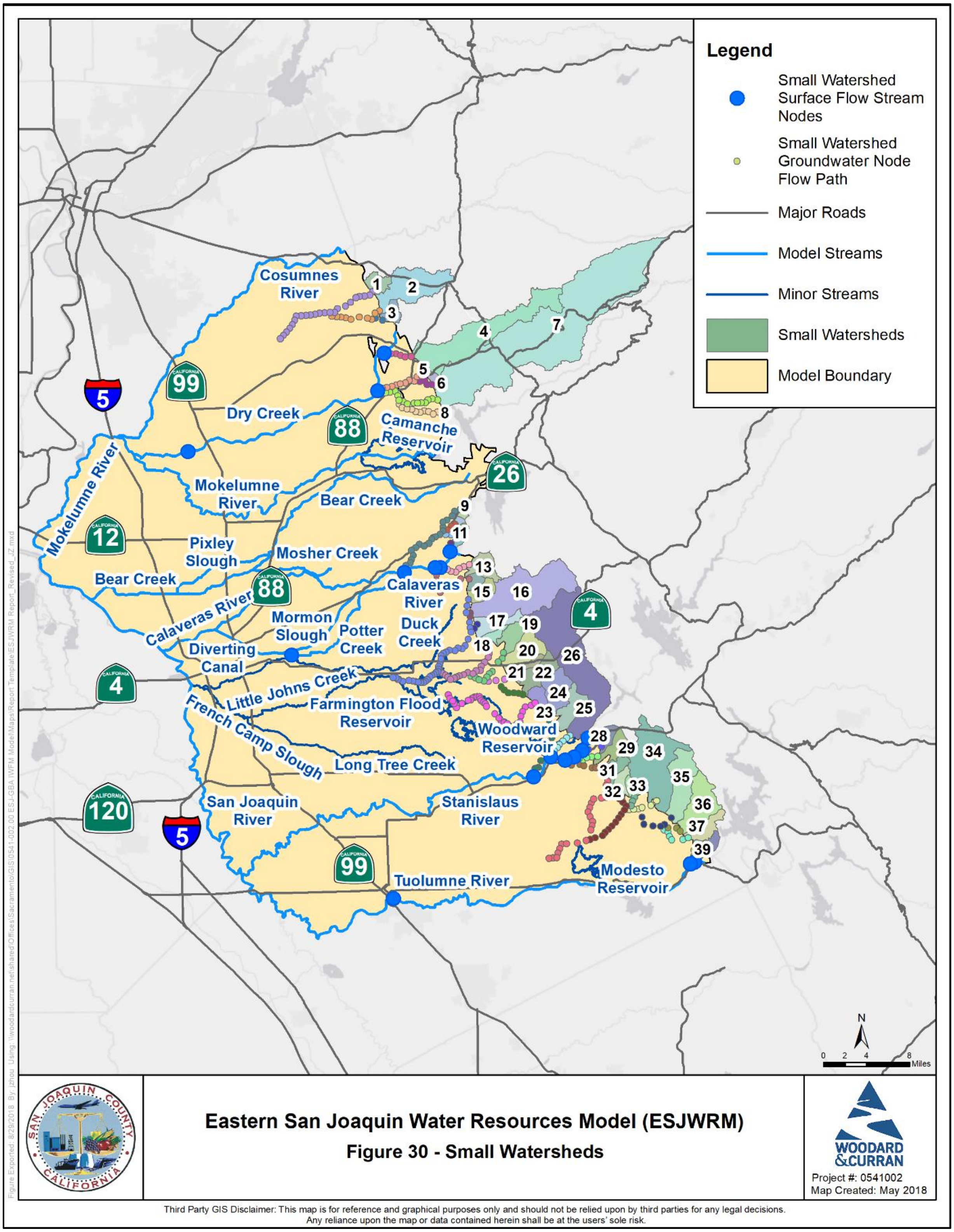


Figure 31: ESJWRM Initial GW Levels (Fall 1994)

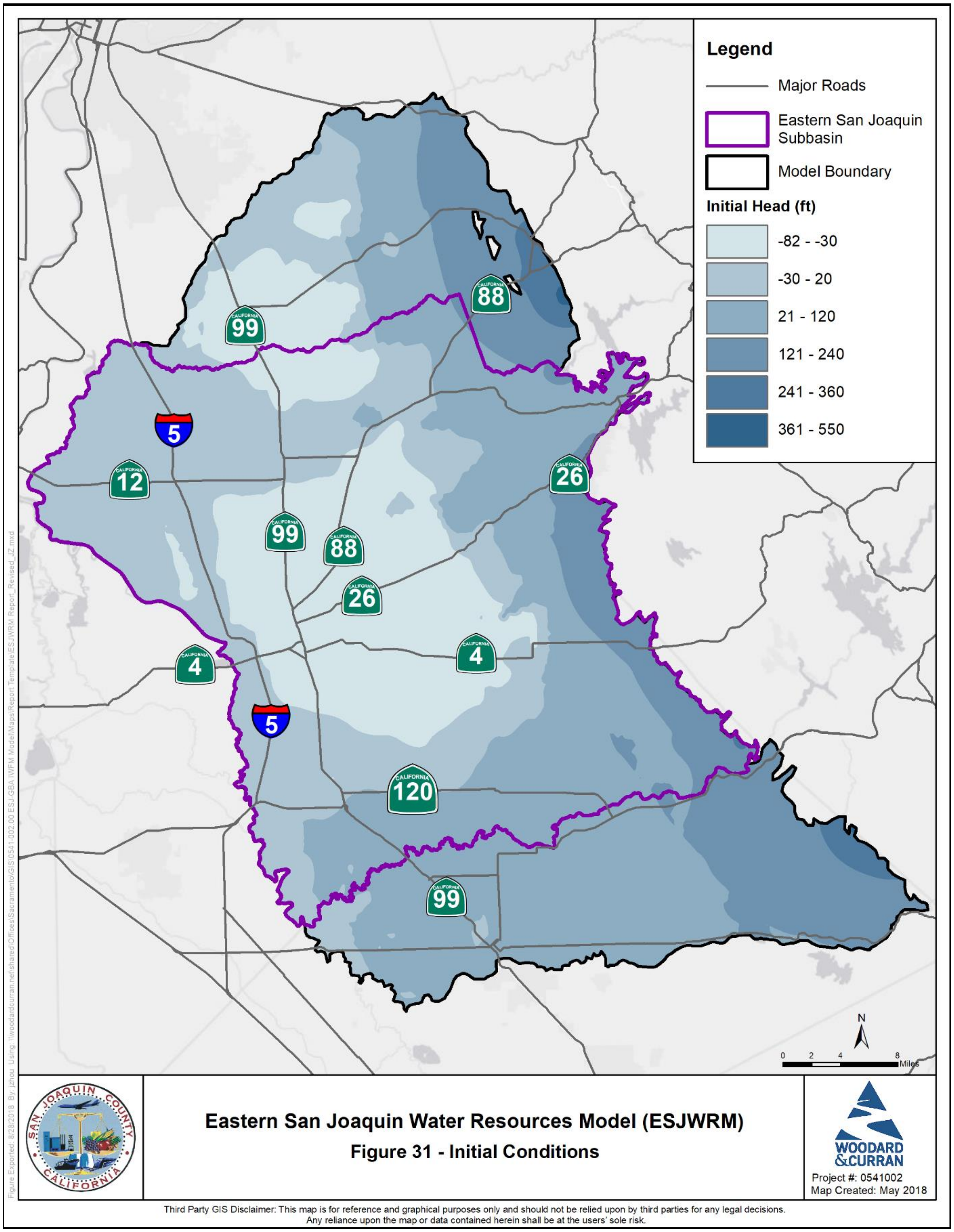


Figure 32: ESJWRM Annual Population by Urban Center

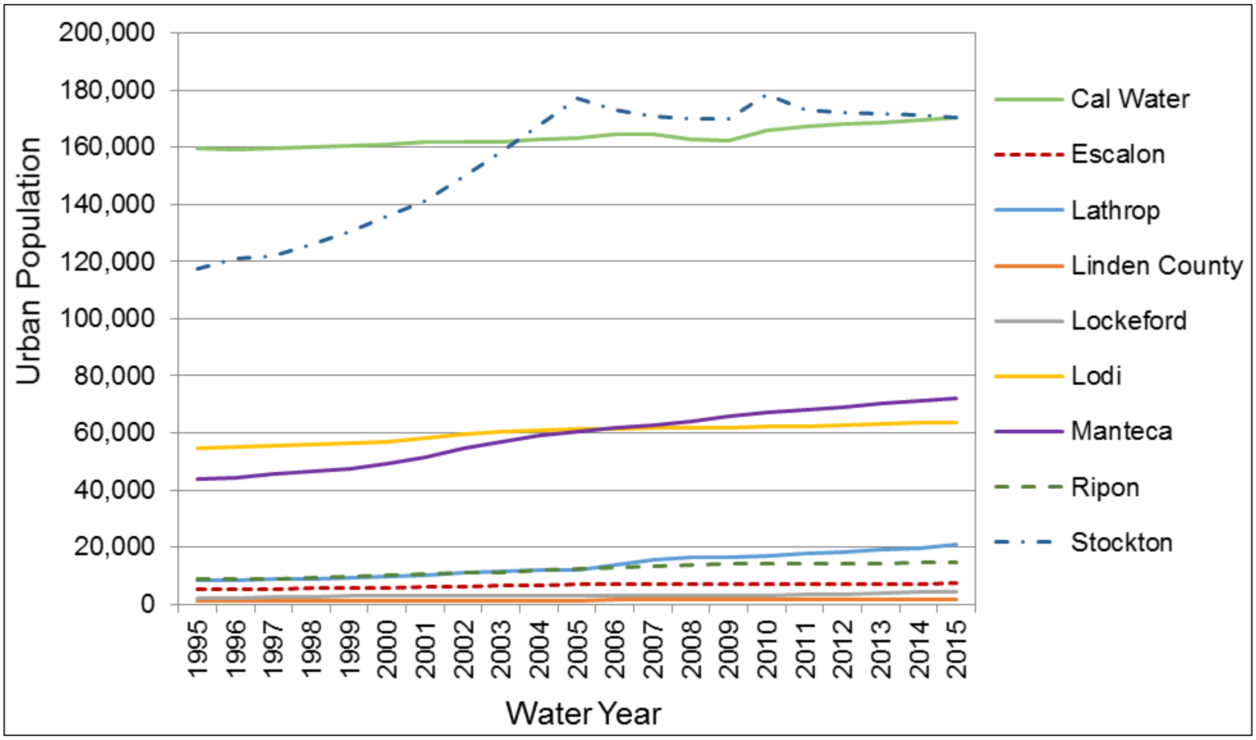


Figure 33: ESJWRM Annual Per Capita Water Use by Urban Center

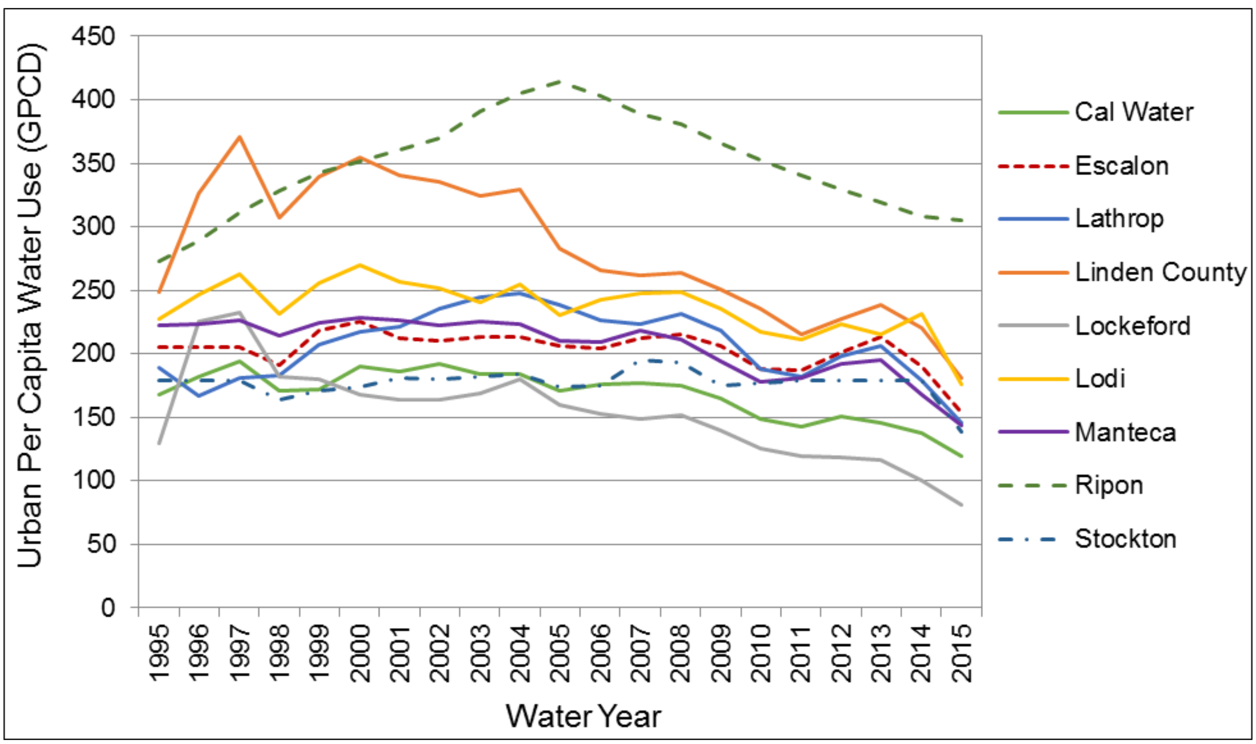


Figure 34: ESJWRM Surface Water Diversion Locations

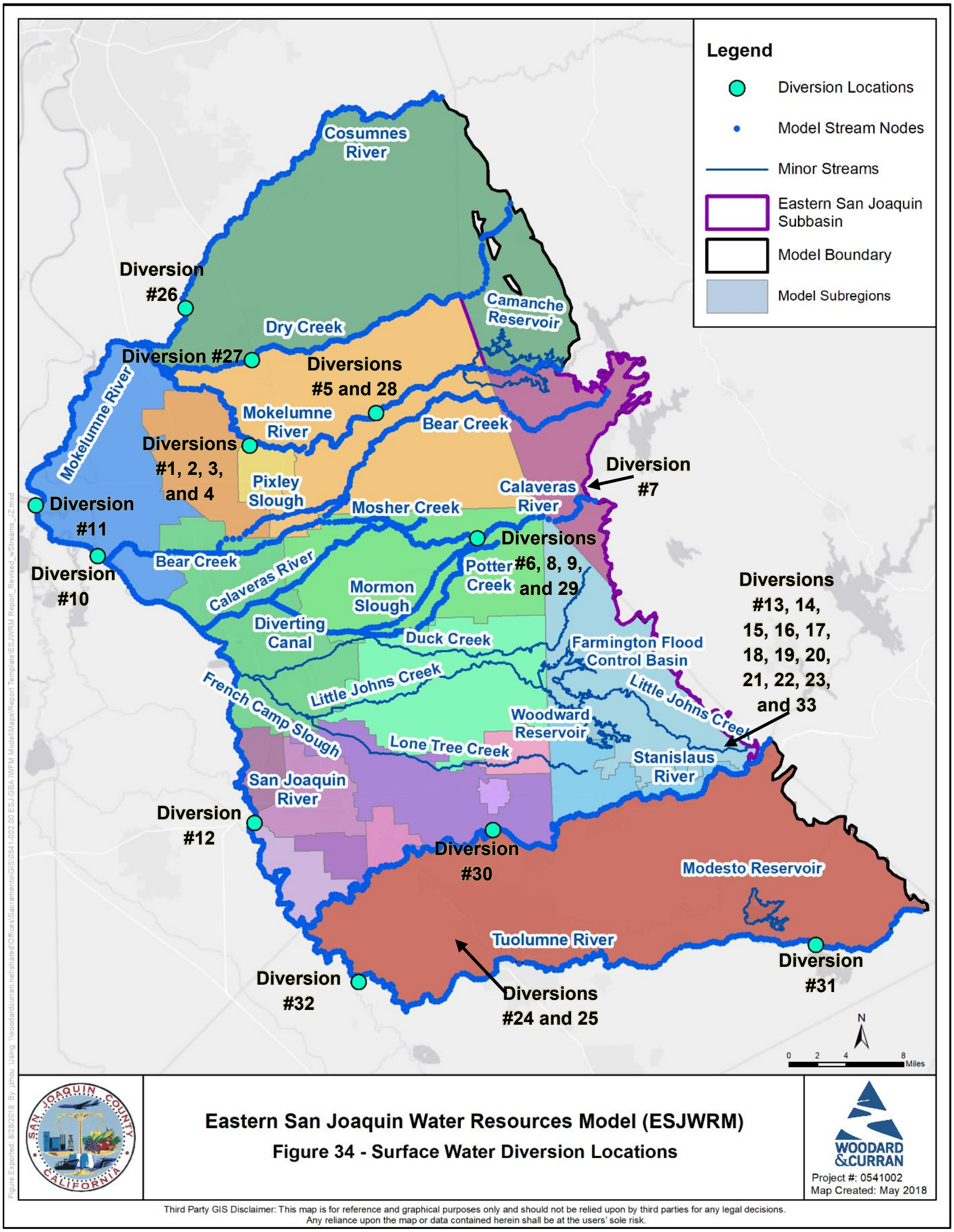


Figure 35: ESJWRM Groundwater Production Wells

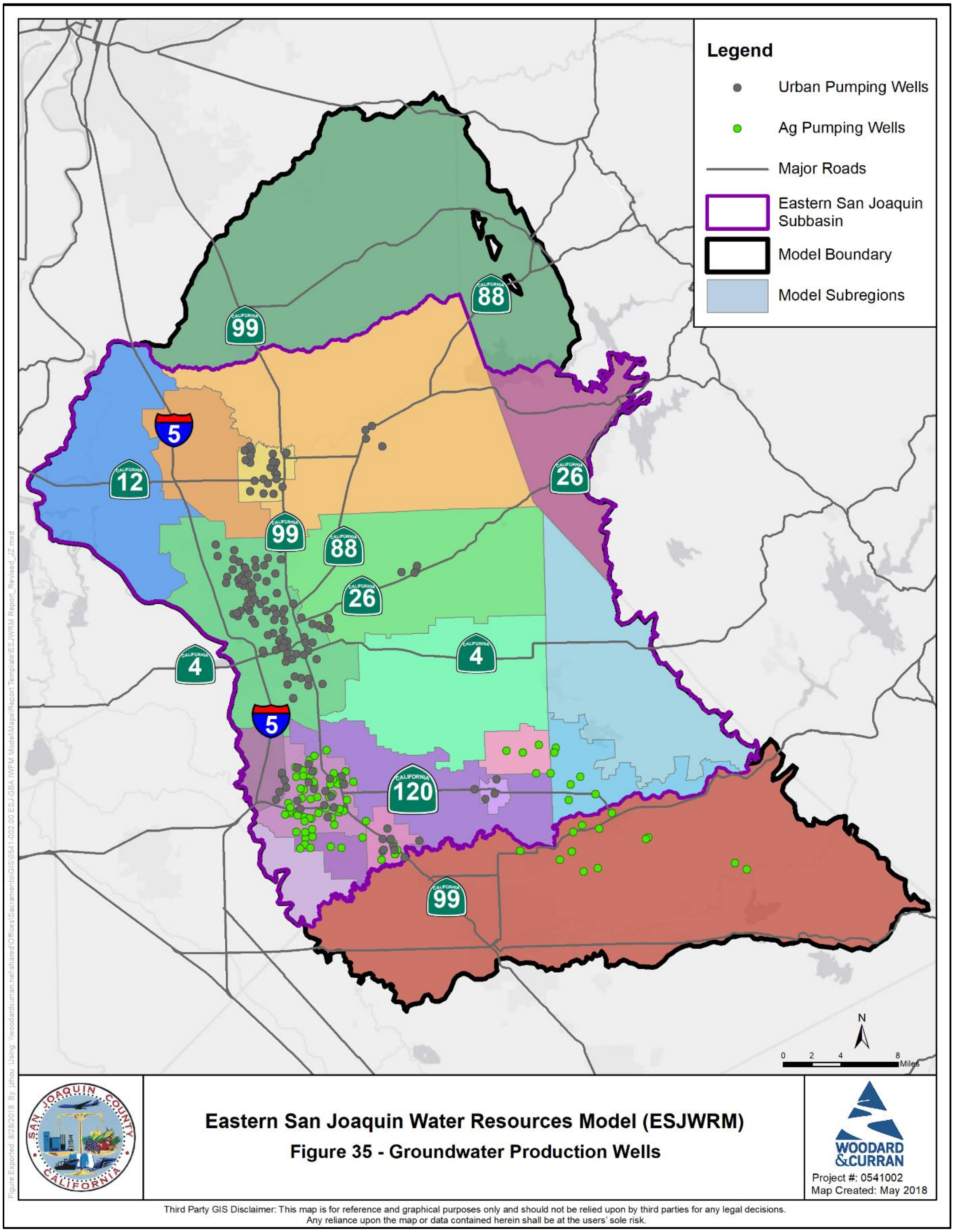


Figure 36: ESJWRM Riparian Surface Water Diversion Areas

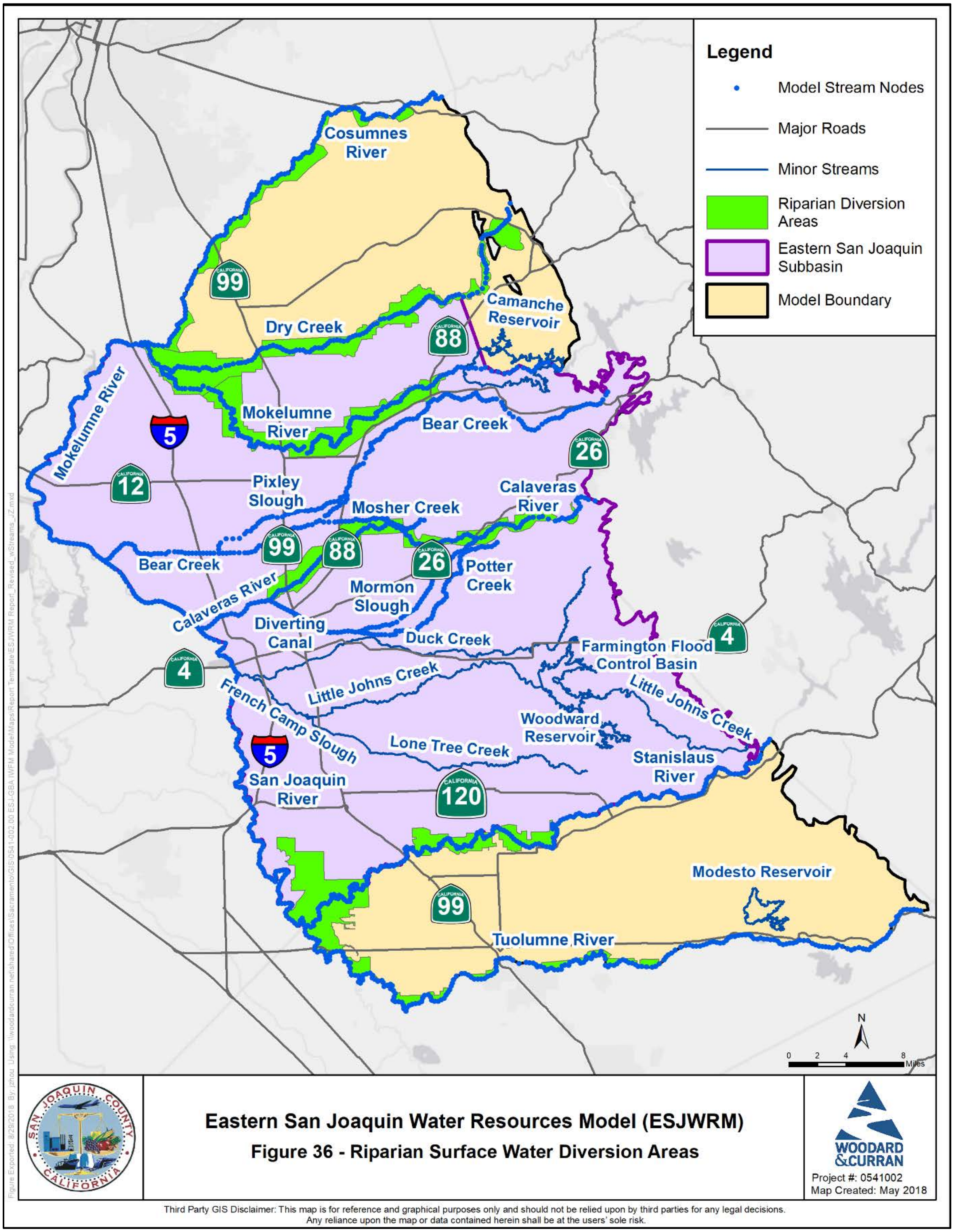


Figure 37: ESJWRM Field Capacity

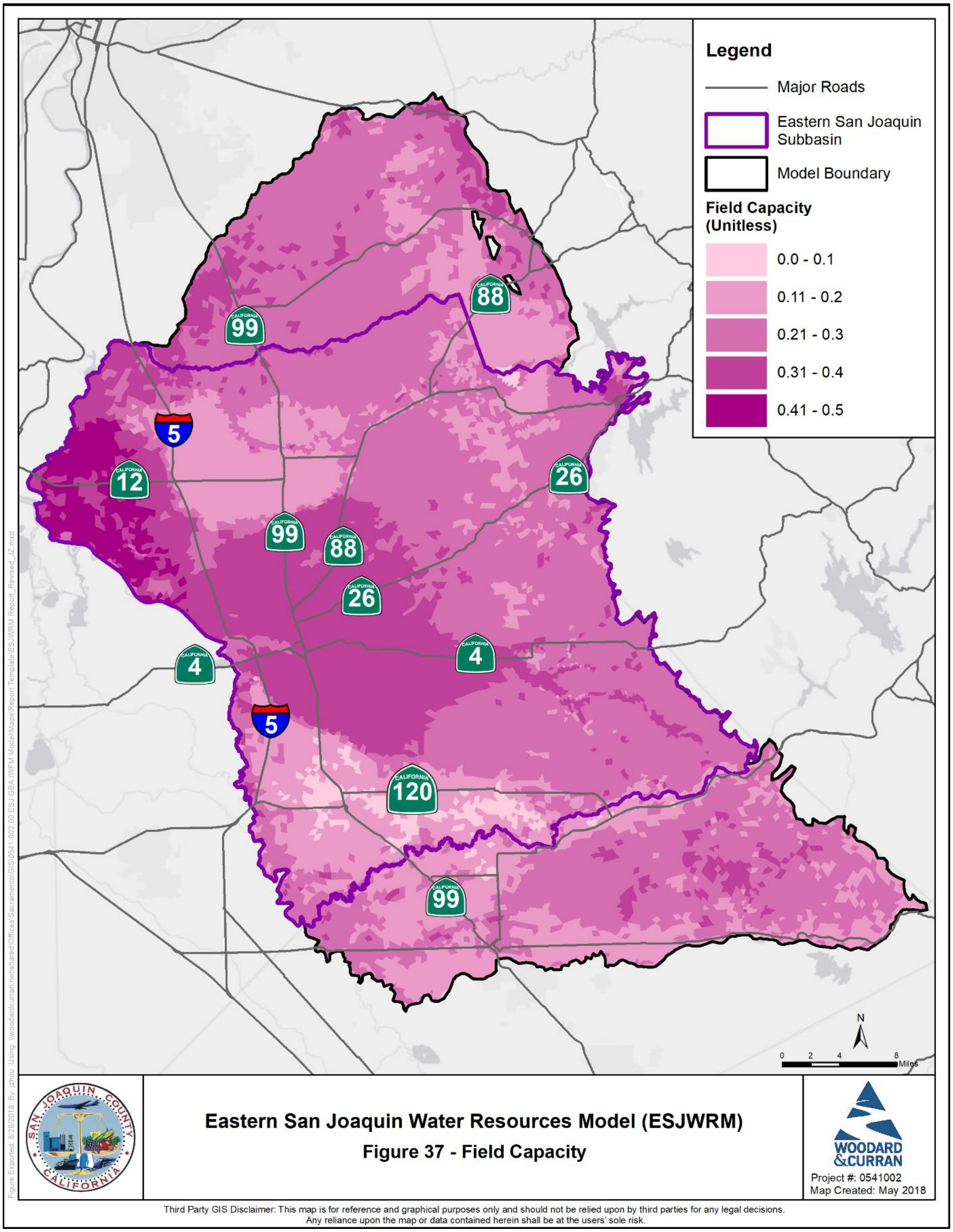


Figure 38: ESJWRM Wilting Point

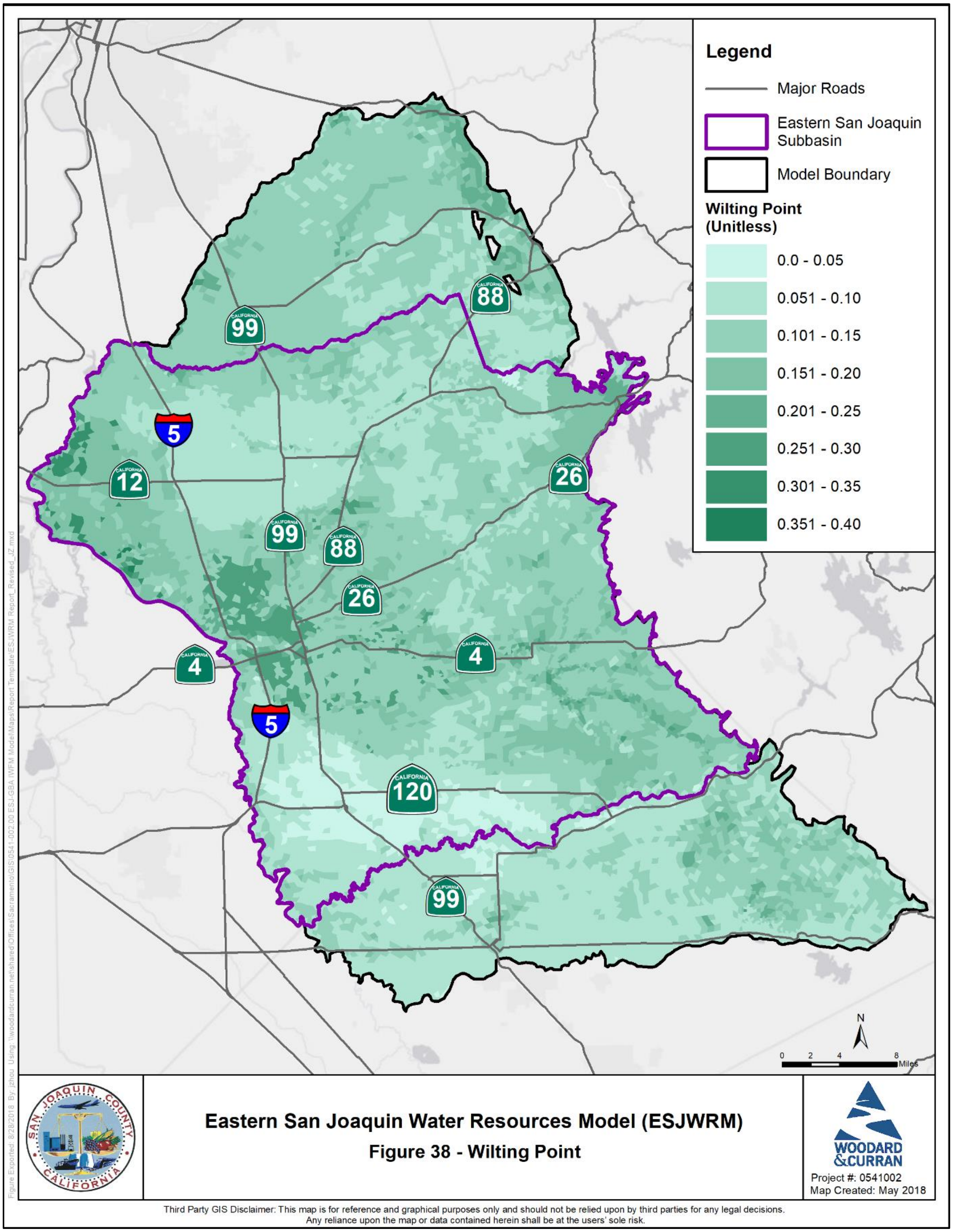


Figure 39: ESJWRM Total Porosity

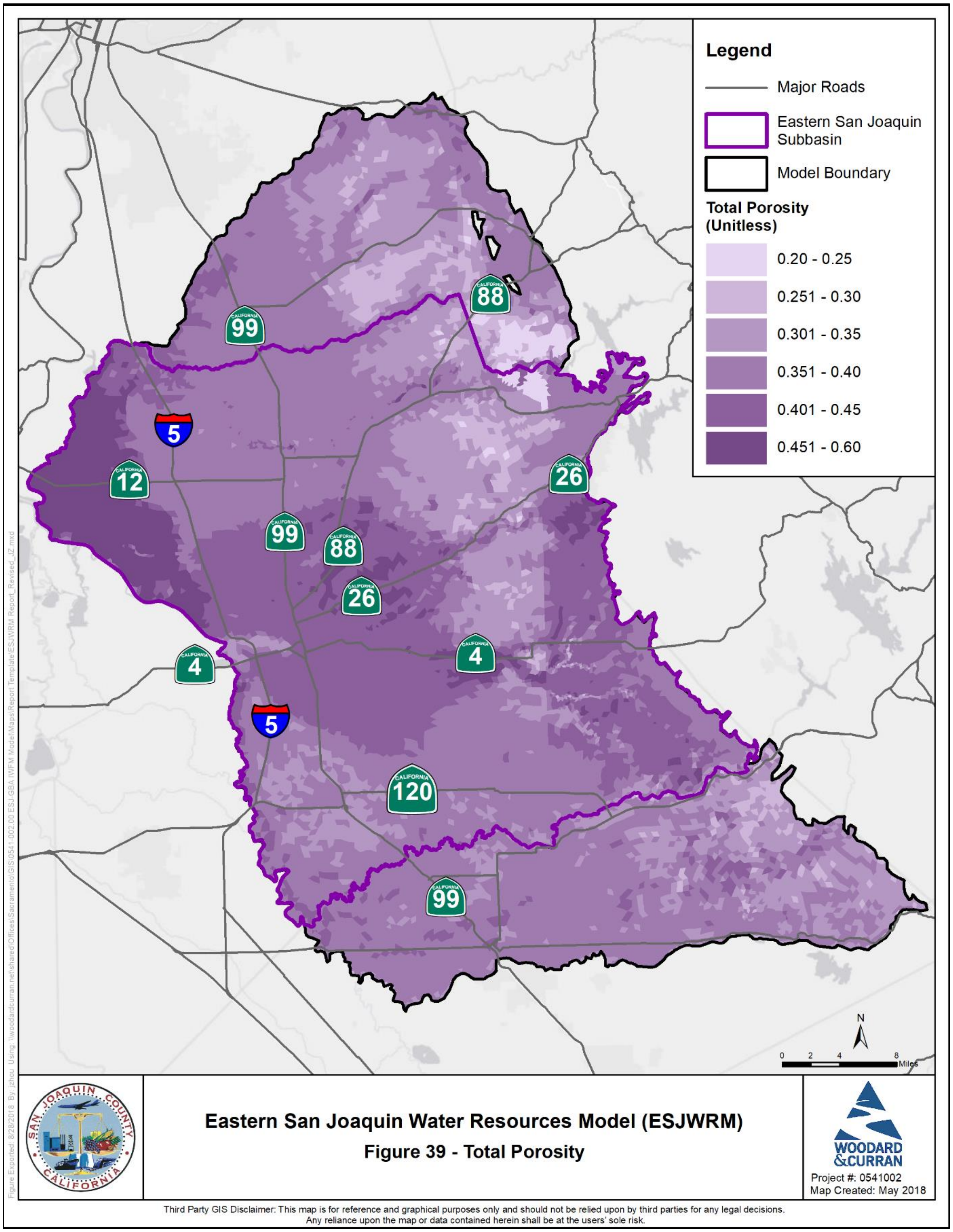


Figure 40: ESJWRM Saturated Hydraulic Conductivity

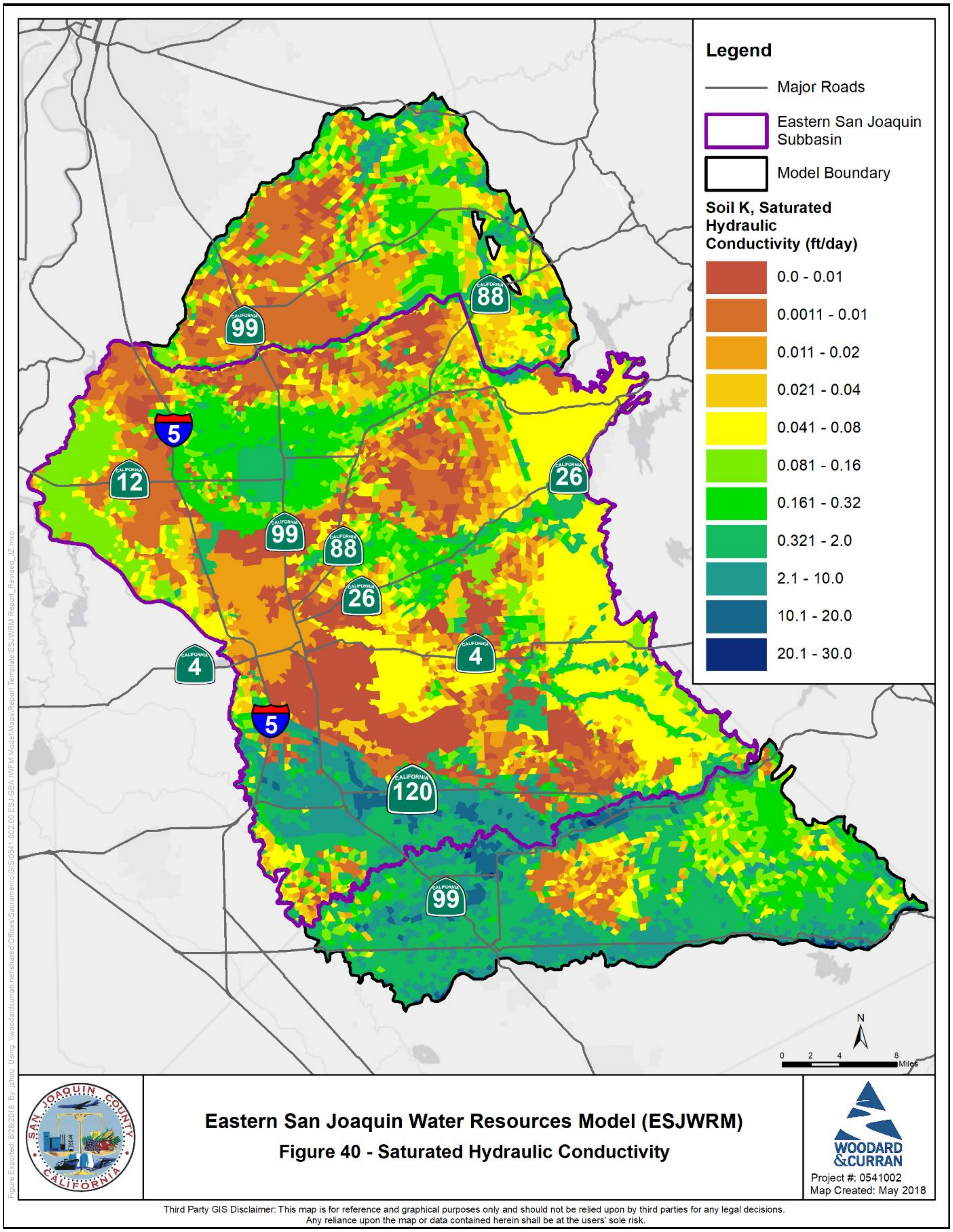


Figure 41: ESJWRM Pore Size Distribution Index

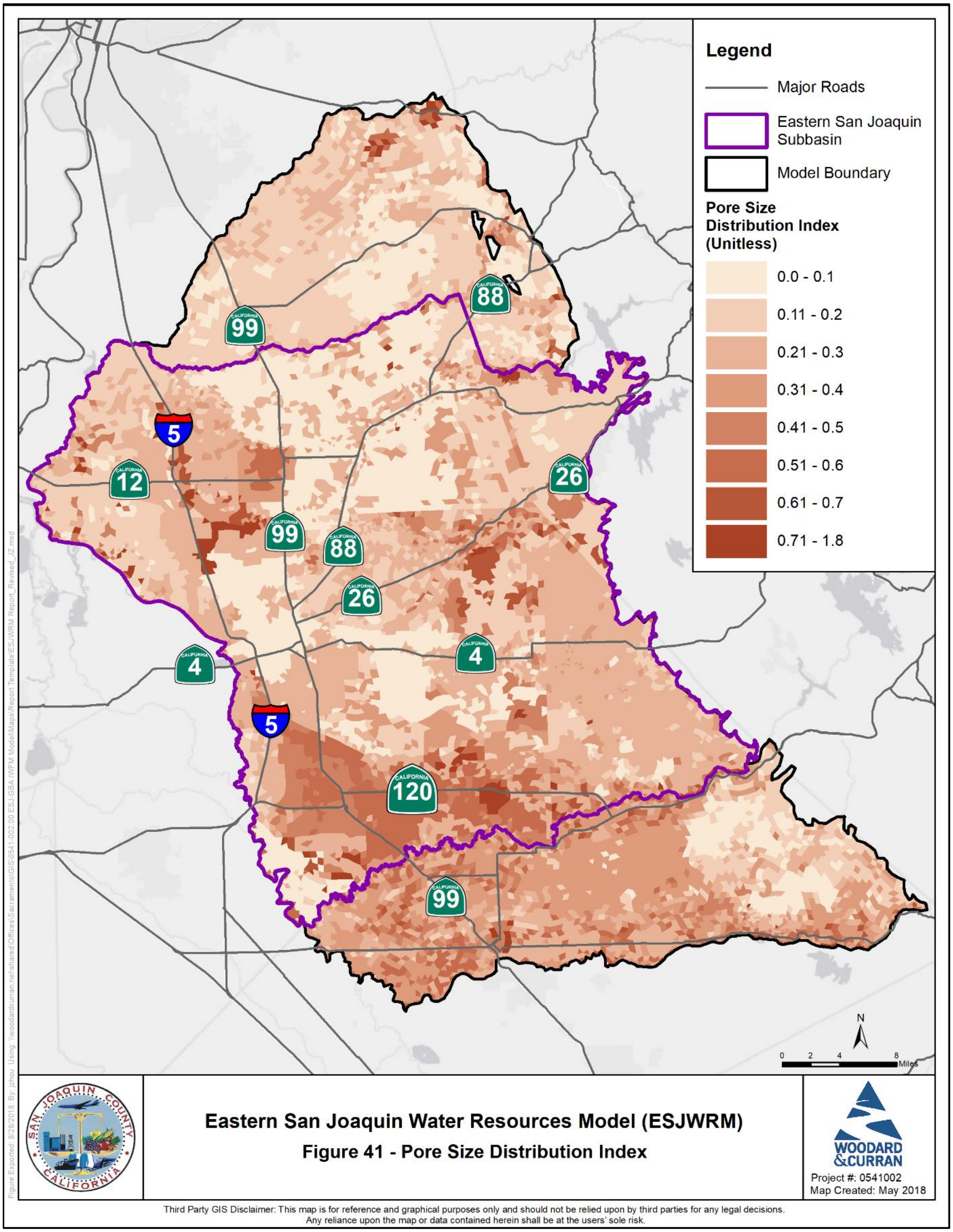


Figure 42a: ESJWRM Agricultural Water Demand – Eastern San Joaquin Subbasin

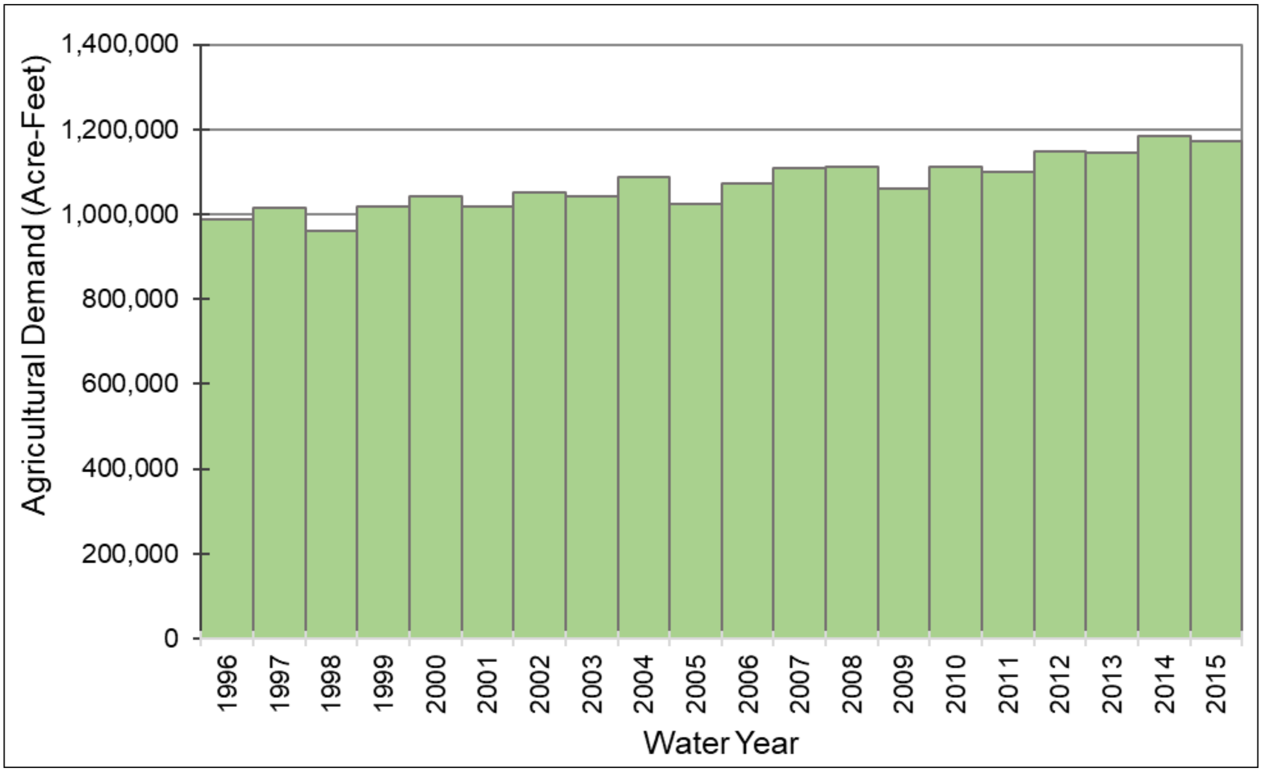


Figure 42b: ESJWRM Unit Agricultural Water Use and ETAW – Eastern San Joaquin Subbasin

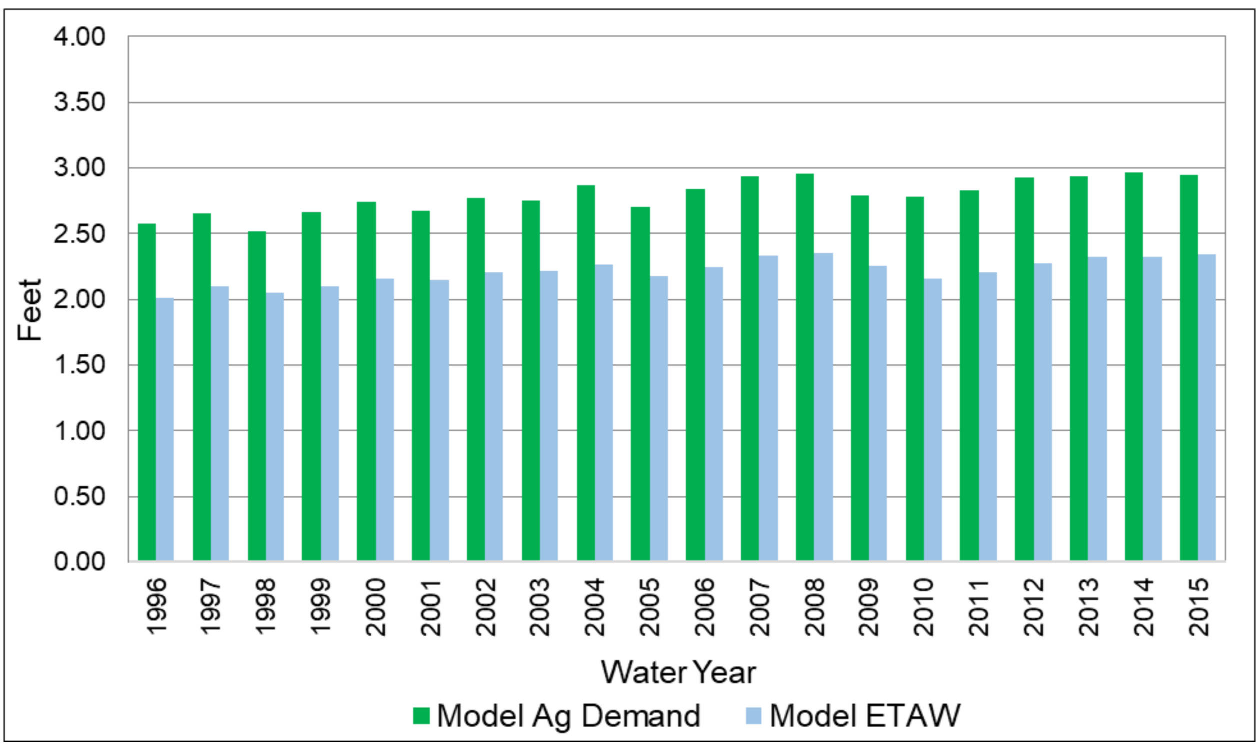


Figure 42c: ESJWRM Agricultural Water Demand – Subarea 1 (North Delta Subarea)

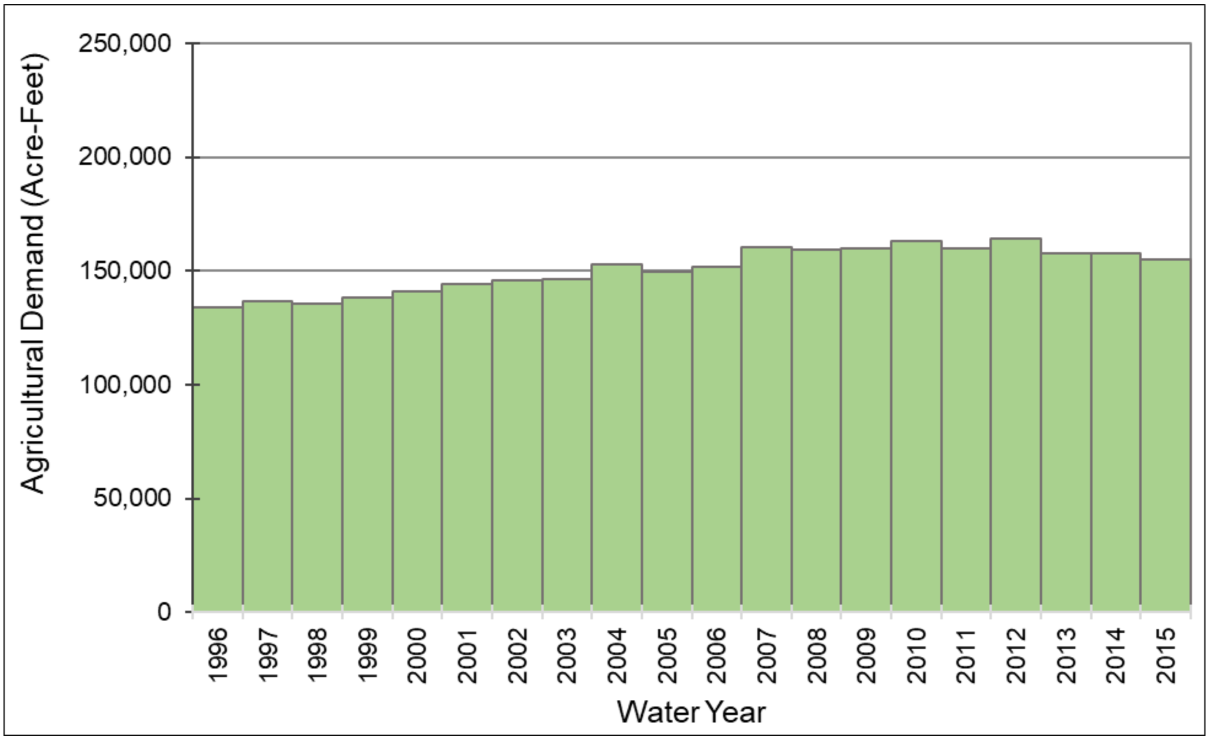


Figure 42d: ESJWRM Unit Agricultural Water Use and ETAW – Subarea 1 (North Delta Subarea)

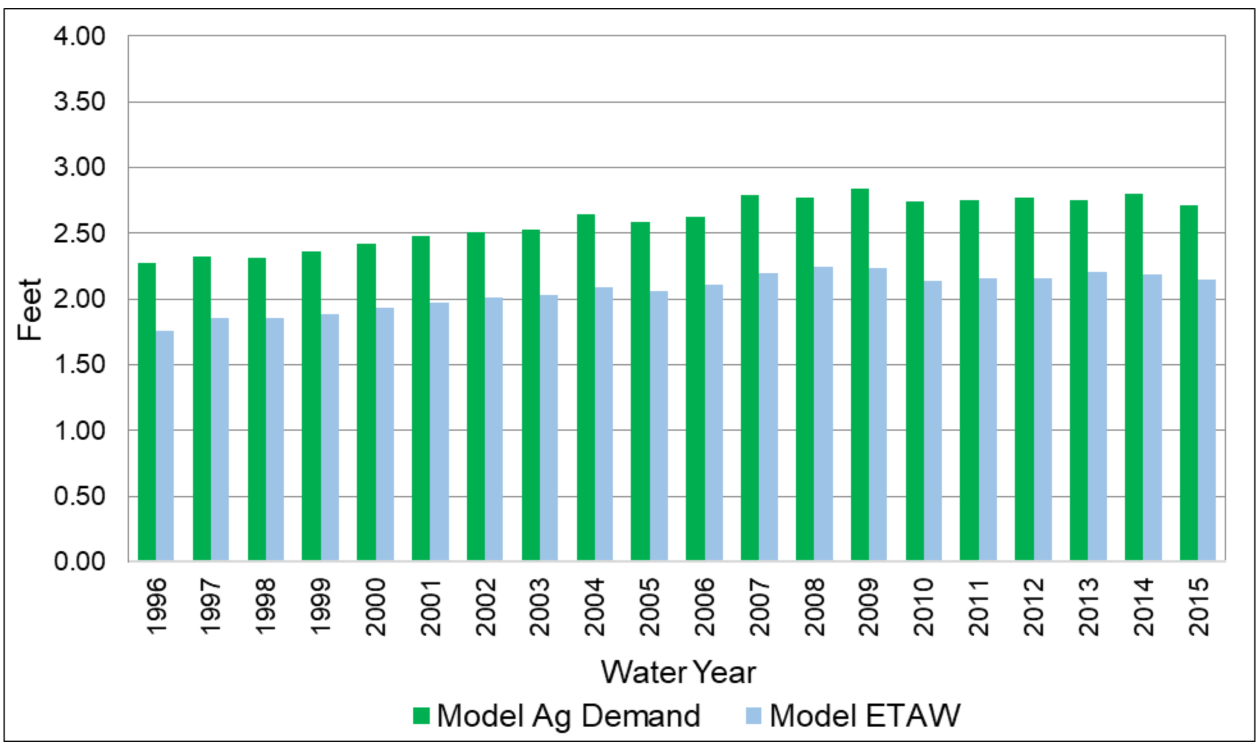


Figure 42e: ESJWRM Agricultural Water Demand – Subarea 2 (North Subarea)

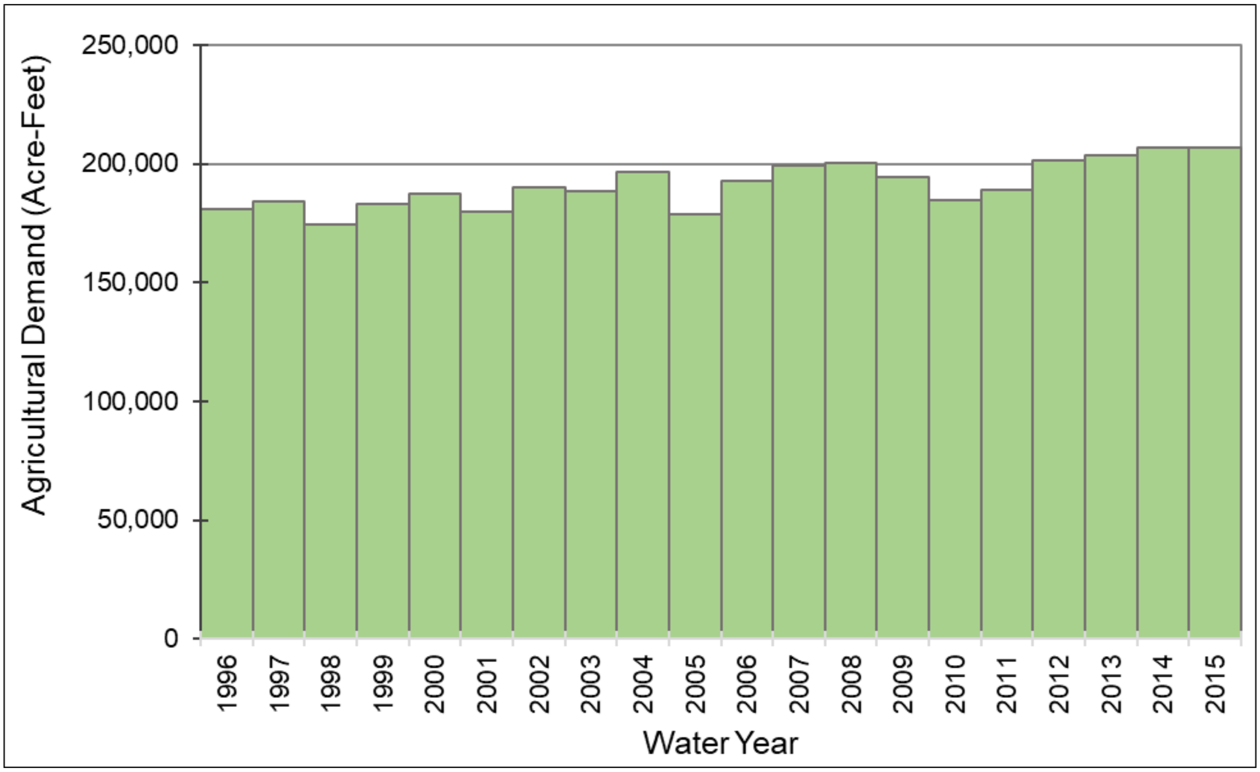


Figure 42f: ESJWRM Unit Agricultural Water Use and ETAW – Subarea 2 (North Subarea)

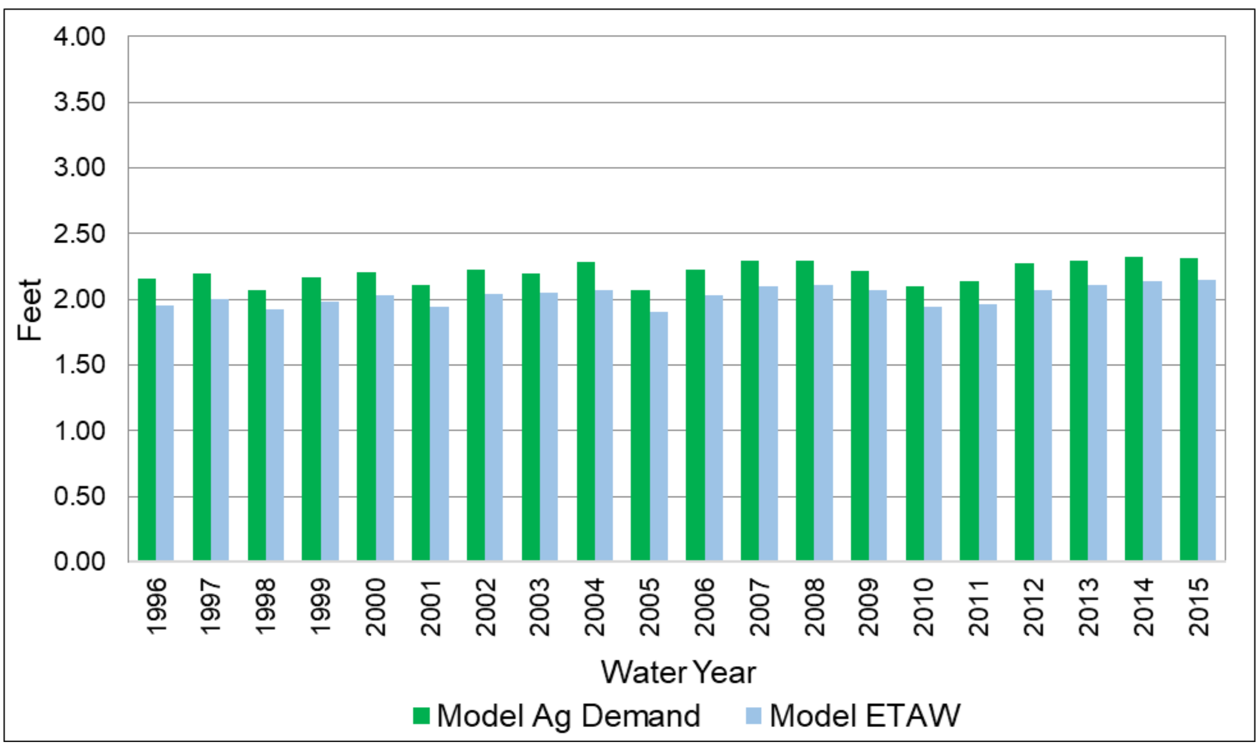


Figure 42g: ESJWRM Agricultural Water Demand – Subarea 3 (Calaveras Subarea)

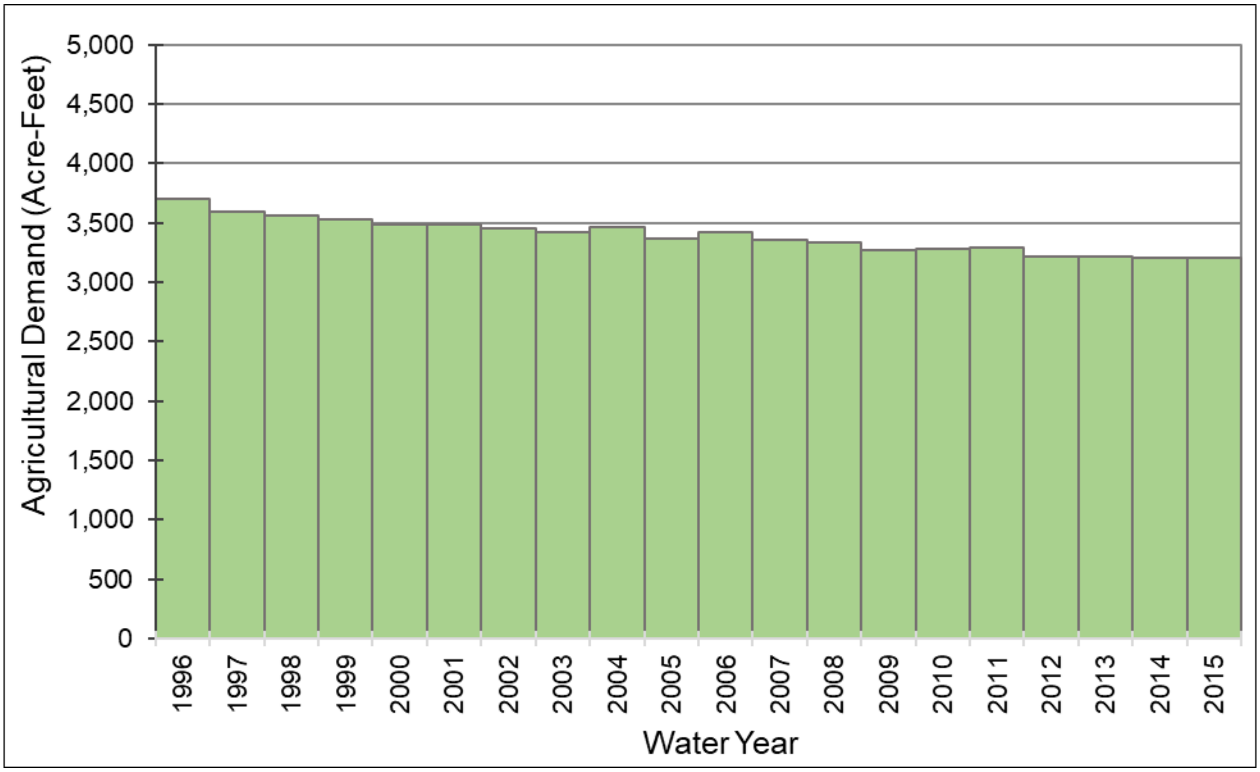


Figure 42h: ESJWRM Unit Agricultural Water Use and ETAW – Subarea 3 (Calaveras Subarea)

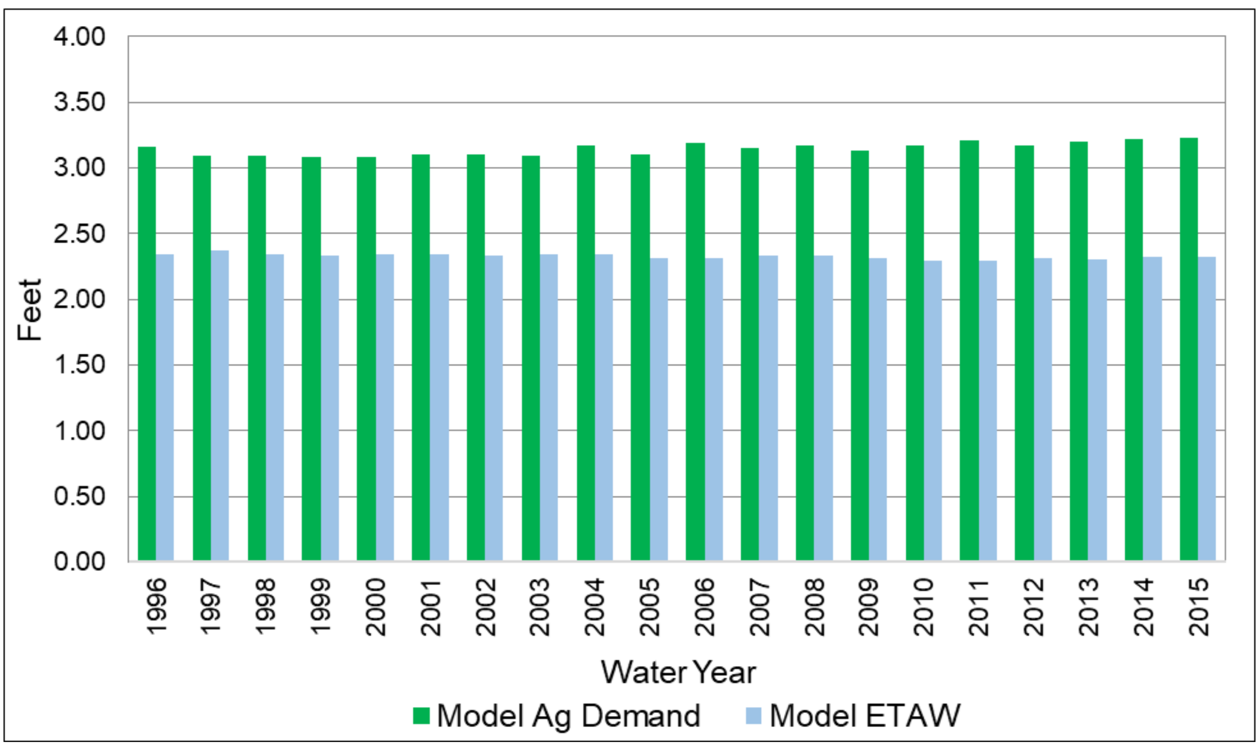


Figure 42i: ESJWRM Agricultural Water Demand – Subarea 4 (Central Subarea)

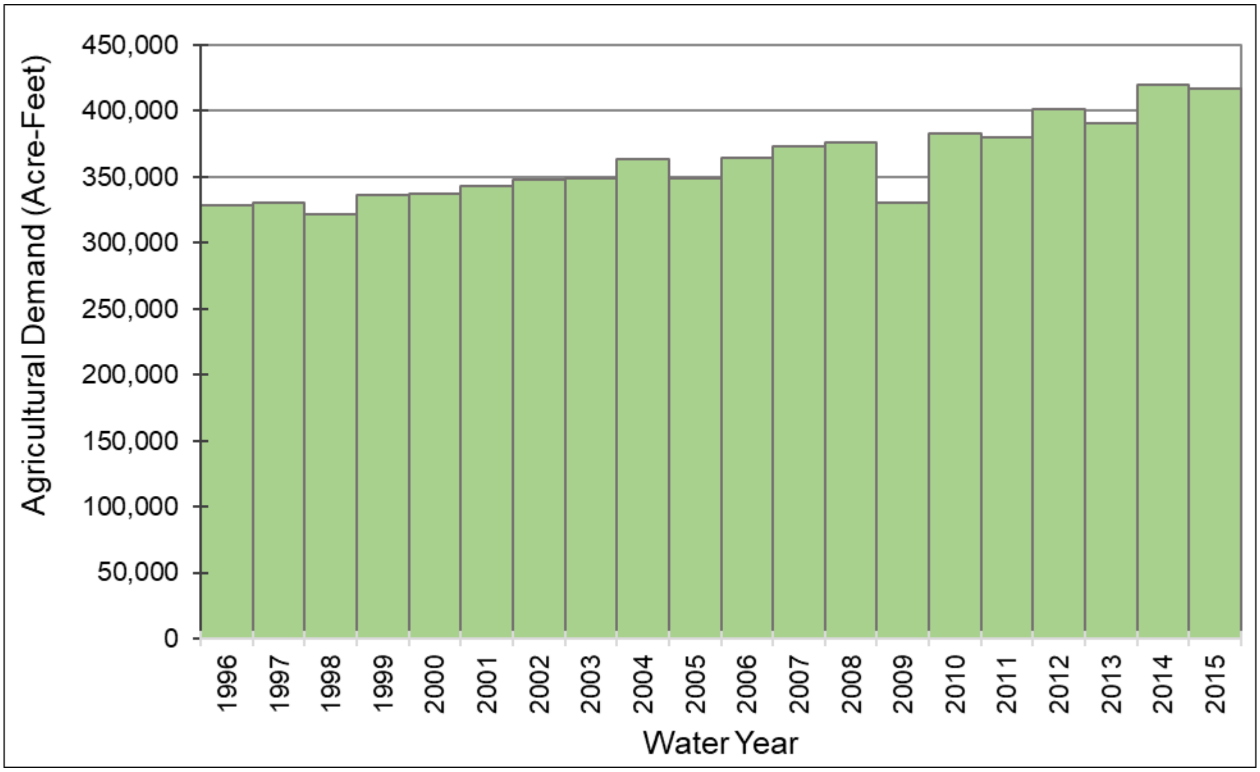


Figure 42j: ESJWRM Unit Agricultural Water Use and ETAW – Subarea 4 (Central Subarea)

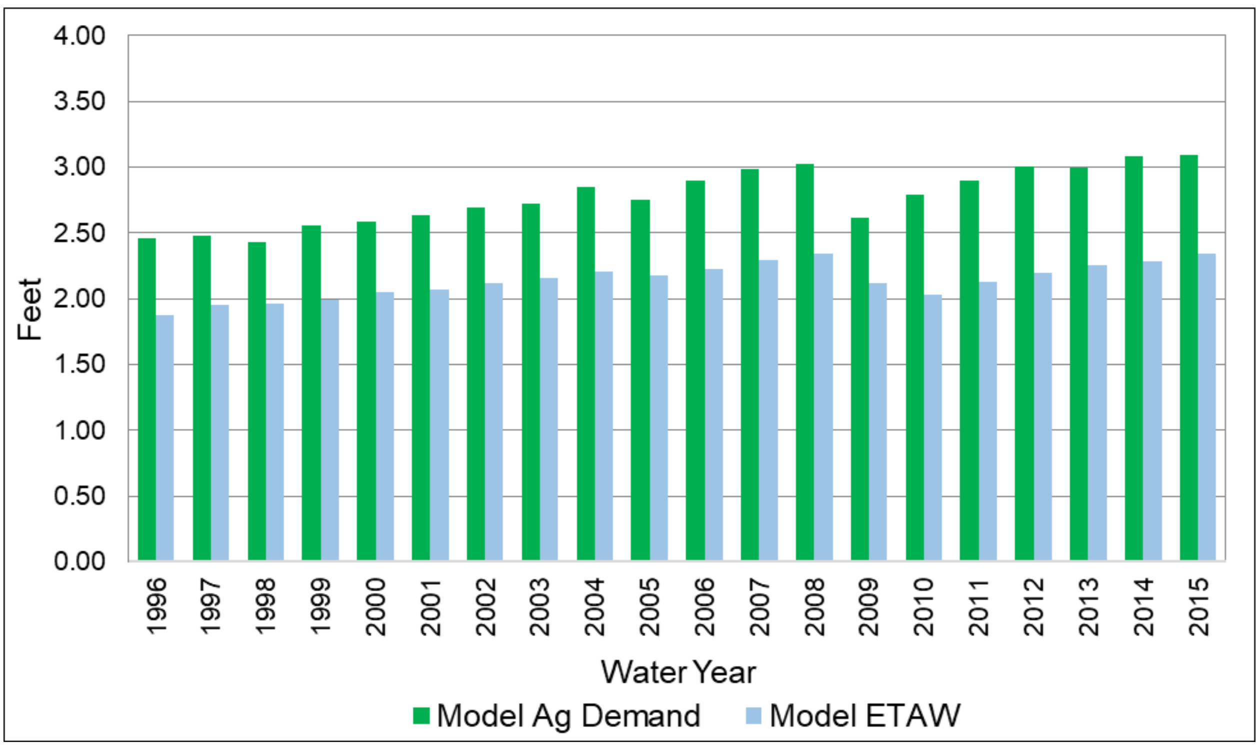


Figure 42k: ESJWRM Agricultural Water Demand – Subarea 5 (South Subarea)

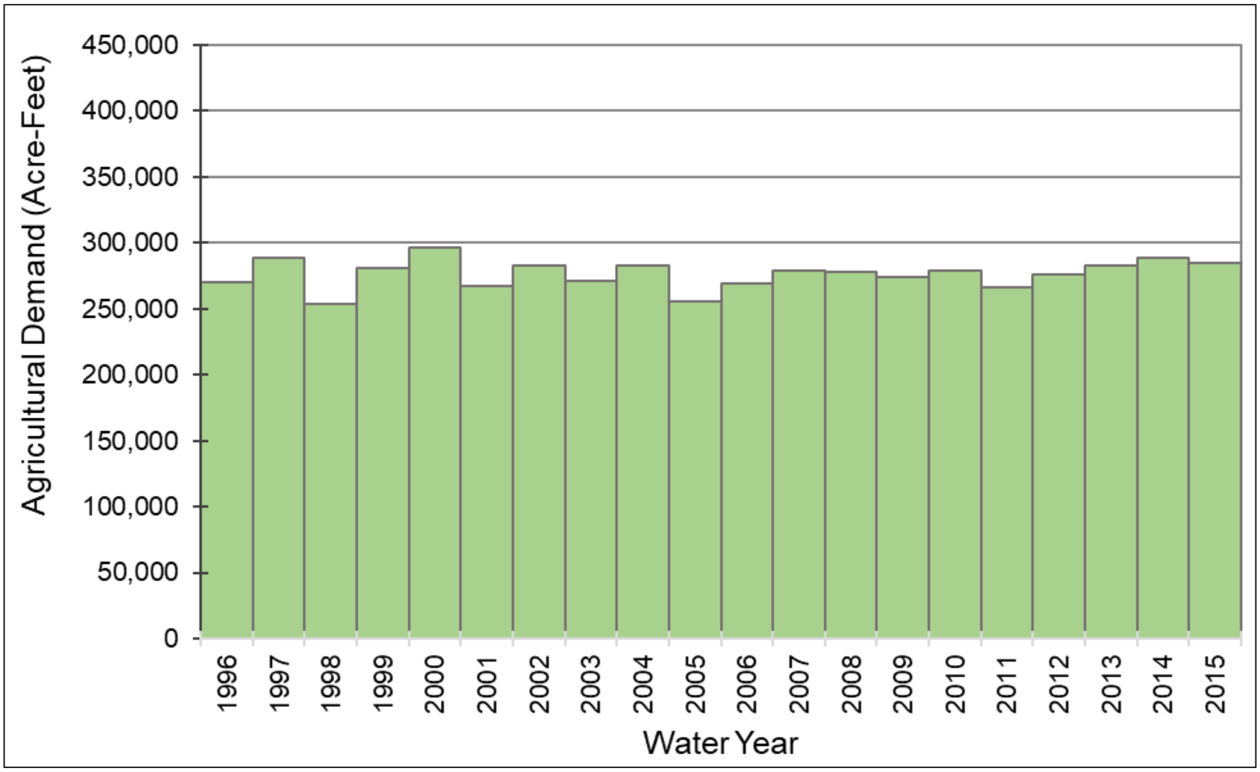


Figure 42l: ESJWRM Unit Agricultural Water Use and ETAW – Subarea 5 (South Subarea)

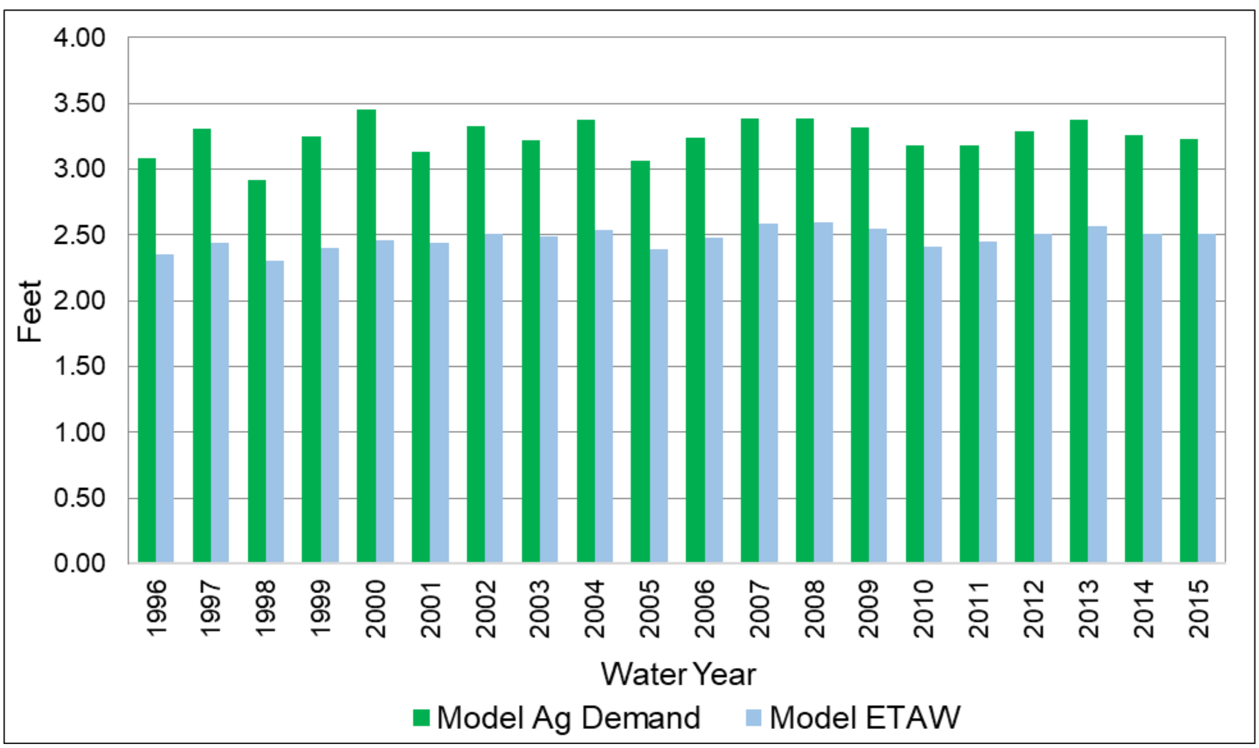


Figure 42m: ESJWRM Agricultural Water Demand – Subarea 6 (Stanislaus Subarea)

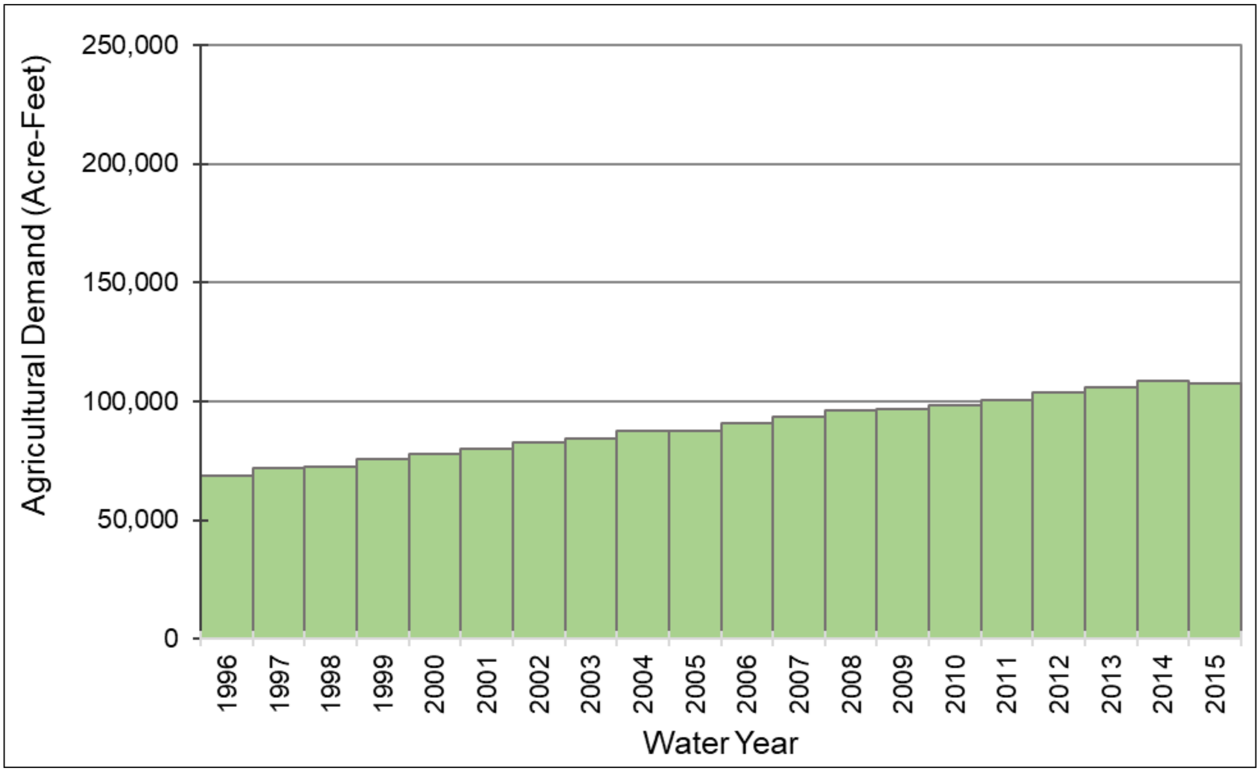


Figure 42n: ESJWRM Unit Agricultural Water Use and ETAW – Subarea 6 (Stanislaus Subarea)

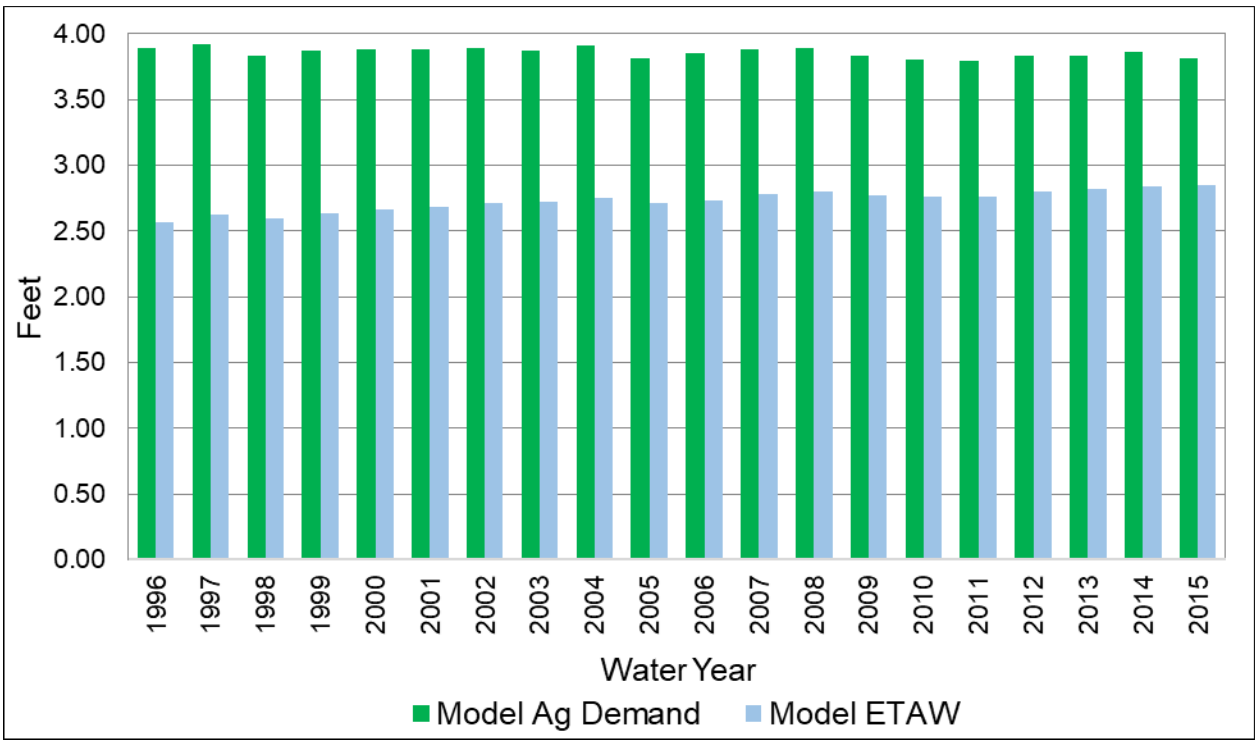


Figure 43a: ESJWRM Urban Water Demand – Eastern San Joaquin Subbasin

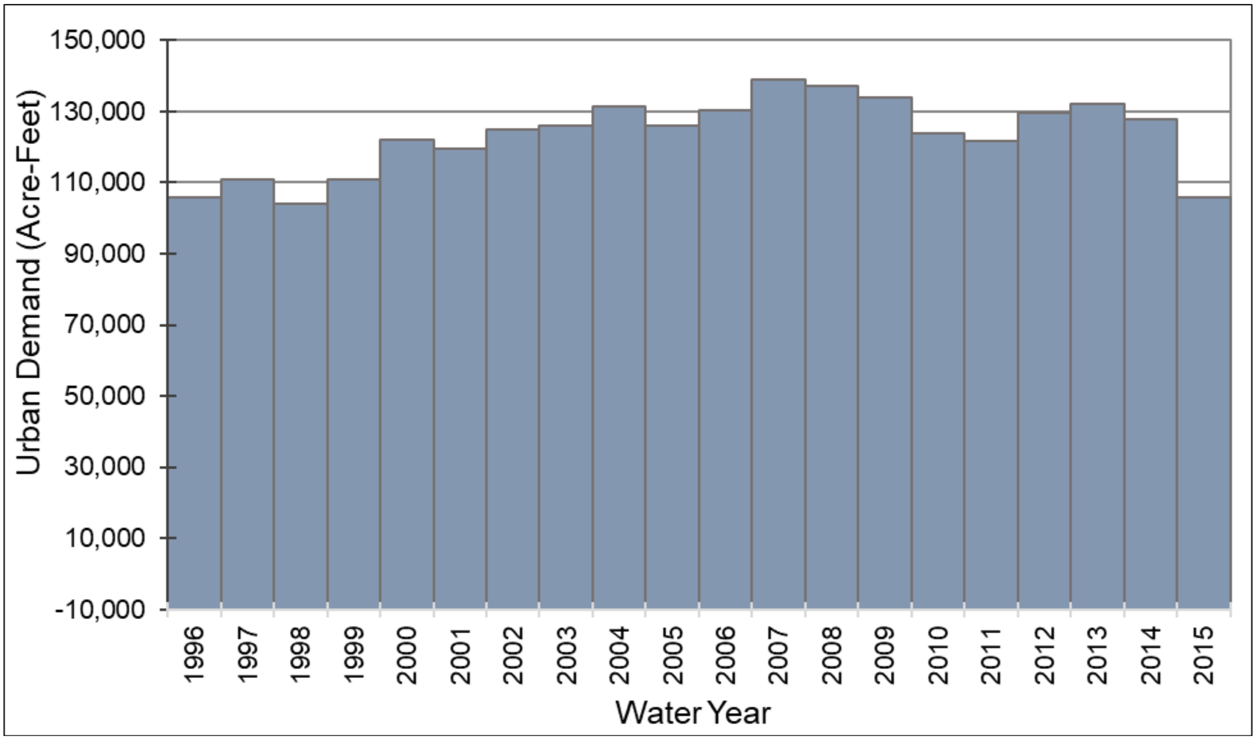


Figure 43b: ESJWRM Urban Water Demand – Subarea 1 (North Delta Subarea)

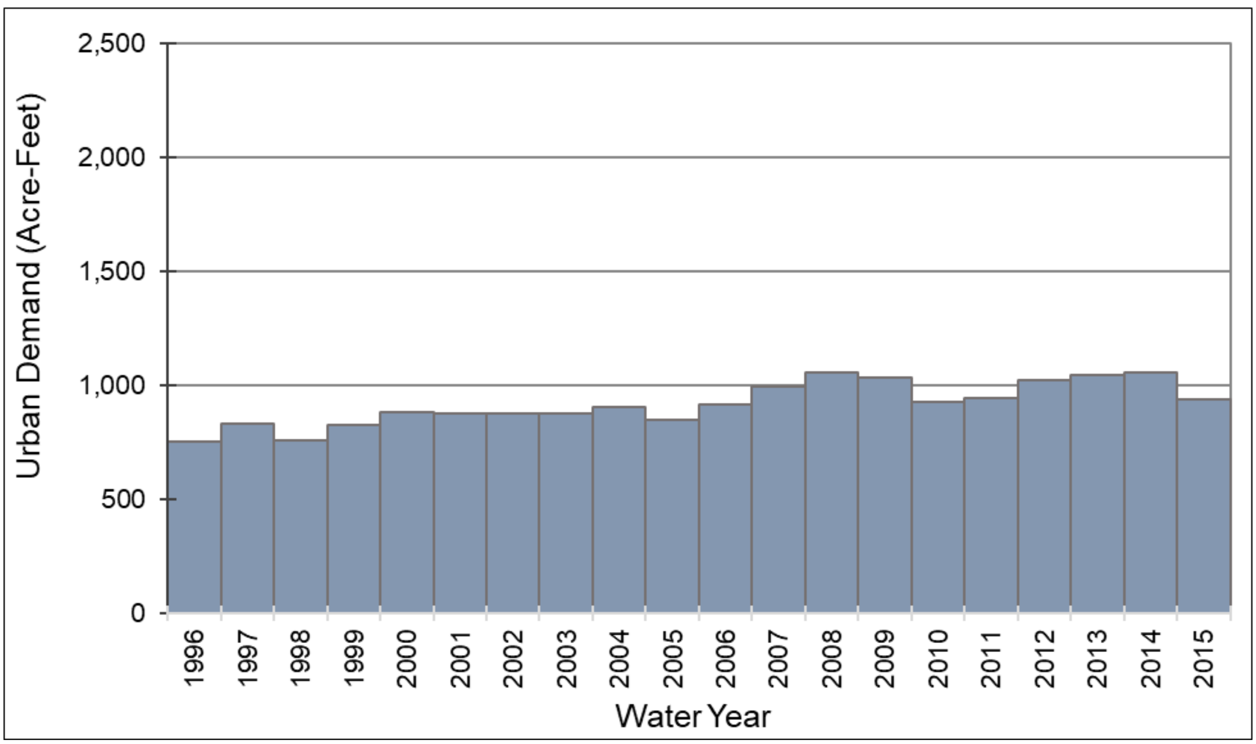


Figure 43c: ESJWRM Urban Water Demand – Subarea 2 (North Subarea)

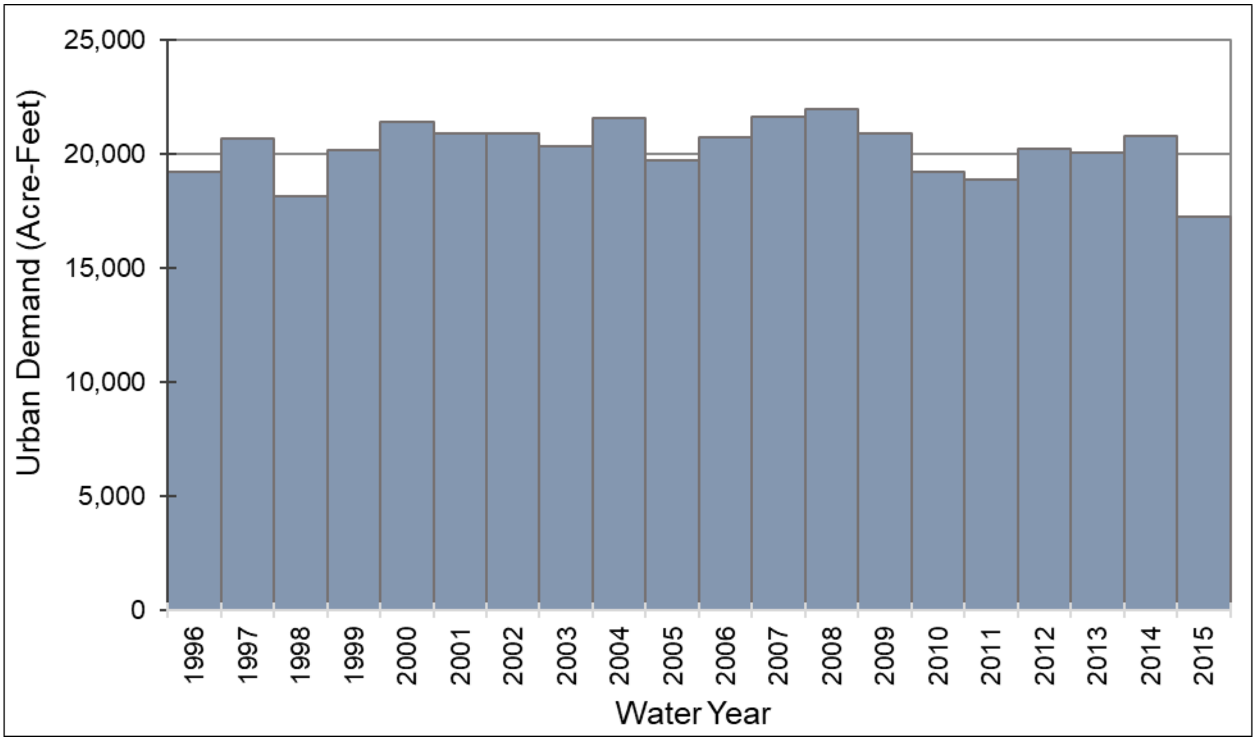


Figure 43d: ESJWRM Urban Water Demand – Subarea 3 (Calaveras Subarea)

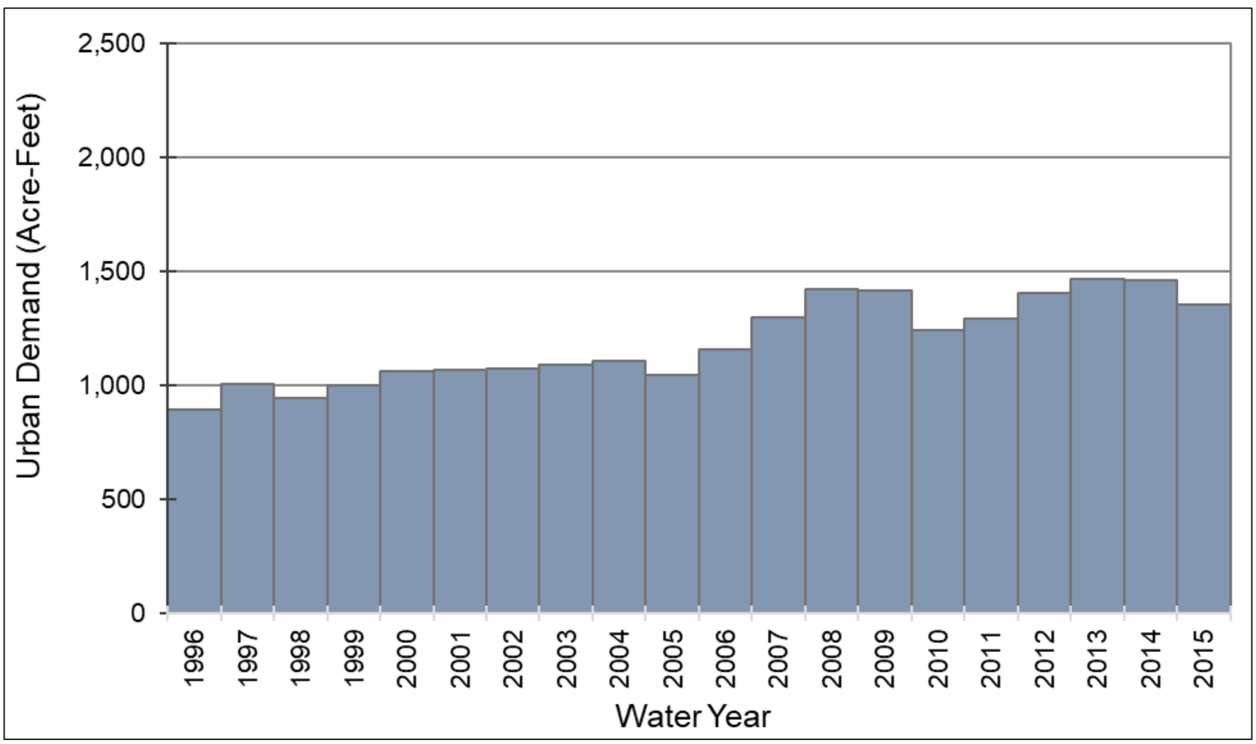


Figure 43e: ESJWRM Urban Water Demand – Subarea 4 (Central Subarea)

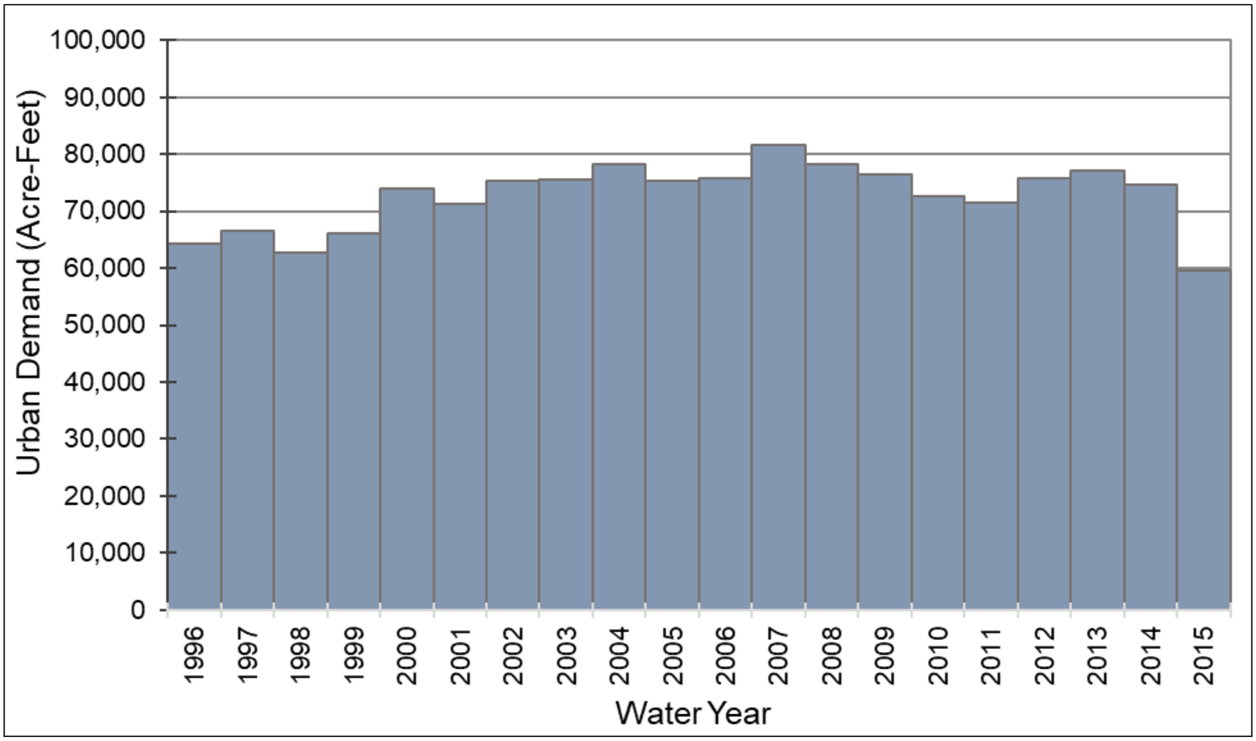


Figure 43f: ESJWRM Urban Water Demand – Subarea 5 (South Subarea)

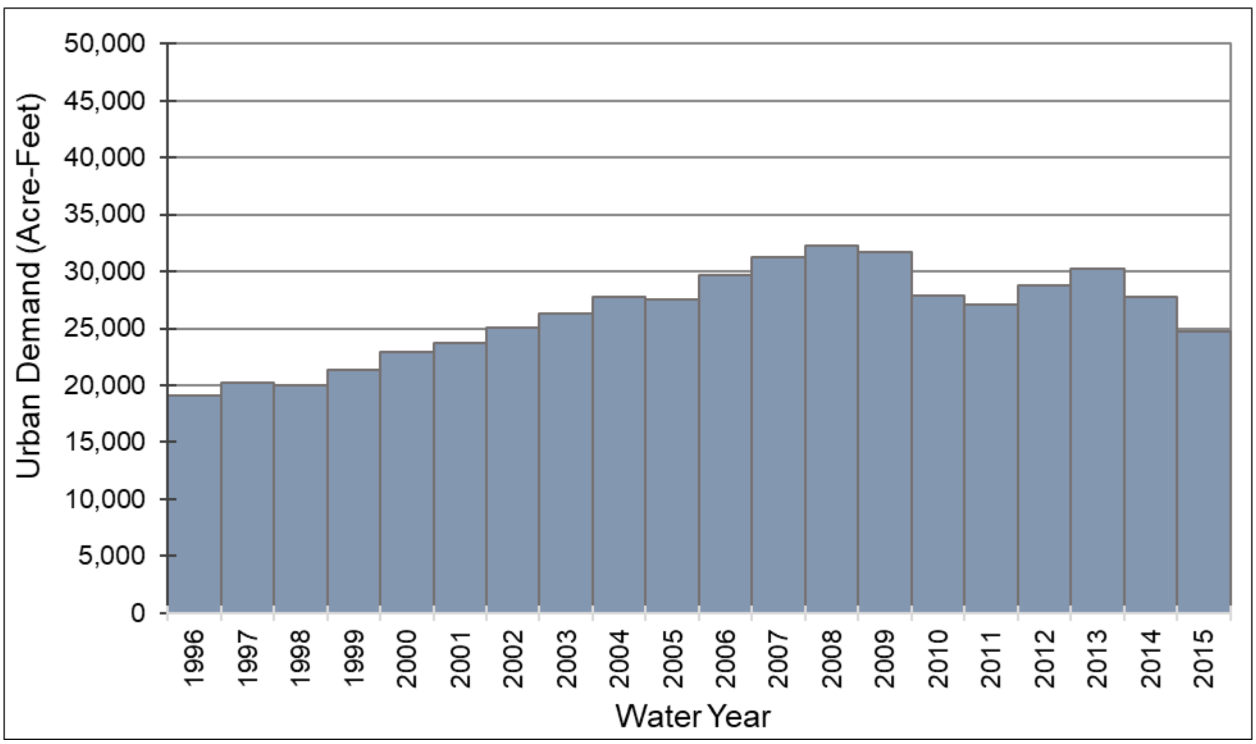


Figure 43g: ESJWRM Urban Water Demand – Subarea 6 (Stanislaus Subarea)

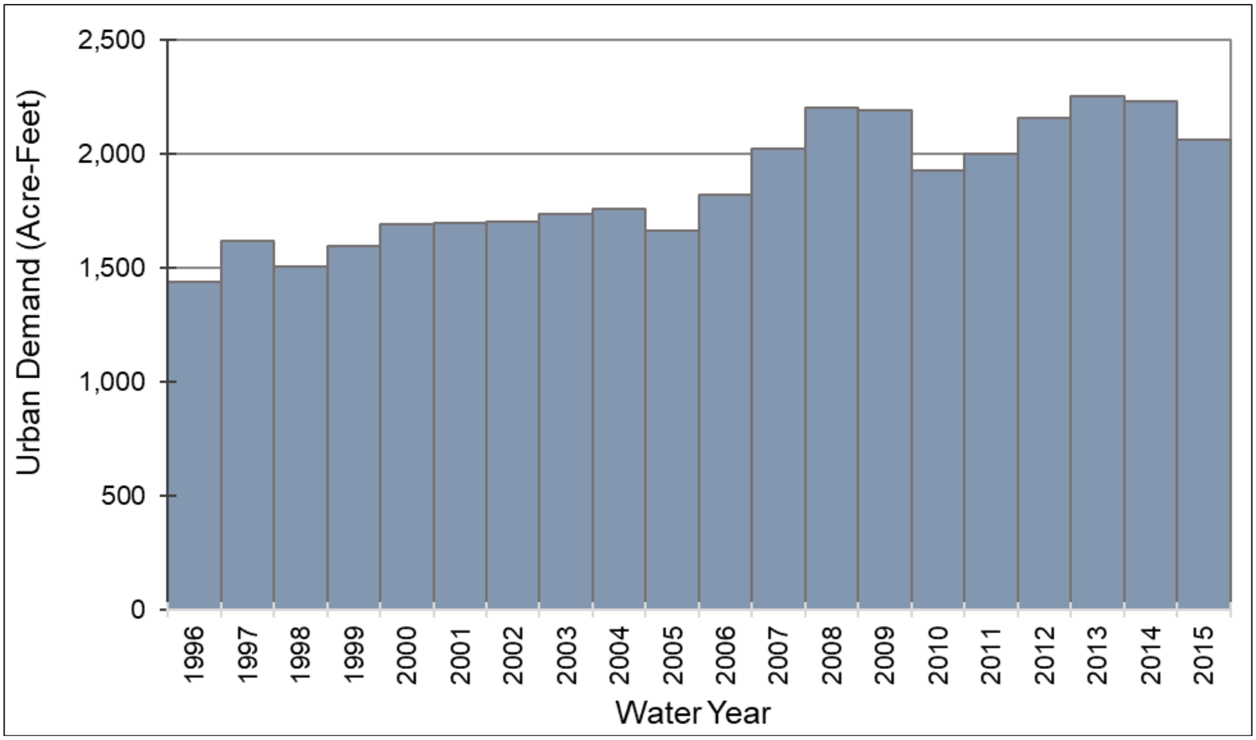


Figure 44: ESJWRM Stream Calibration Gauges

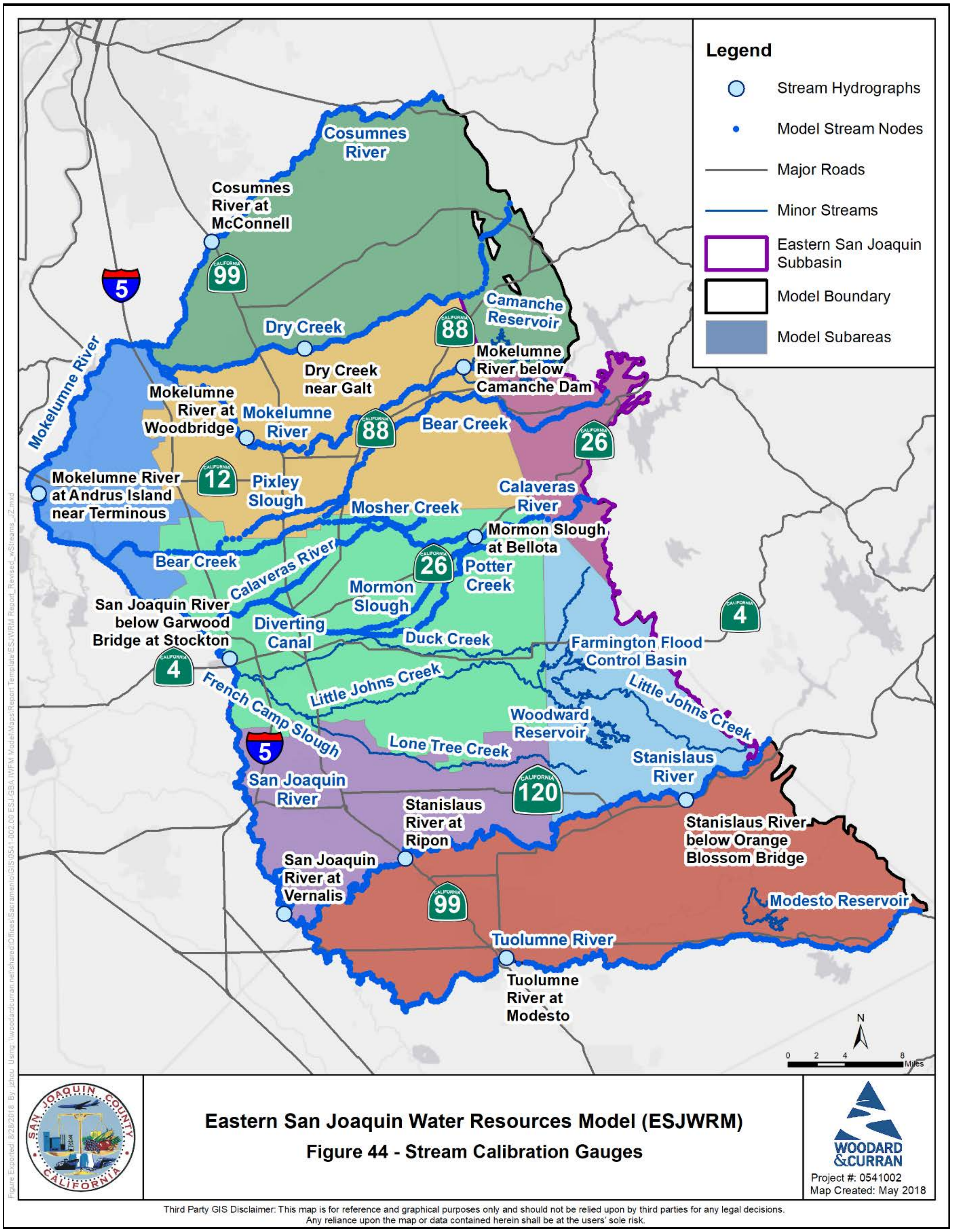


Figure 45: ESJWRM Stream Bed Hydraulic Conductivity

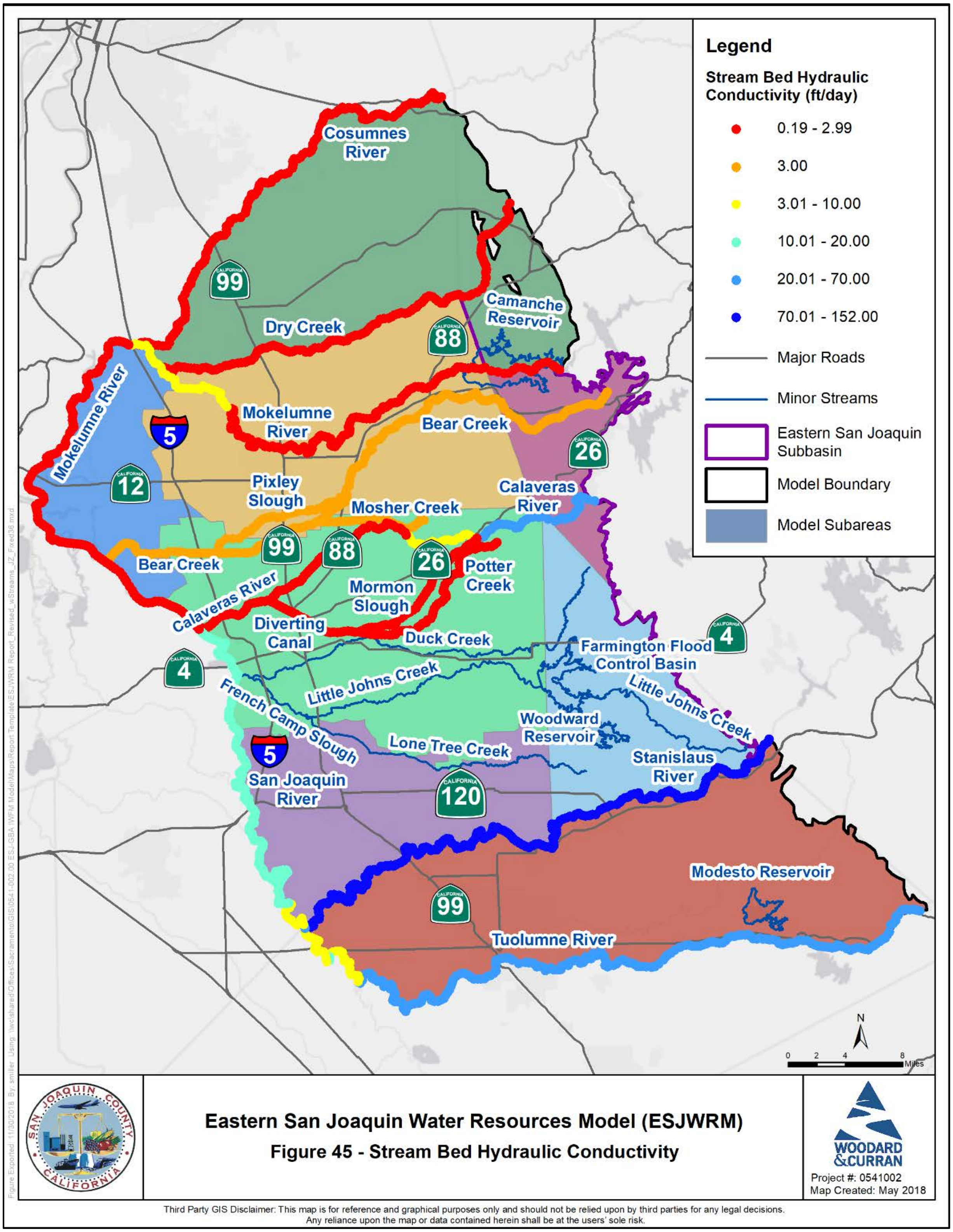


Figure 46a: ESJWRM Stream Calibration Gauges Streamflow – Dry Creek near Galt

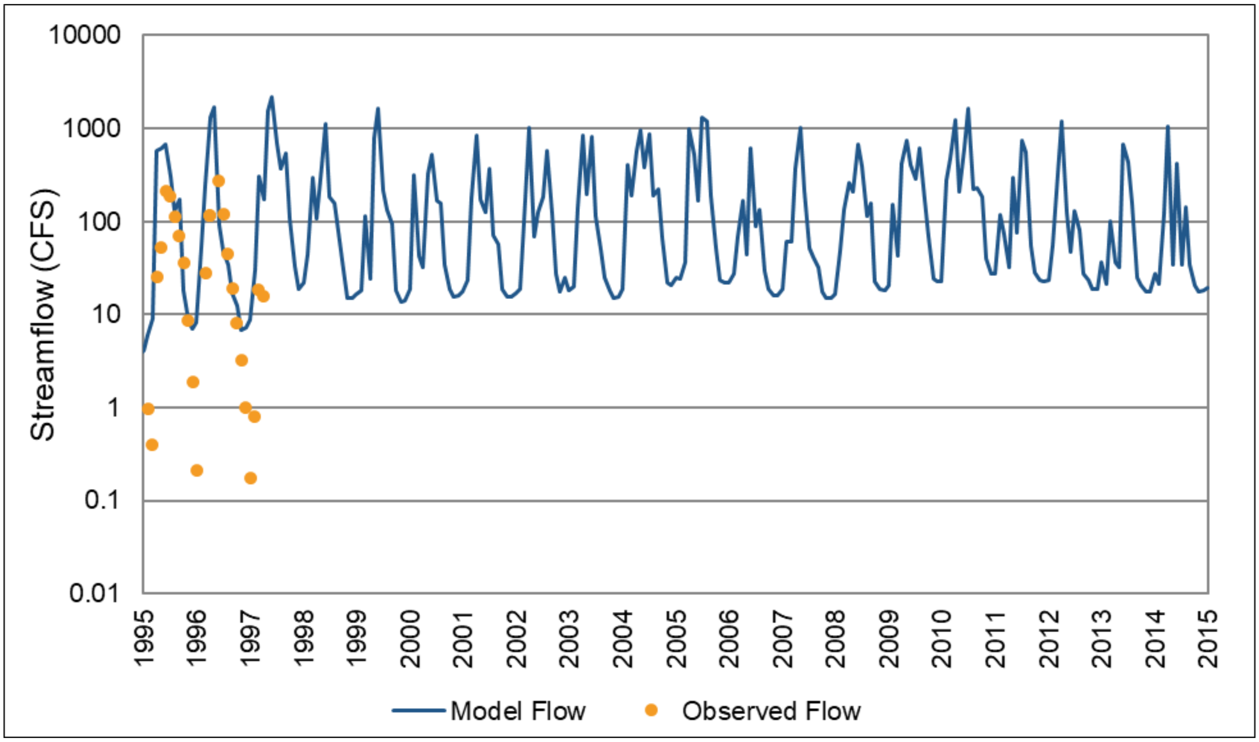


Figure 46b: ESJWRM Stream Calibration Gauges Exceedance – Dry Creek near Galt

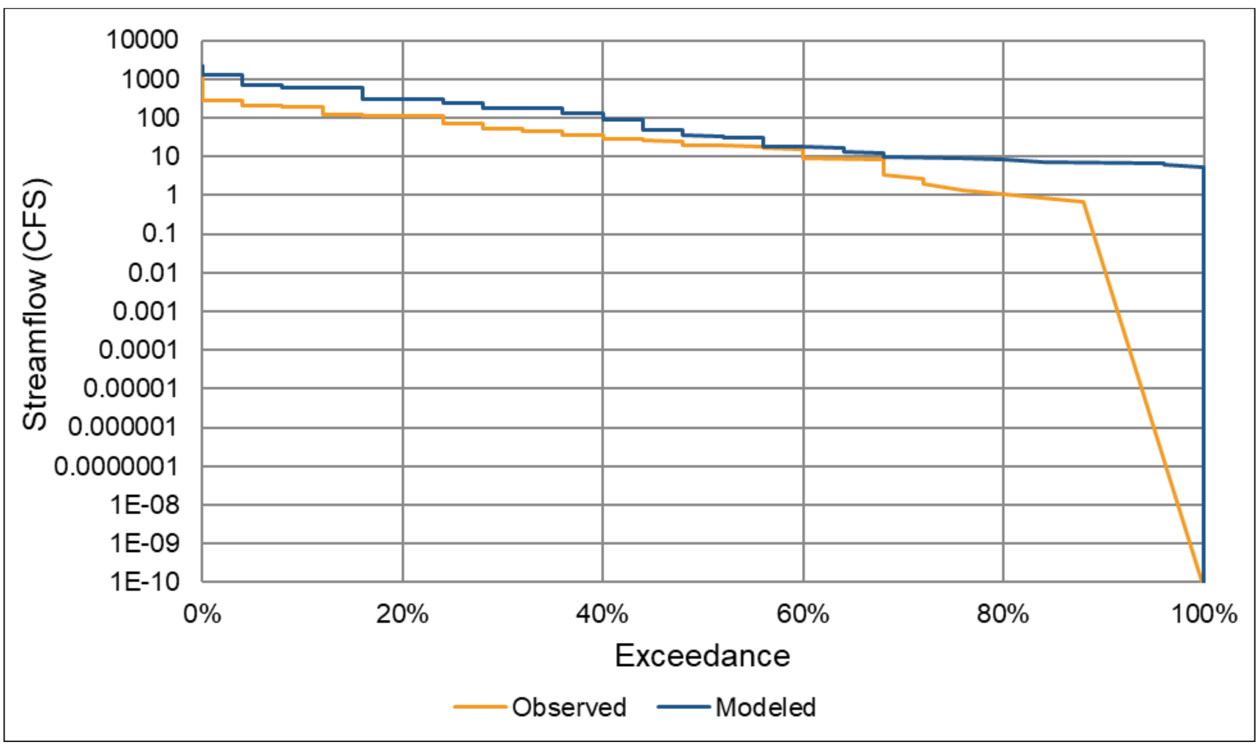


Figure 46c: ESJWRM Stream Calibration Gauges Streamflow – Mokelumne River at Woodbridge

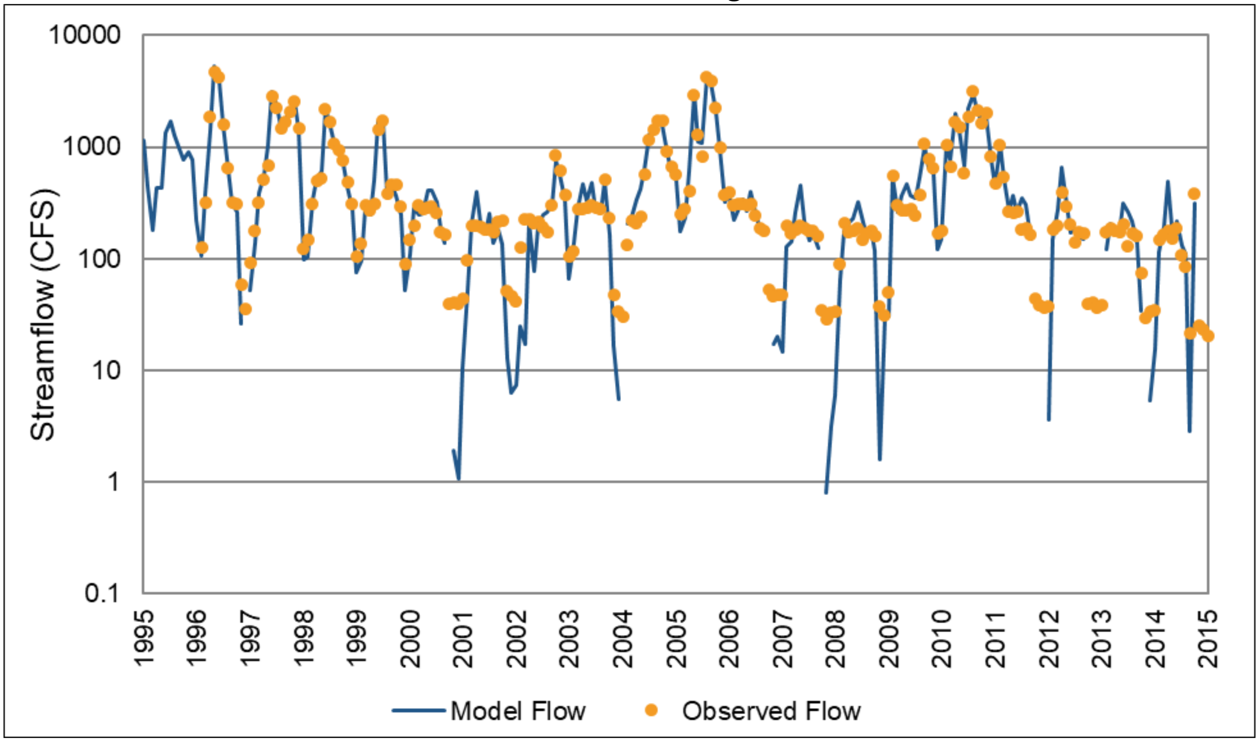


Figure 46d: ESJWRM Stream Calibration Gauges Exceedance – Mokelumne River at Woodbridge

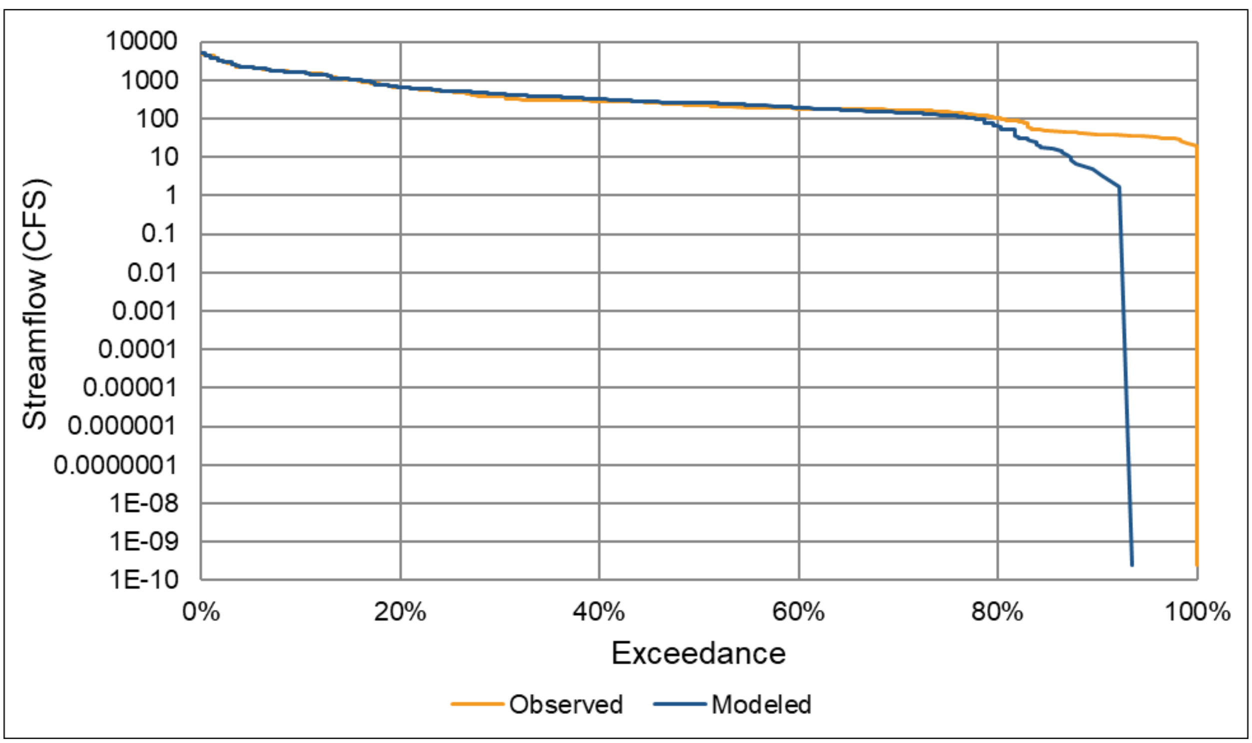


Figure 46e: ESJWRM Stream Calibration Gauges Streamflow – Mormon Slough at Bellota

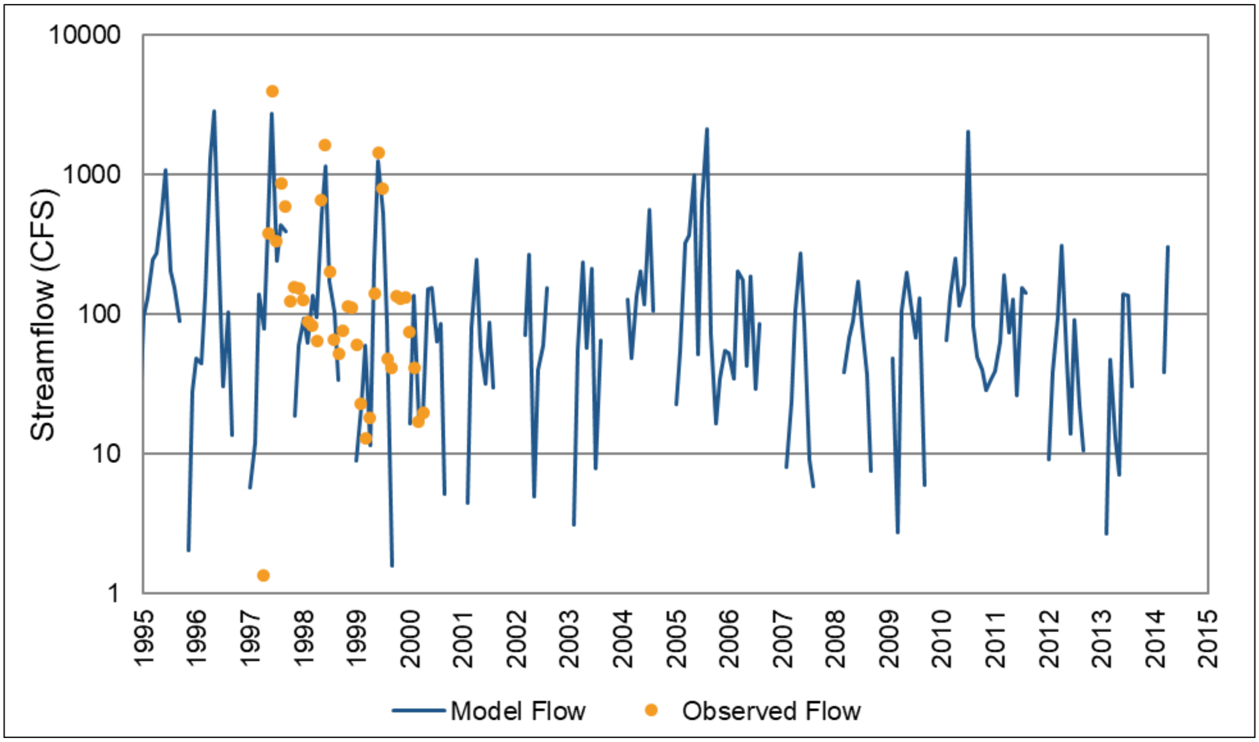


Figure 46f: ESJWRM Stream Calibration Gauges Exceedance – Mormon Slough at Bellota

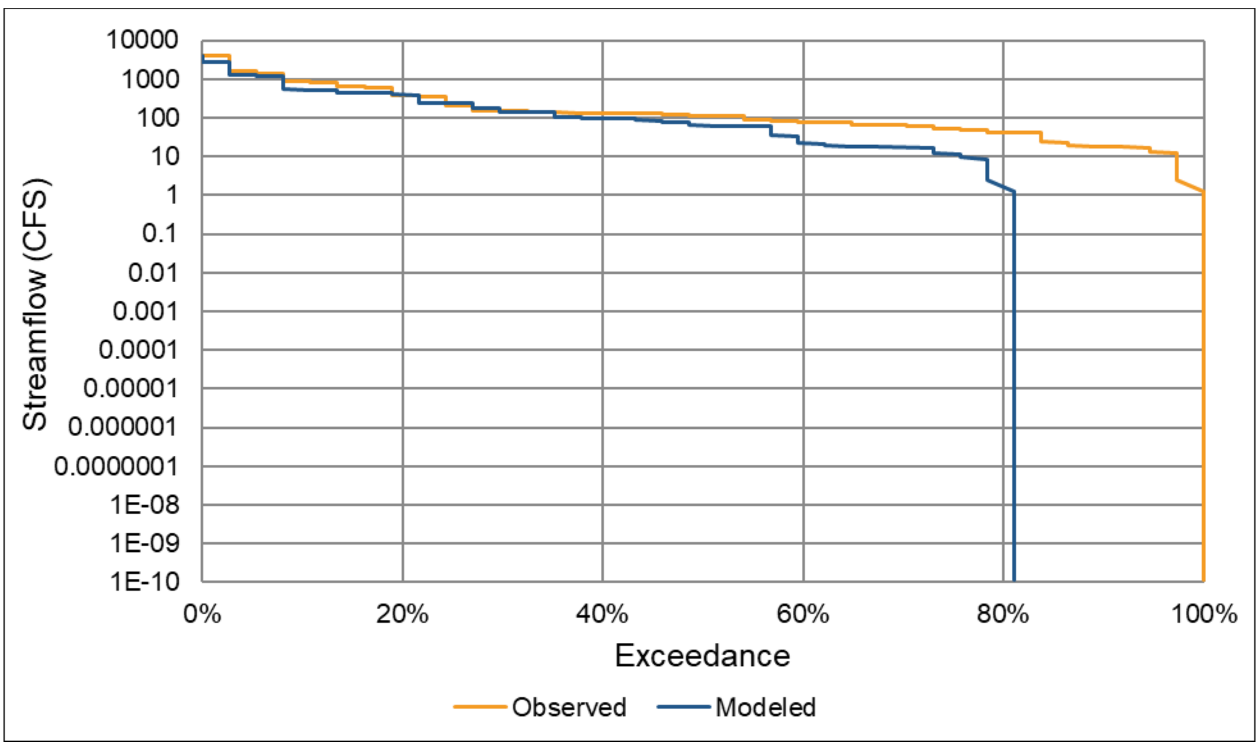


Figure 46g: ESJWRM Stream Calibration Gauges Streamflow – Stanislaus River below Orange Blossom Bridge

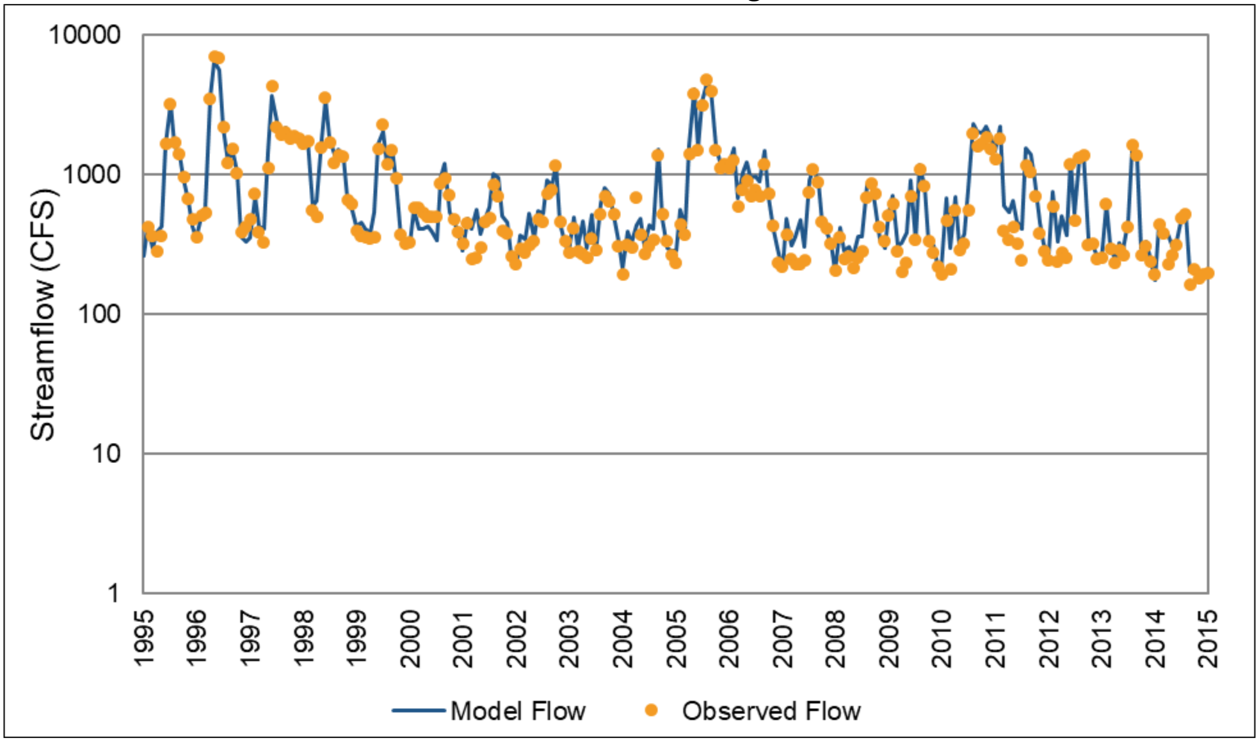


Figure 46h: ESJWRM Stream Calibration Gauges Exceedance – Stanislaus River below Orange Blossom Bridge

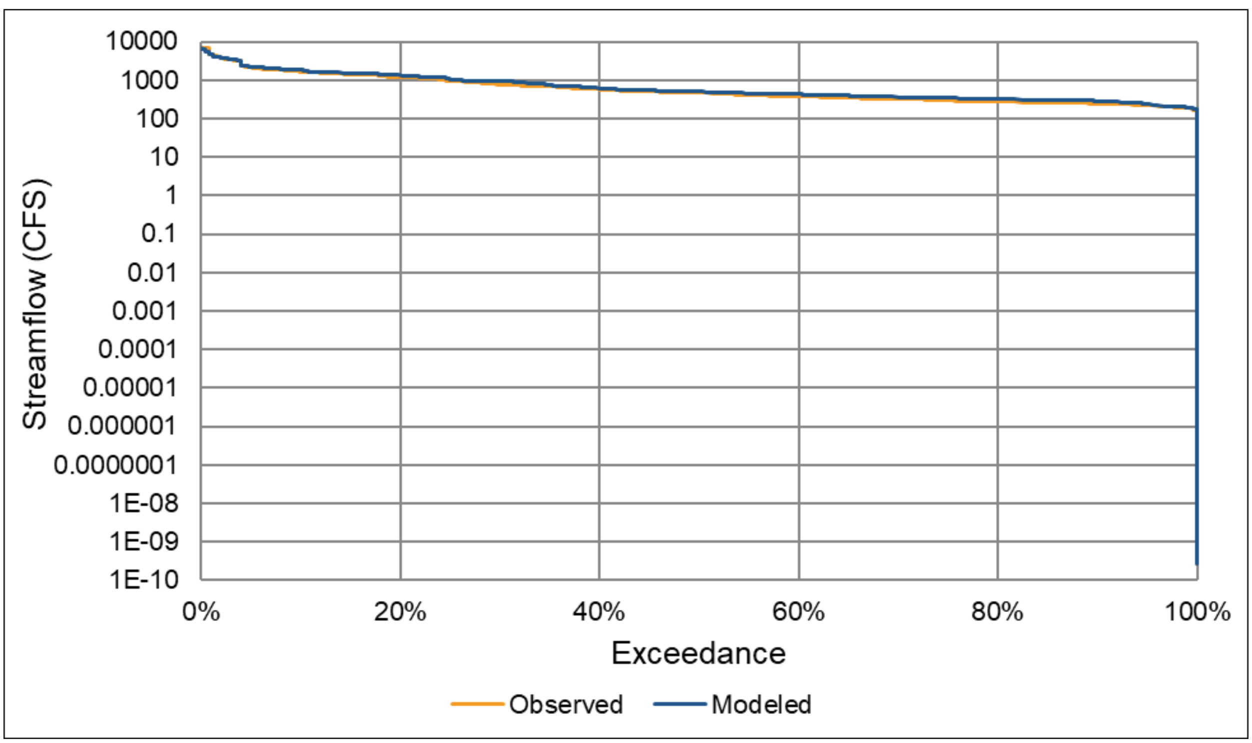


Figure 46i: ESJWRM Stream Calibration Gauges Streamflow – San Joaquin River below Garwood Bridge at Stockton

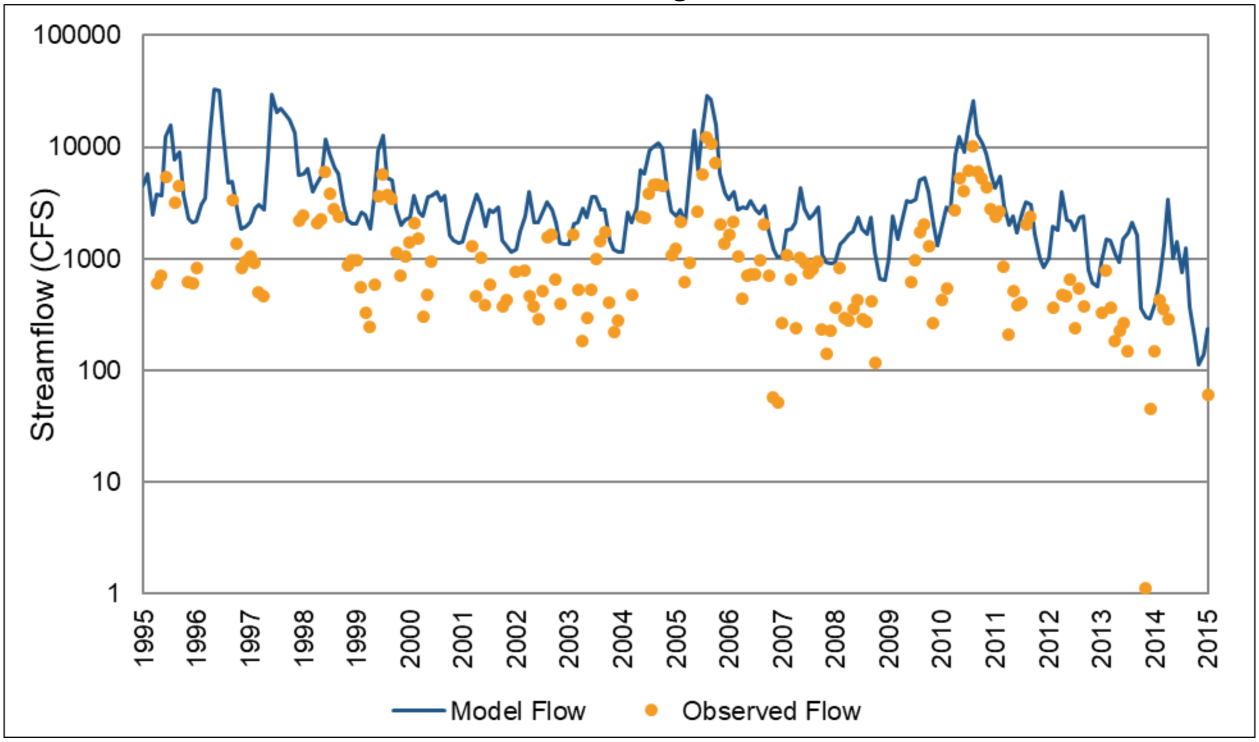


Figure 46j: ESJWRM Stream Calibration Gauges Exceedance – San Joaquin River below Garwood Bridge at Stockton

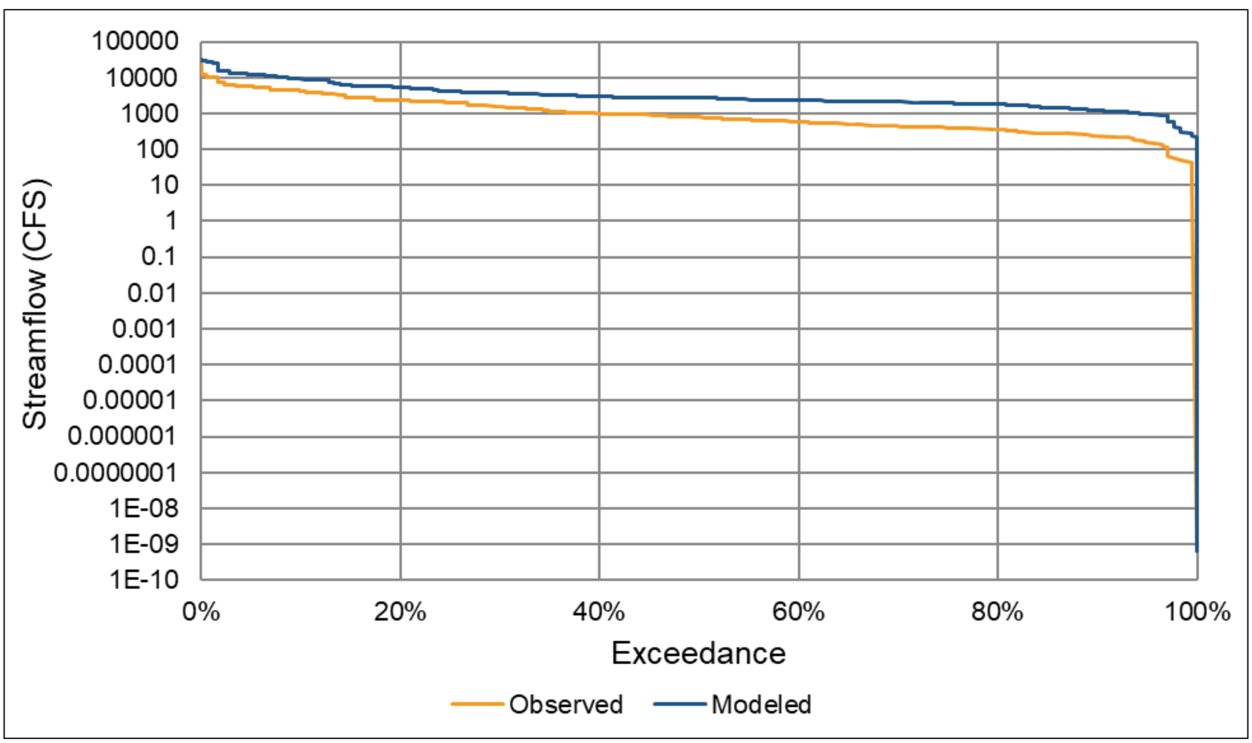


Figure 47a: ESJWRM Agricultural Land and Water Use Budget – Eastern San Joaquin Subbasin

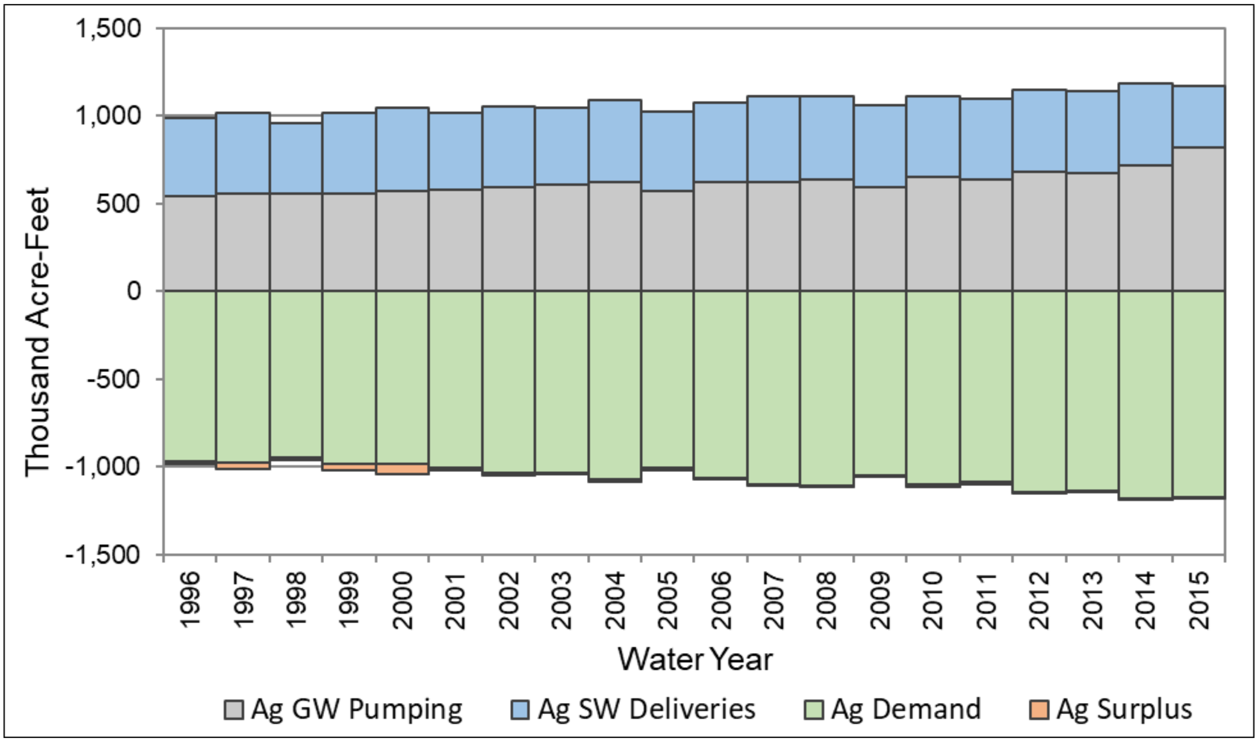


Figure 47b: ESJWRM Agricultural Land and Water Use Budget – Subarea 1 (North Delta Subarea)

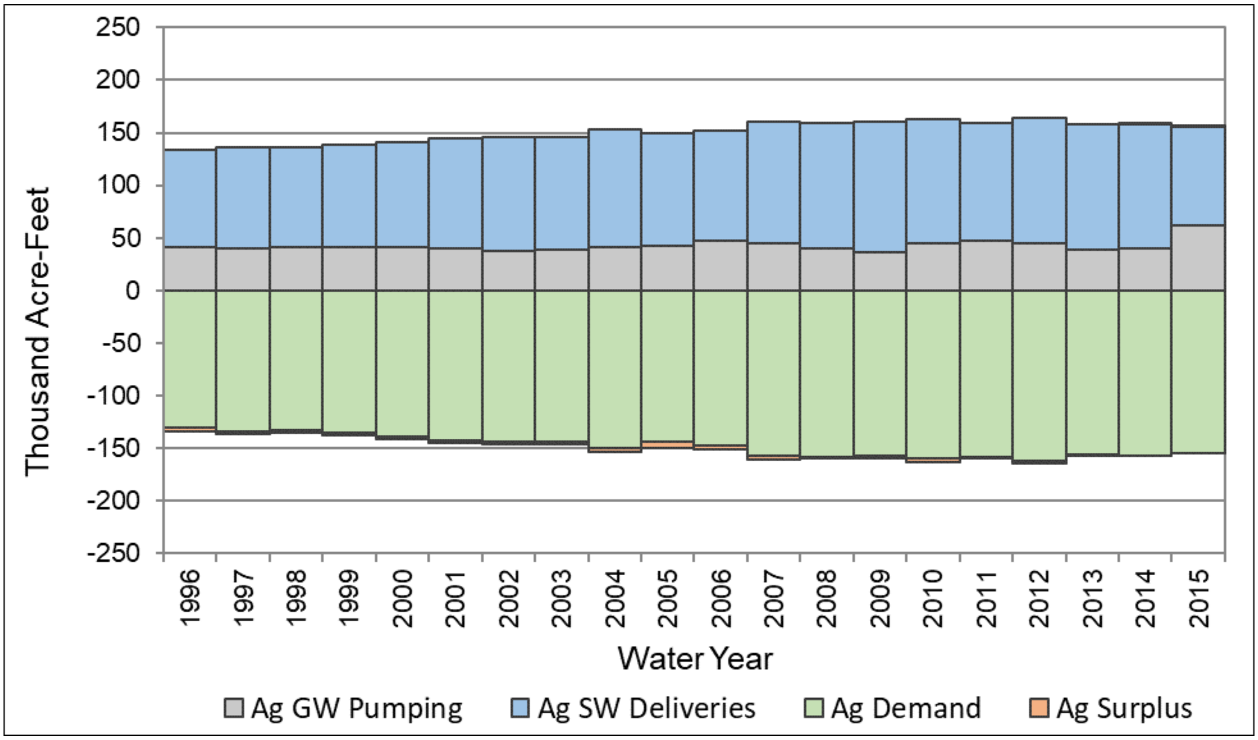


Figure 47c: ESJWRM Agricultural Land and Water Use Budget – Subarea 2 (North Subarea)

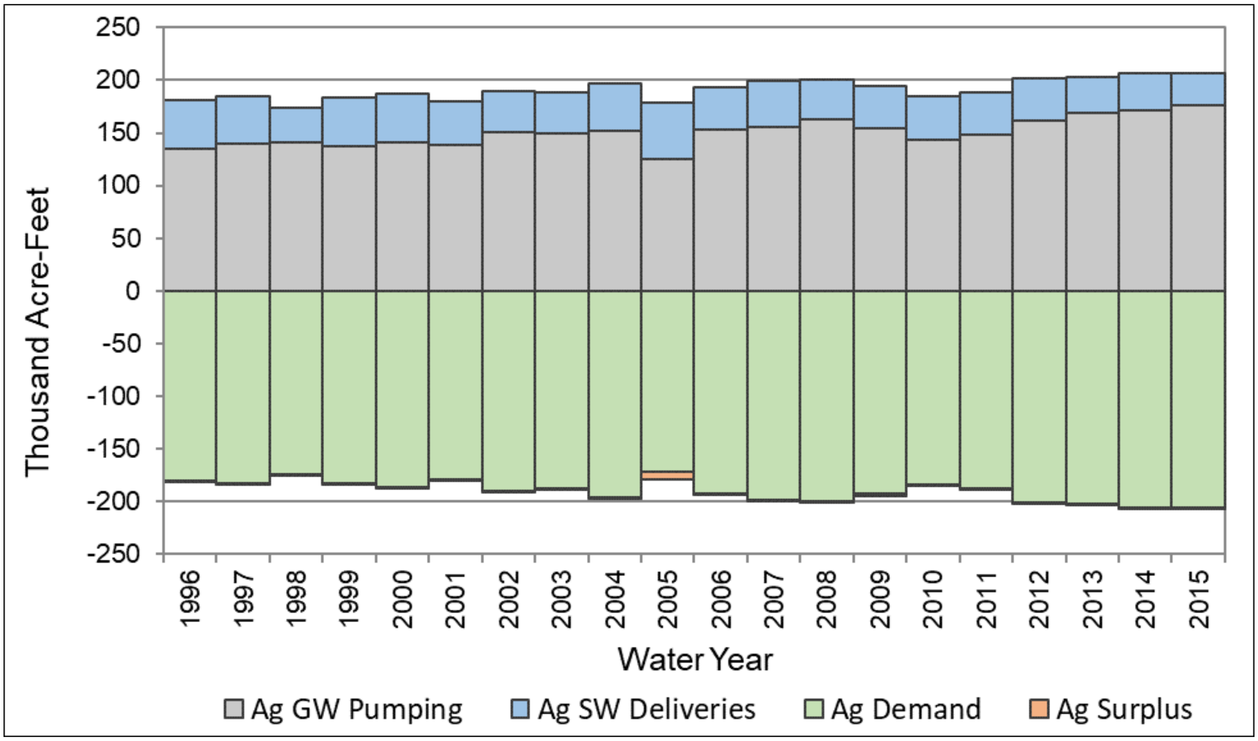


Figure 47d: ESJWRM Agricultural Land and Water Use Budget – Subarea 3 (Calaveras Subarea)

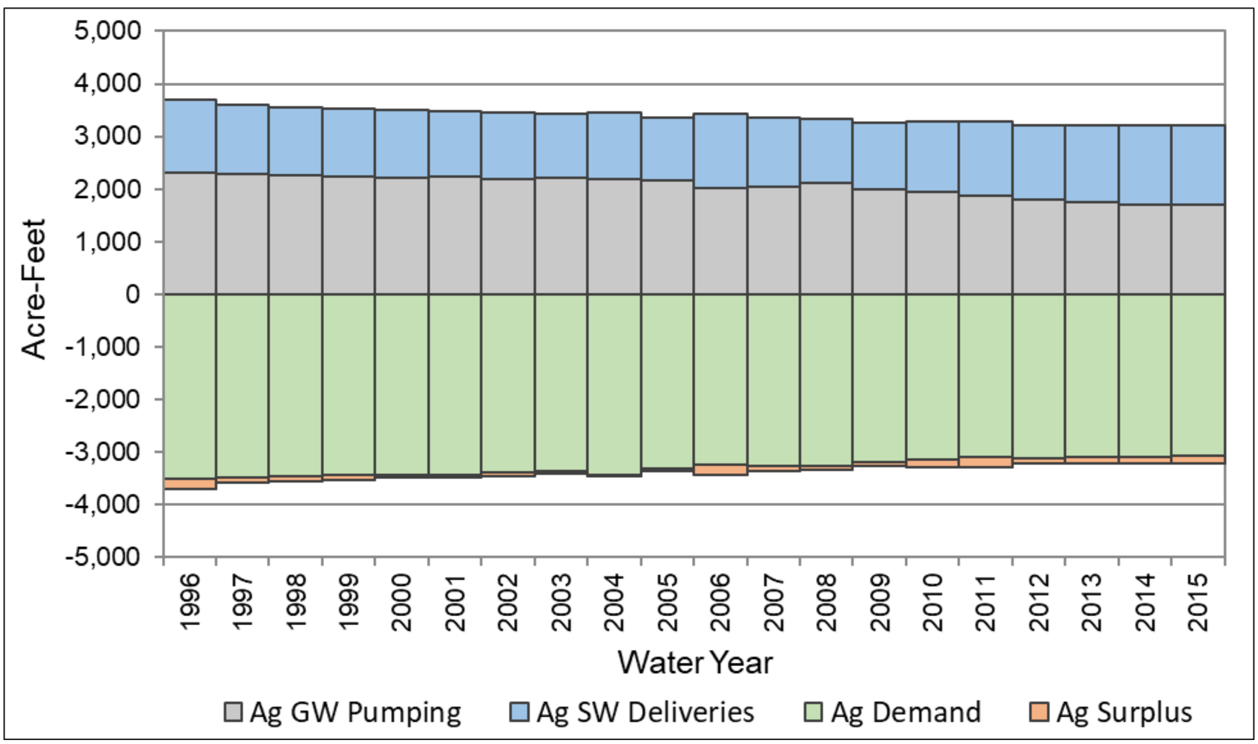


Figure 47e: ESJWRM Agricultural Land and Water Use Budget – Subarea 4 (Central Subarea)

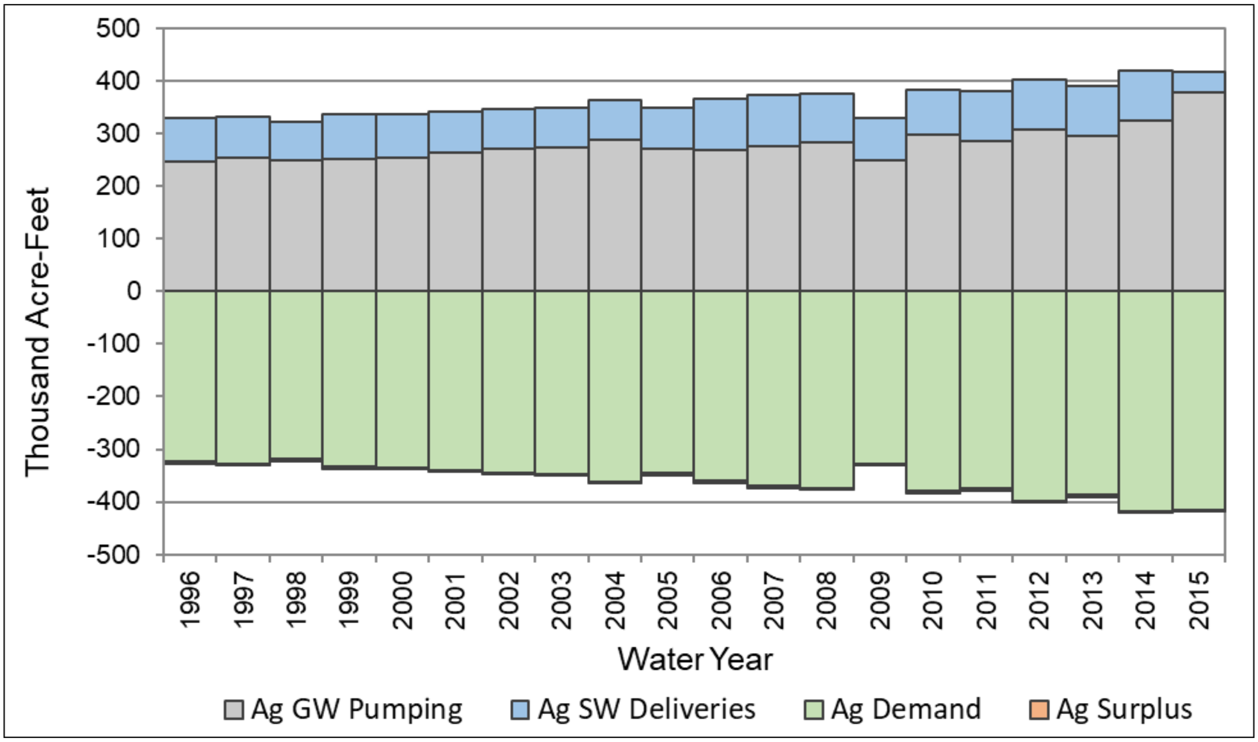


Figure 47f: ESJWRM Agricultural Land and Water Use Budget – Subarea 5 (South Subarea)

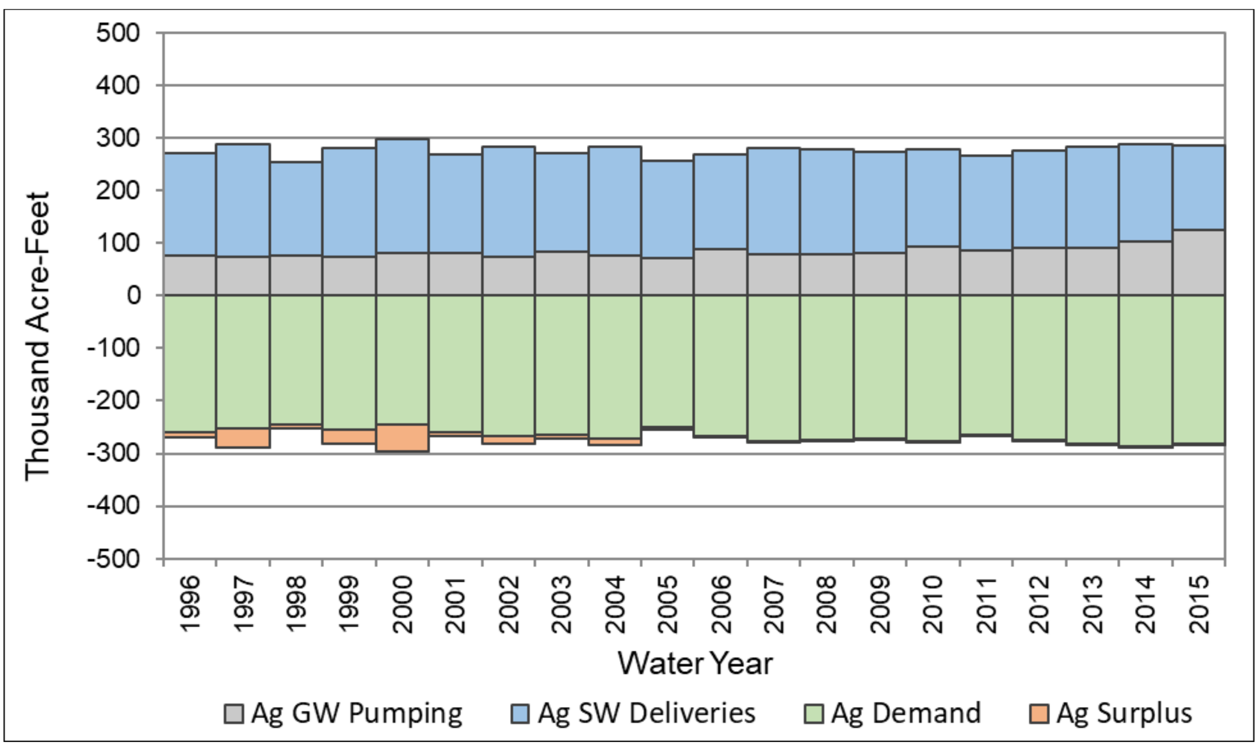


Figure 47g: ESJWRM Agricultural Land and Water Use Budget – Subarea 6 (Stanislaus Subarea)

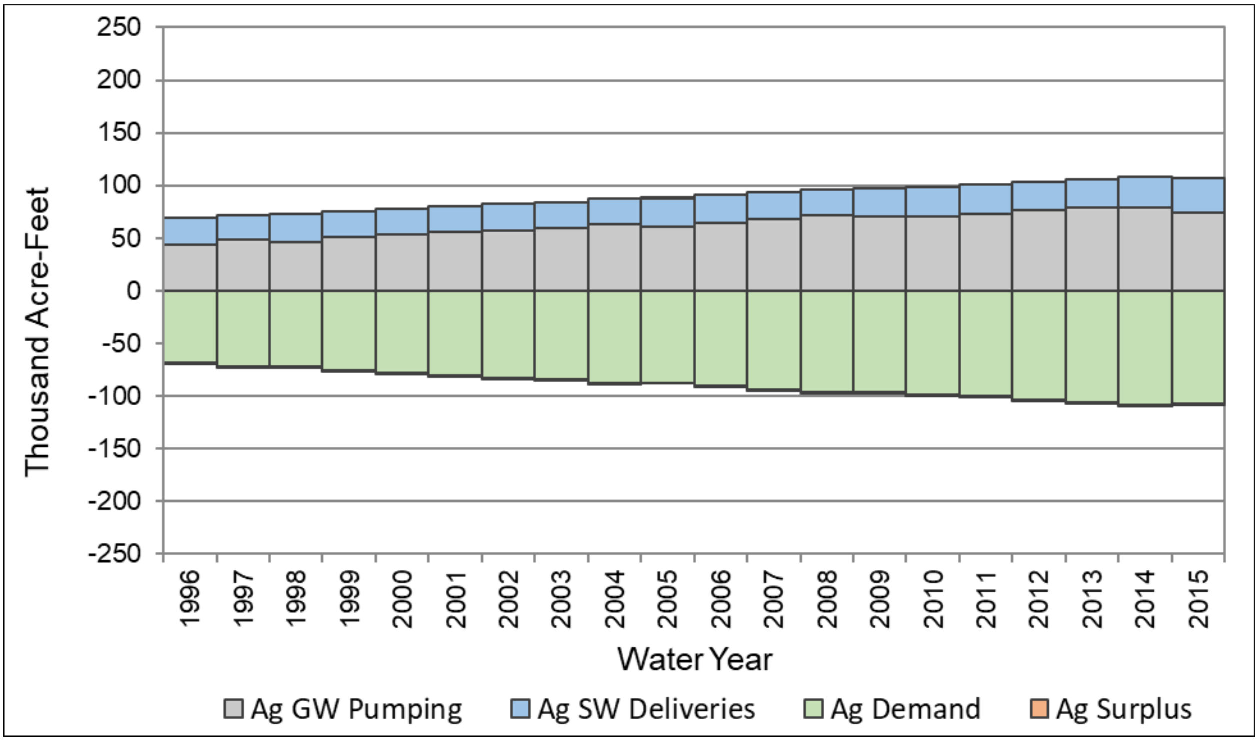


Figure 48a: ESJWRM Urban Land and Water Use Budget – Eastern San Joaquin Subbasin

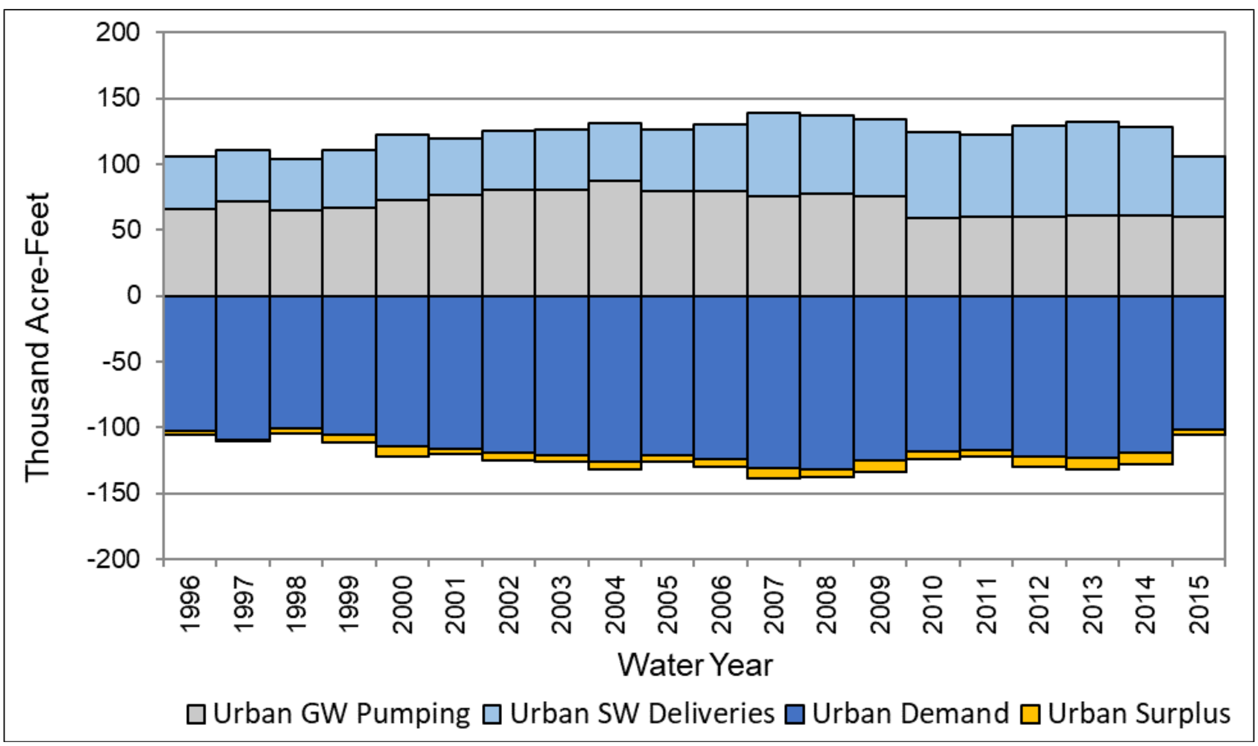


Figure 48b: ESJWRM Urban Land and Water Use Budget – Subarea 1 (North Delta Subarea)

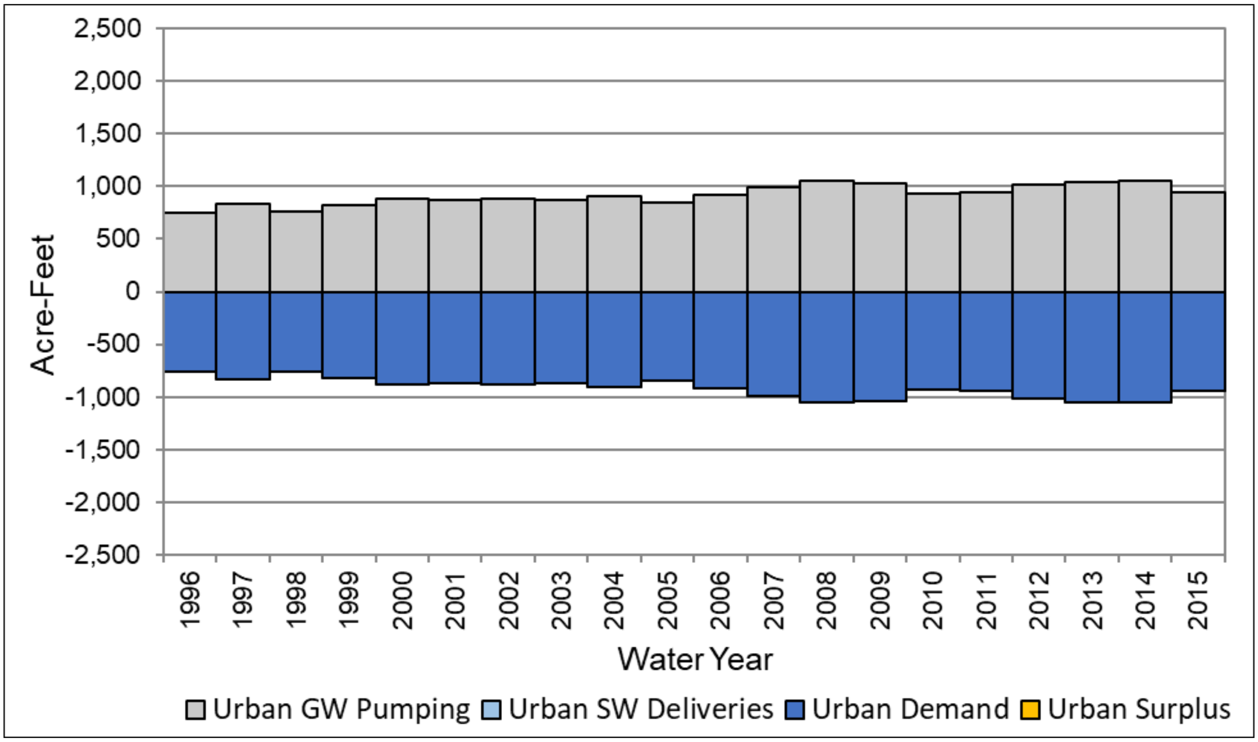


Figure 48c: ESJWRM Urban Land and Water Use Budget – Subarea 2 (North Subarea)

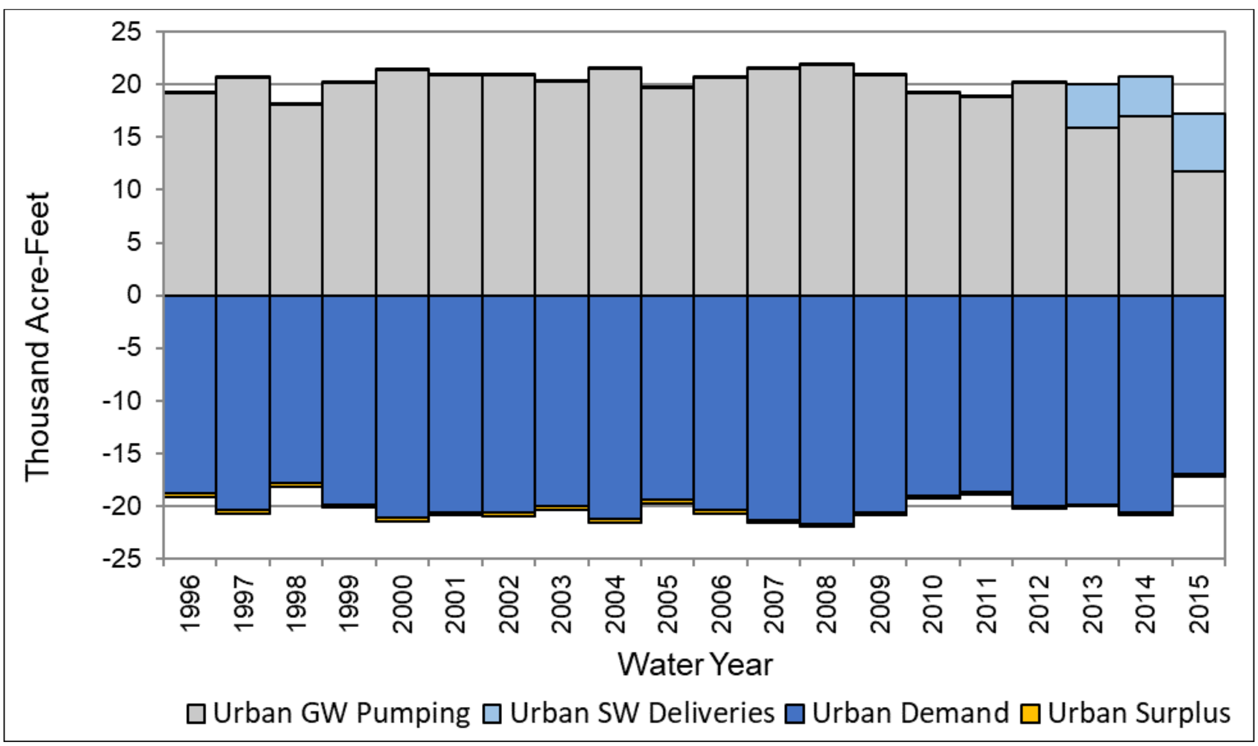


Figure 48d: ESJWRM Urban Land and Water Use Budget – Subarea 3 (Calaveras Subarea)

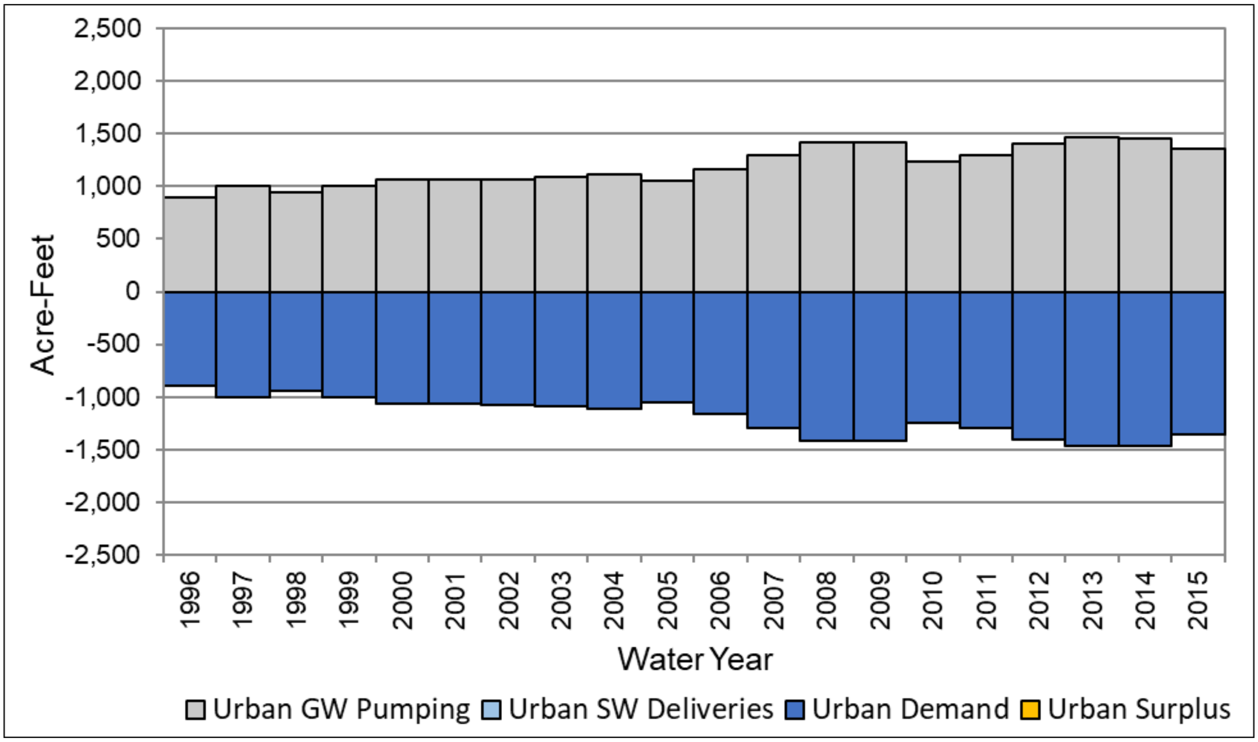


Figure 48e: ESJWRM Urban Land and Water Use Budget – Subarea 4 (Central Subarea)

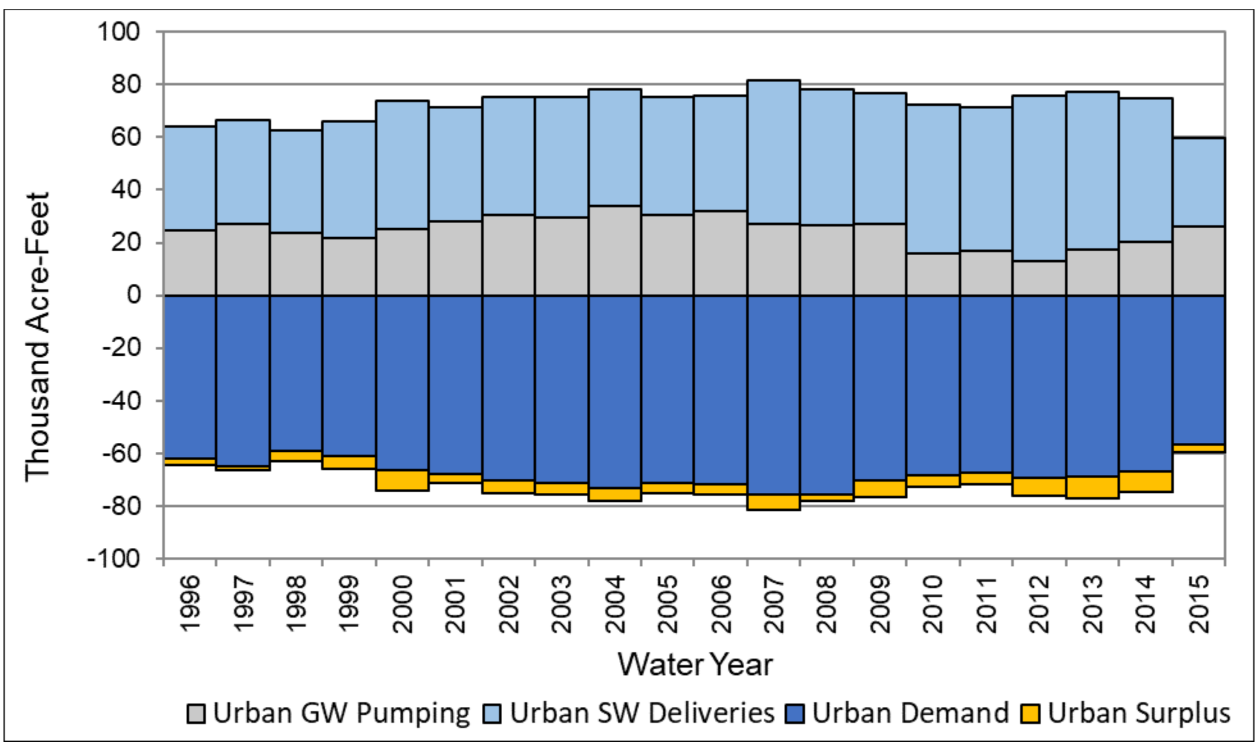


Figure 48f: ESJWRM Urban Land and Water Use Budget – Subarea 5 (South Subarea)

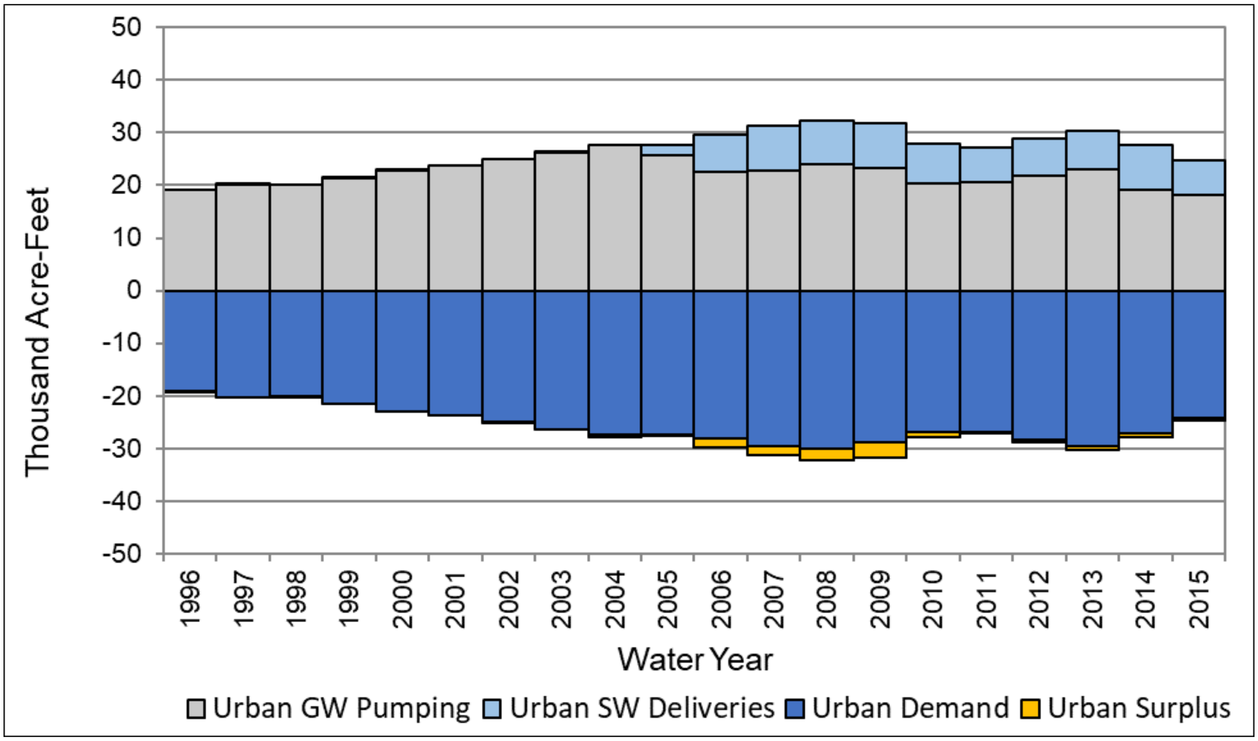


Figure 48g: ESJWRM Urban Land and Water Use Budget – Subarea 6 (Stanislaus Subarea)

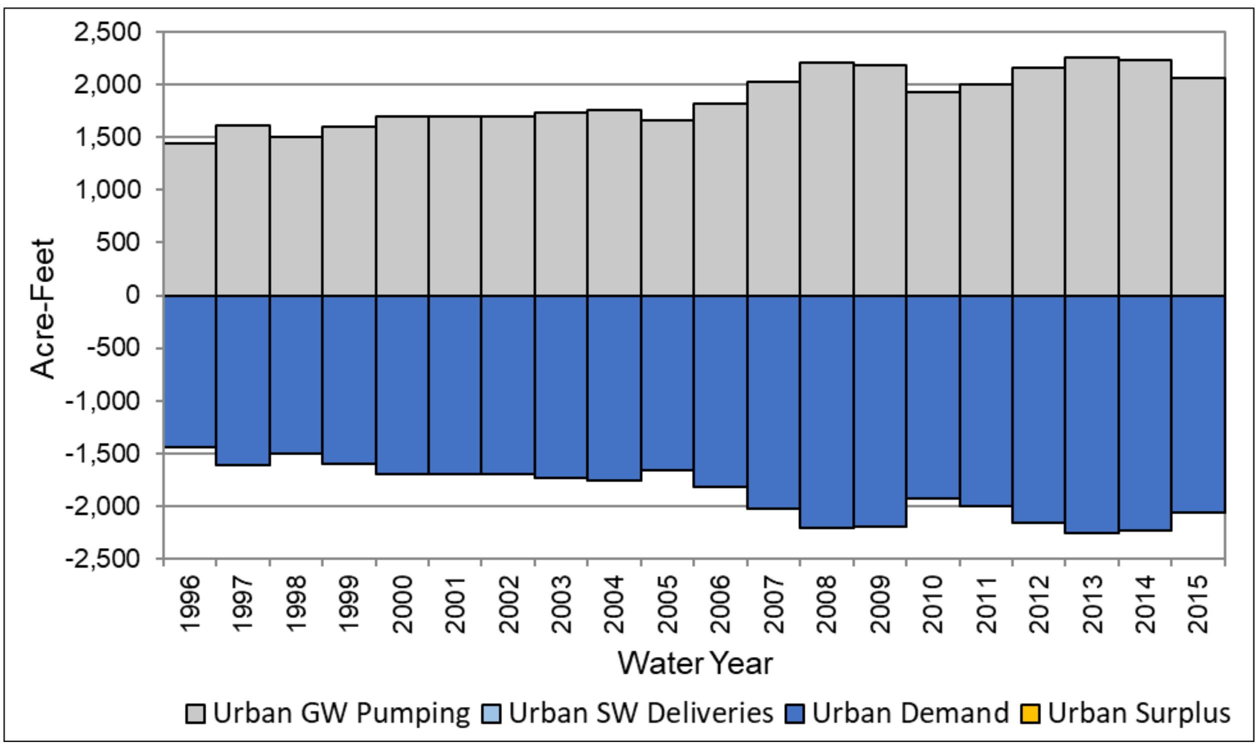


Figure 49a: ESJWRM Groundwater Budget – Eastern San Joaquin Subbasin

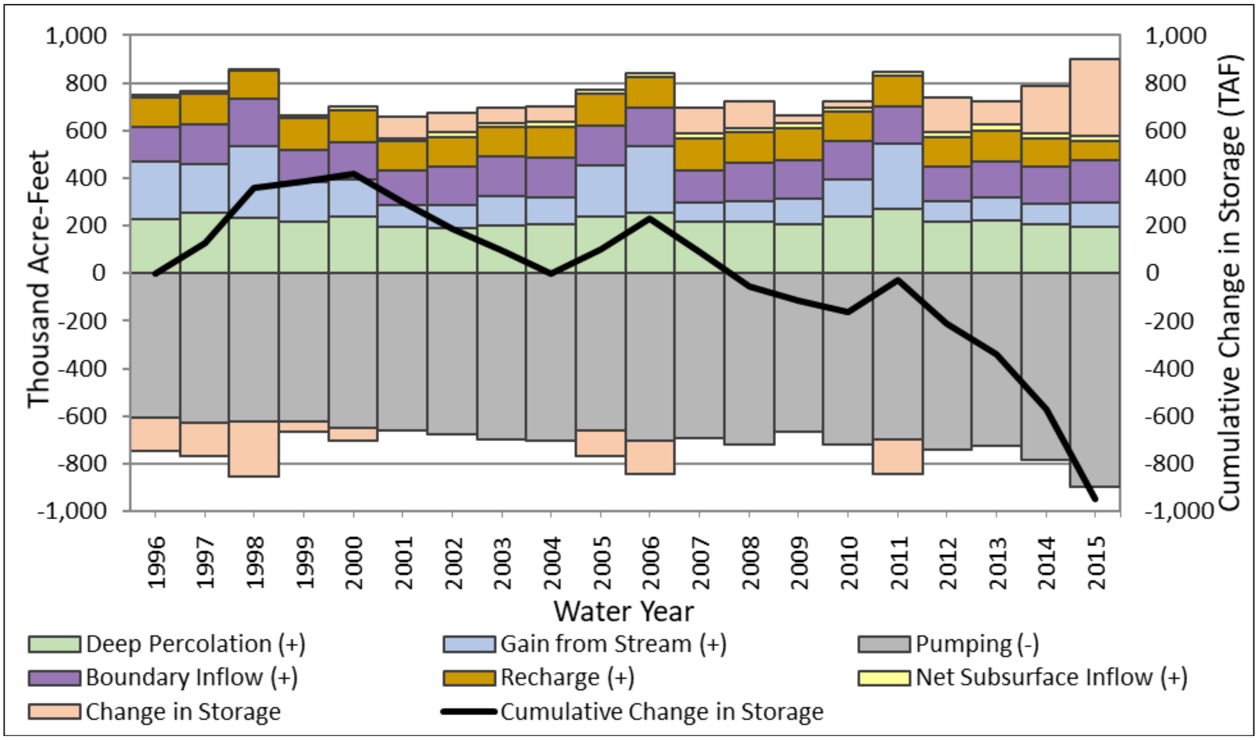


Figure 49b: ESJWRM Groundwater Budget – Subarea 1 (North Delta Subarea)

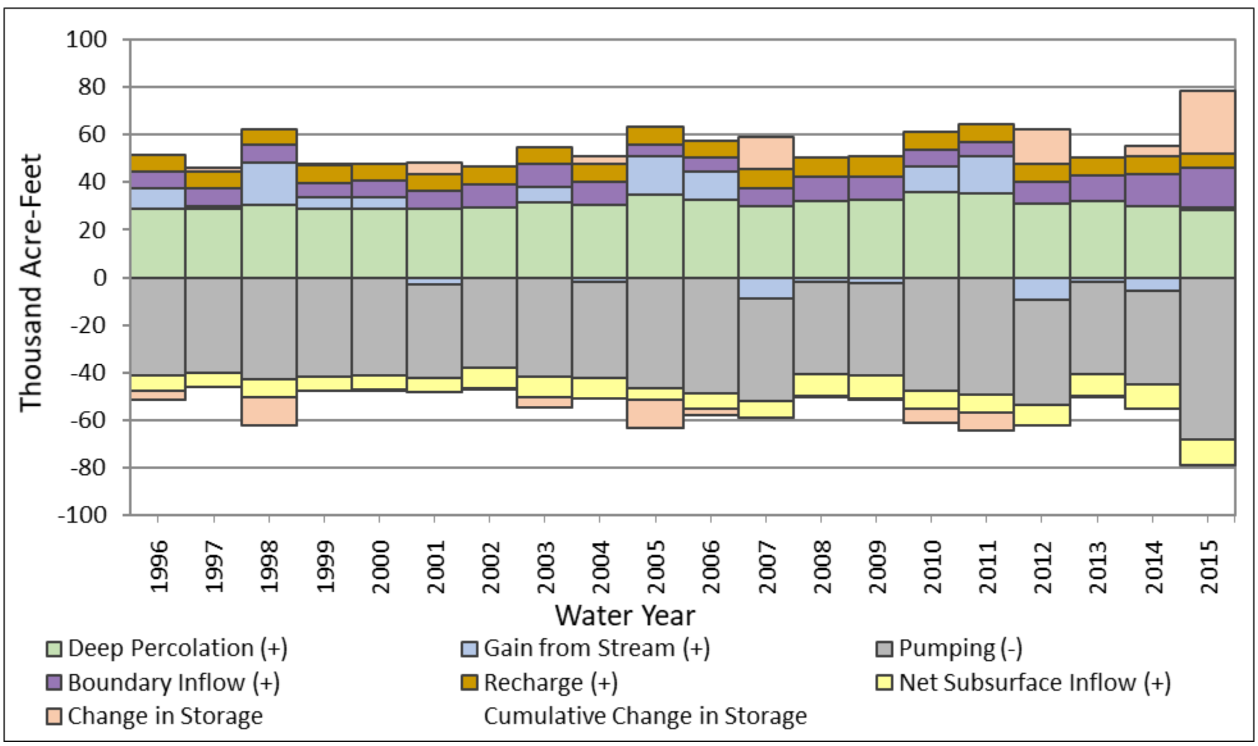


Figure 49c: ESJWRM Groundwater Budget – Subarea 2 (North Subarea)

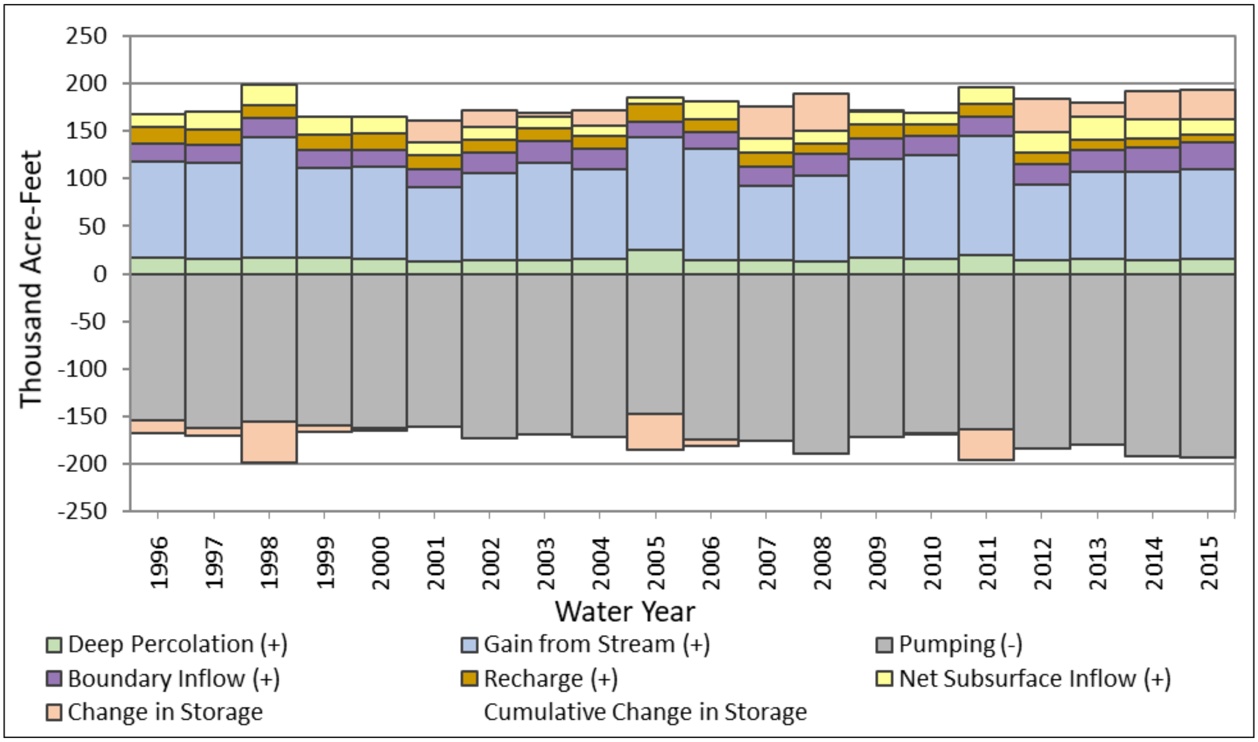


Figure 49d: ESJWRM Groundwater Budget – Subarea 3 (Calaveras Subarea)

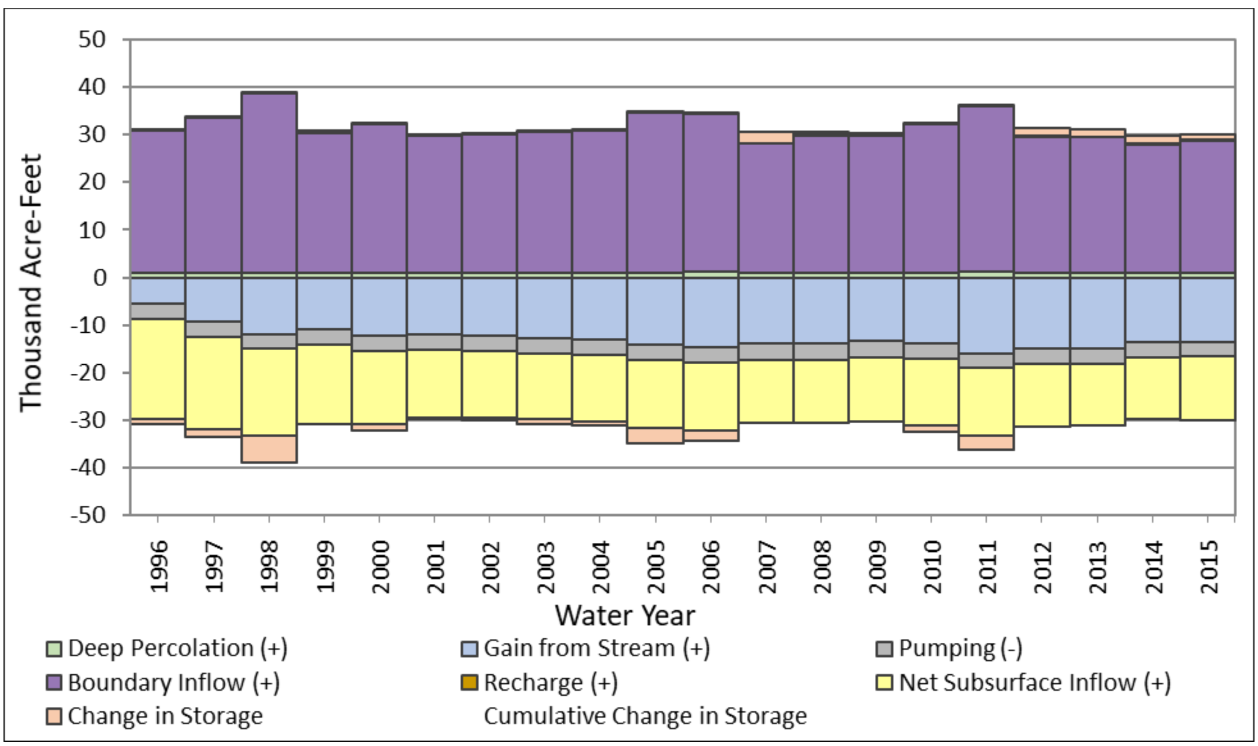


Figure 49e: ESJWRM Groundwater Budget – Subarea 4 (Central Subarea)

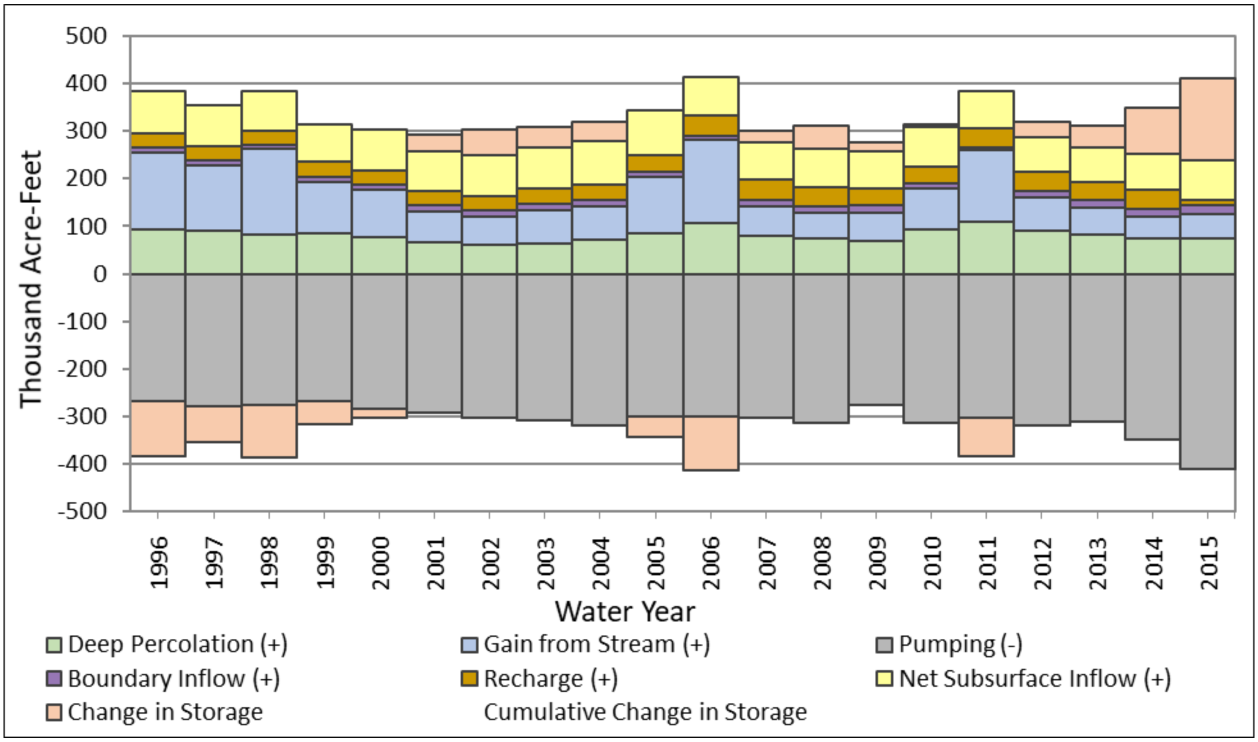


Figure 49f: ESJWRM Groundwater Budget – Subarea 5 (South Subarea)

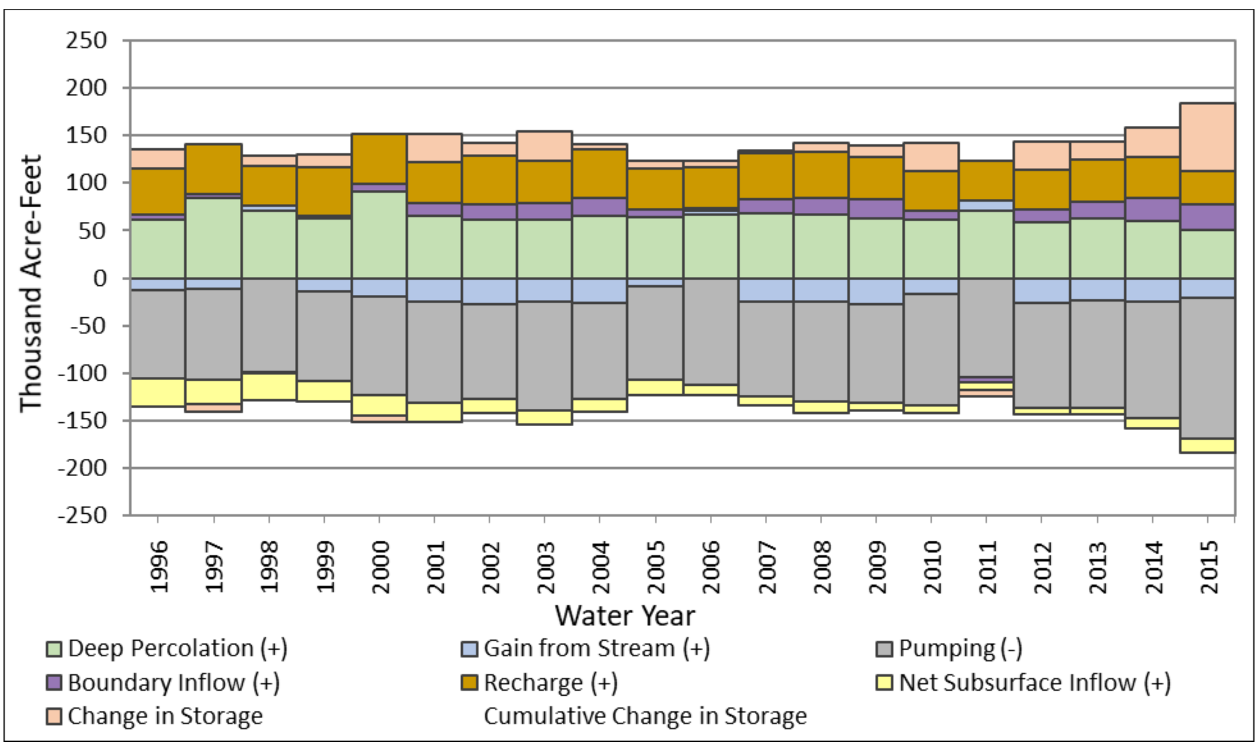


Figure 49g: ESJWRM Groundwater Budget – Subarea 6 (Stanislaus Subarea)

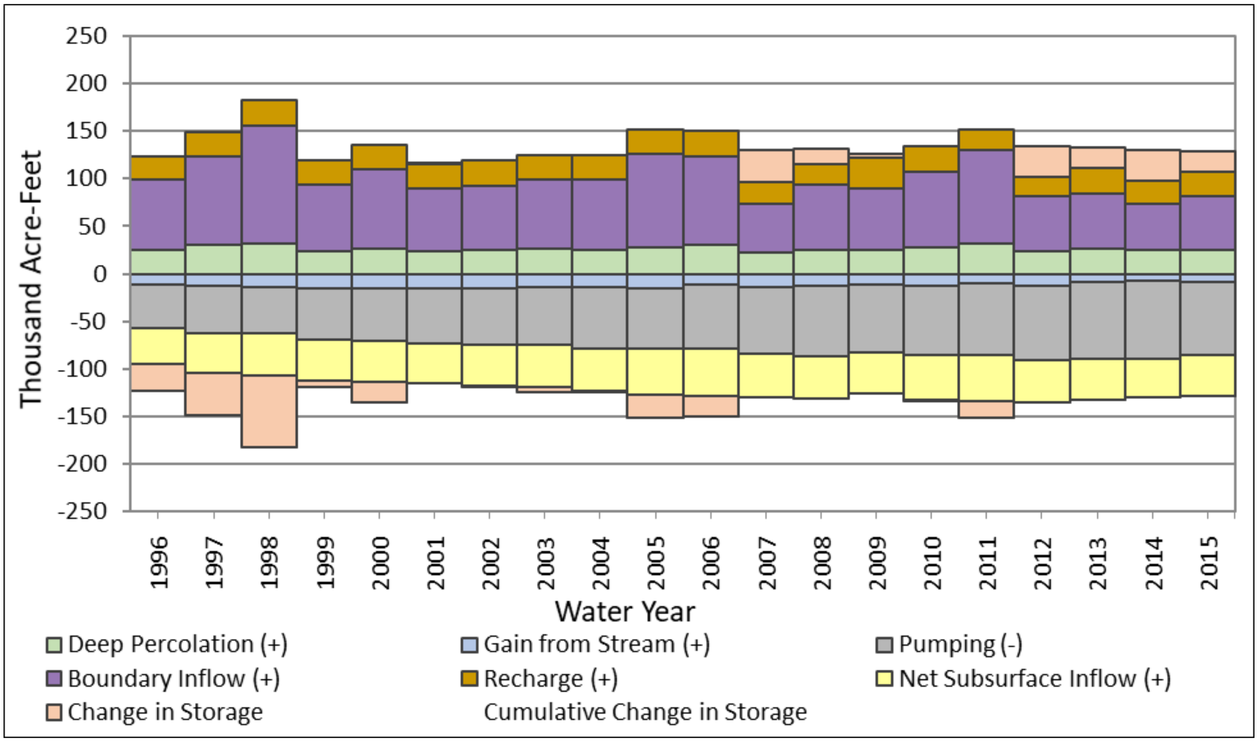


Figure 50: ESJWRM Groundwater Level Calibration Wells

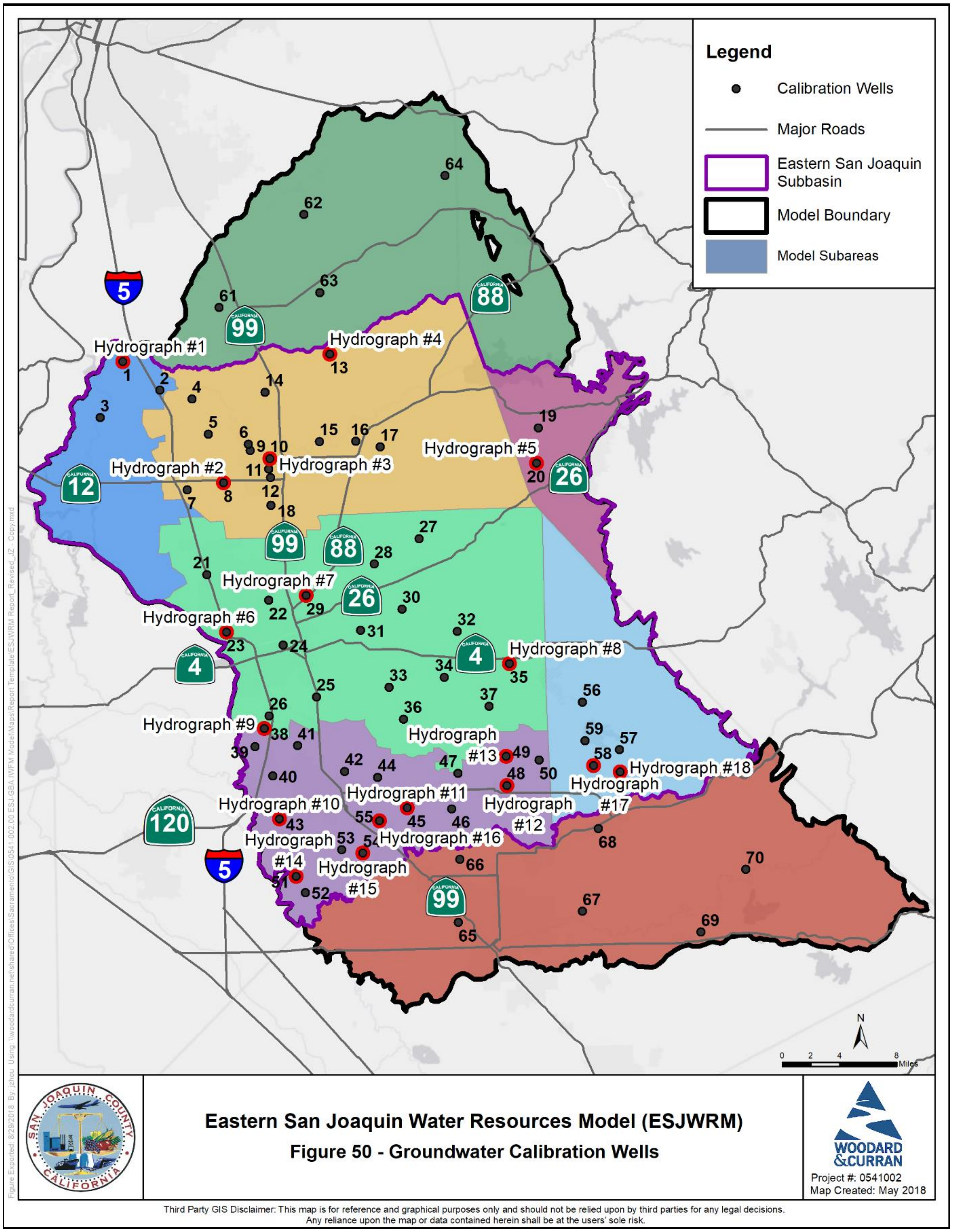


Figure 51a: ESJWRM Groundwater Level Contours (Fall 2015)

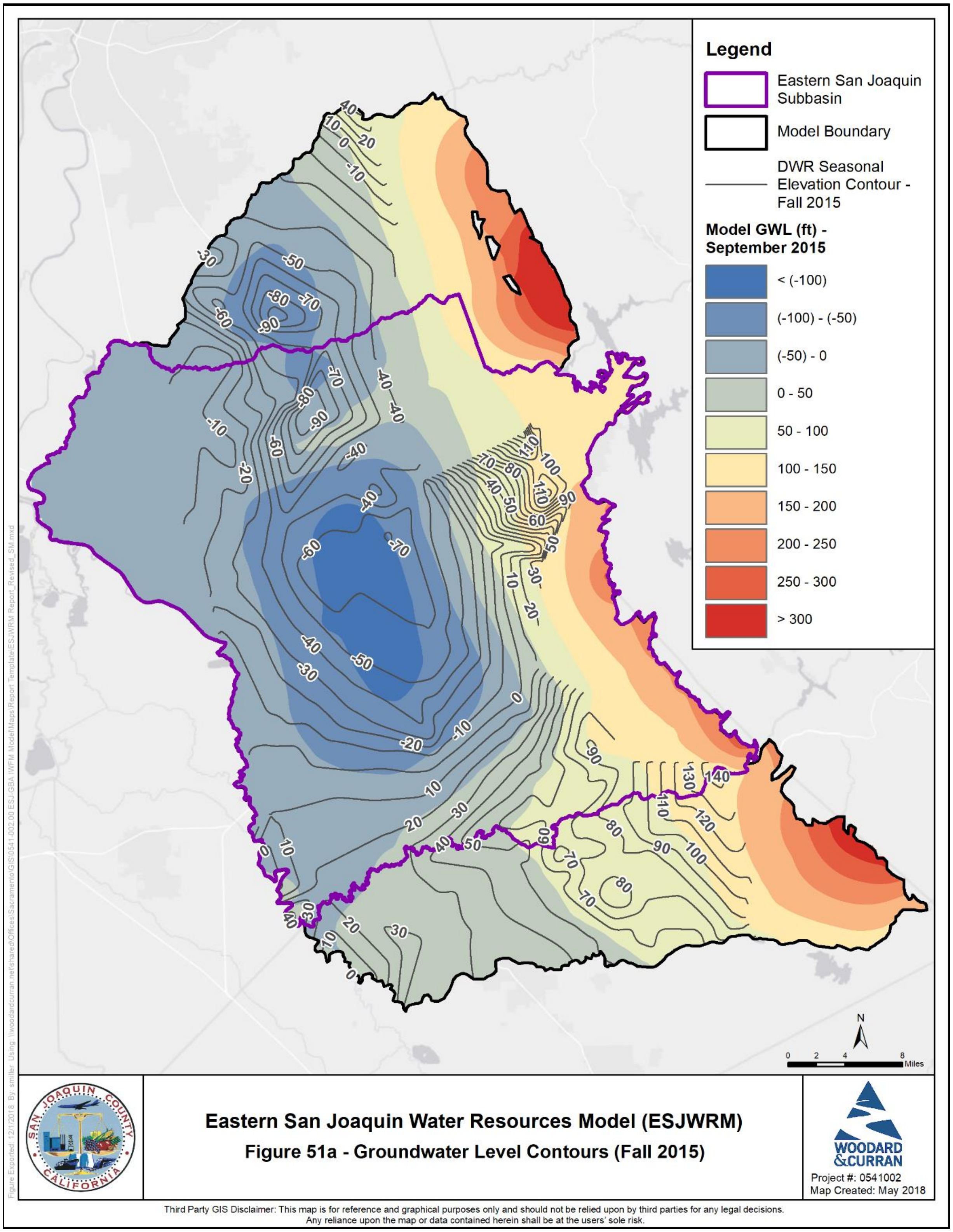


Figure 51b: ESJWRM Groundwater Level Contours (Spring 2015)

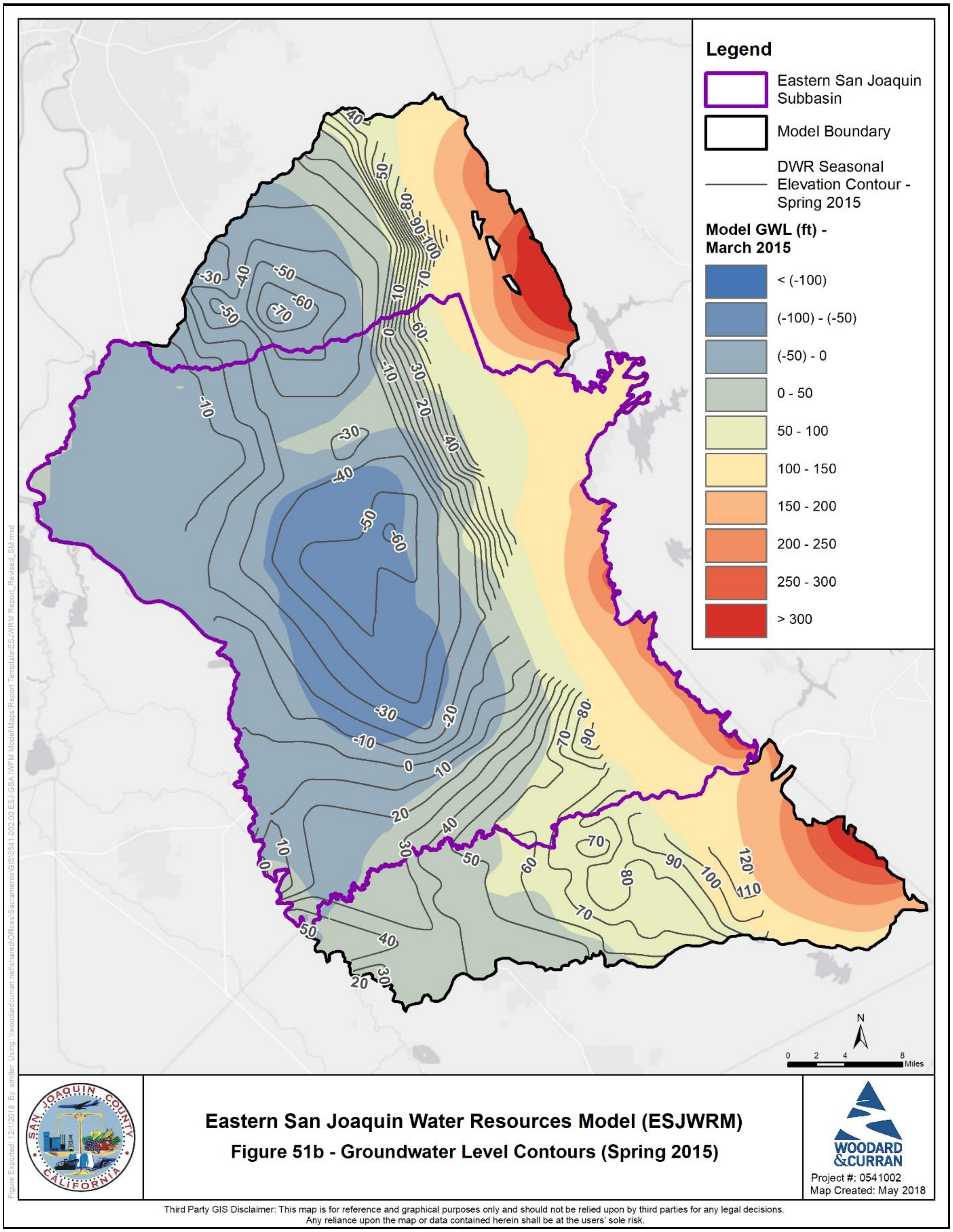


Figure 51c: ESJWRM Groundwater Level Contours (Fall 2013)

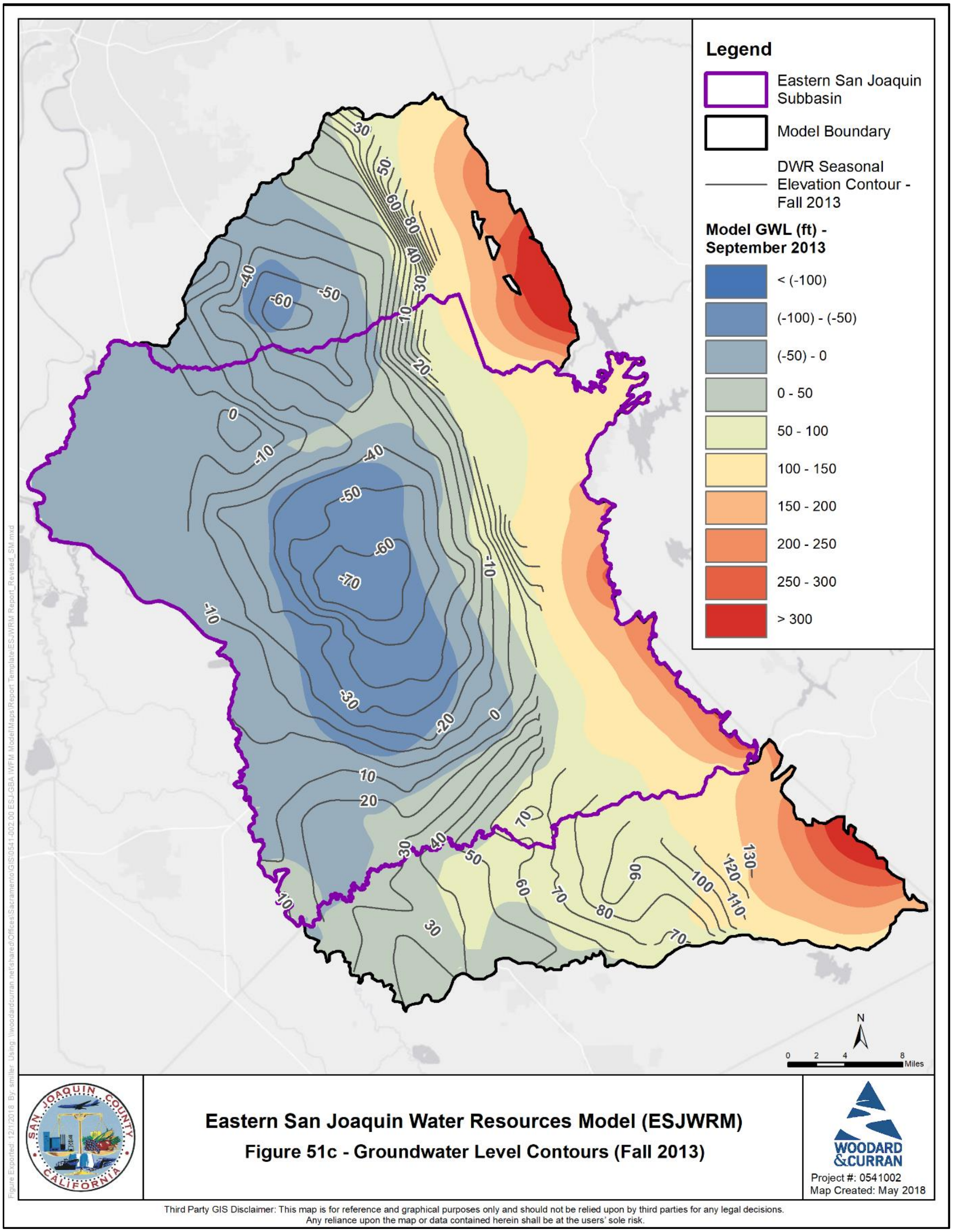


Figure 51d: ESJWRM Groundwater Level Contours (Spring 2011)

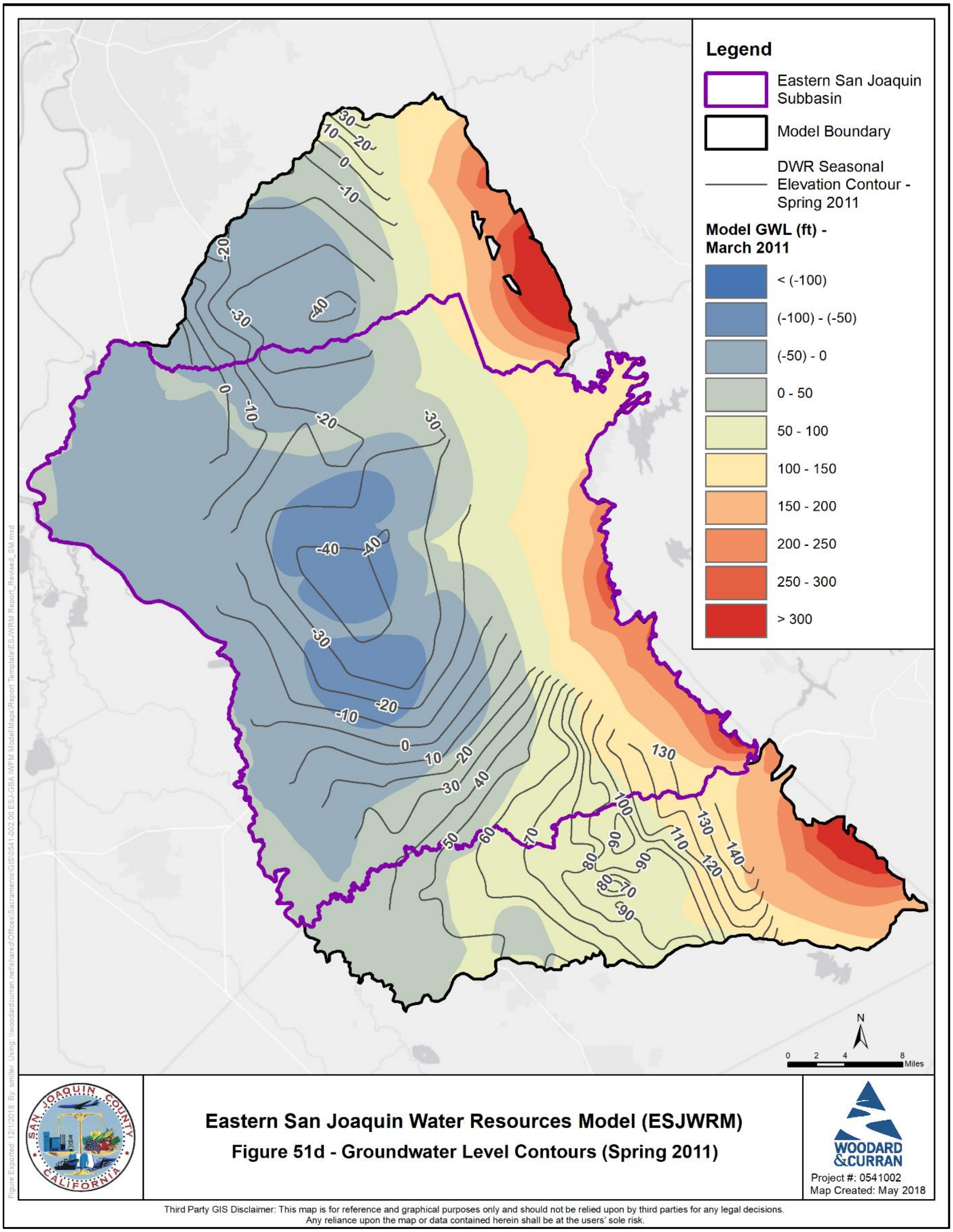


Figure 52a: ESJWRM Groundwater Level Hydrograph – Hydrograph #1

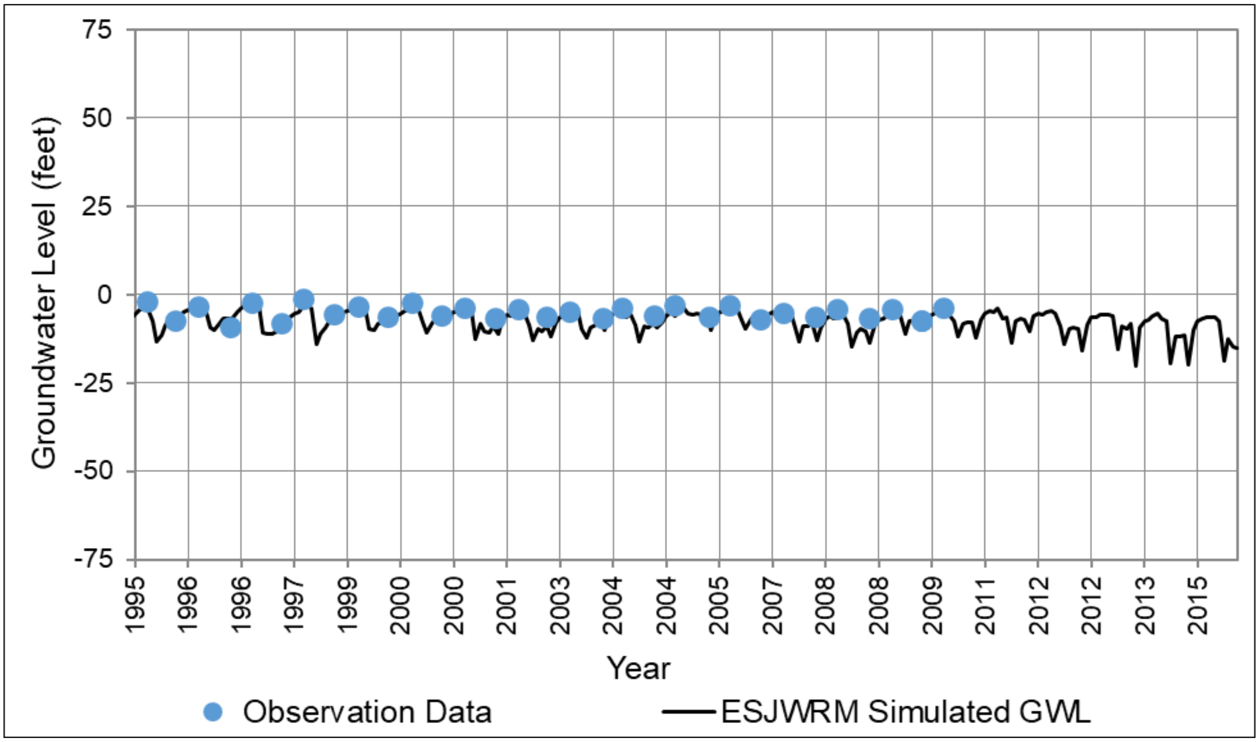


Figure 52b: ESJWRM Groundwater Level Hydrograph – Hydrograph #2

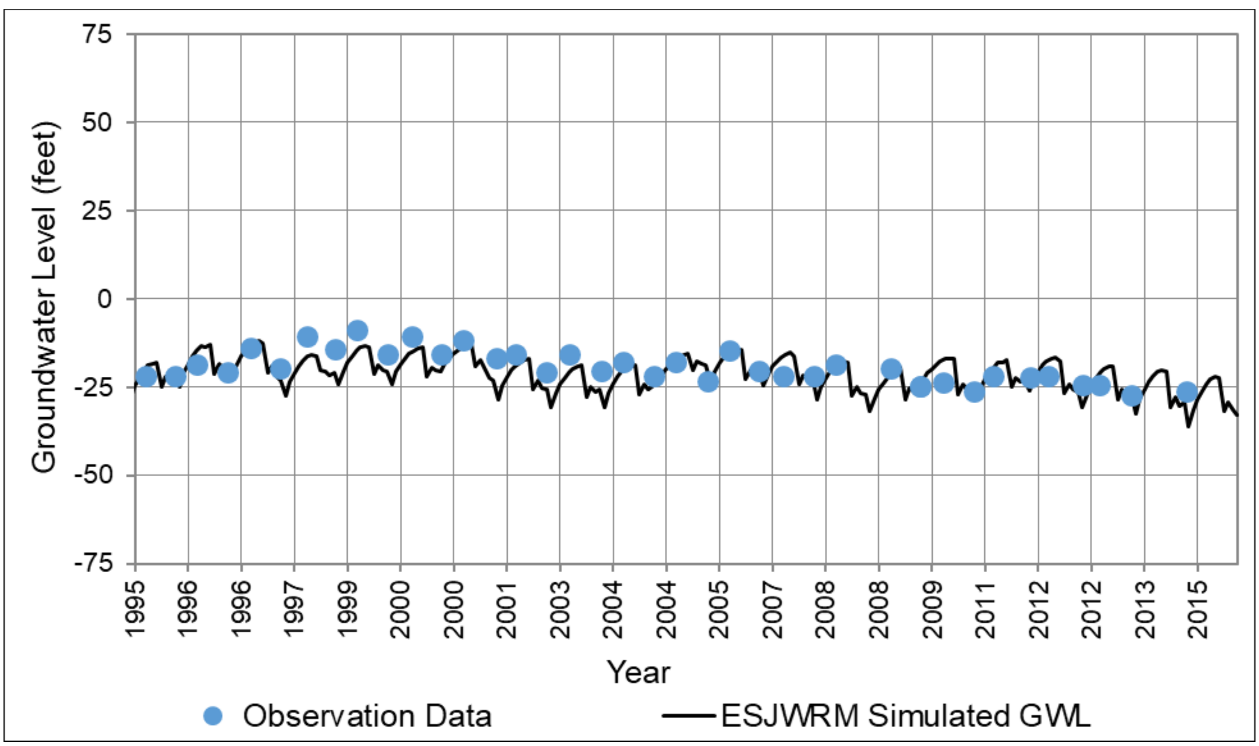


Figure 52c: ESJWRM Groundwater Level Hydrograph – Hydrograph #3

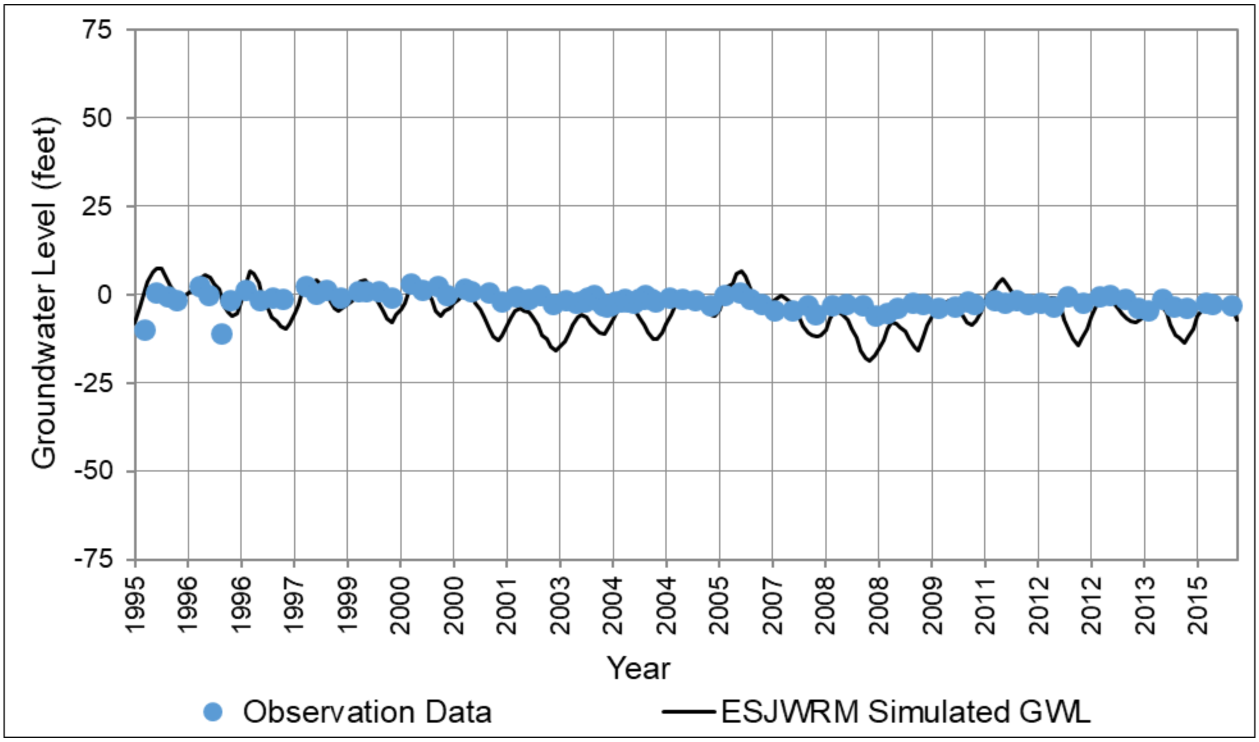


Figure 52d: ESJWRM Groundwater Level Hydrograph – Hydrograph #4

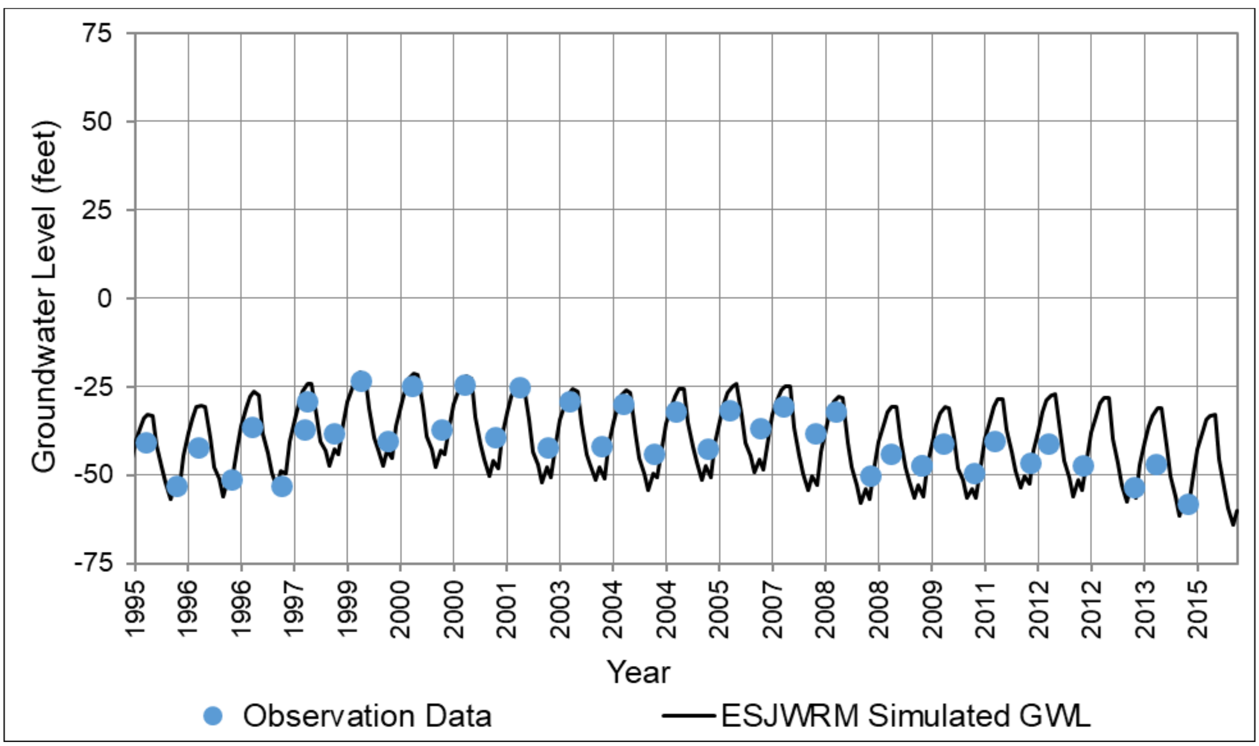


Figure 52e: ESJWRM Groundwater Level Hydrograph – Hydrograph #5

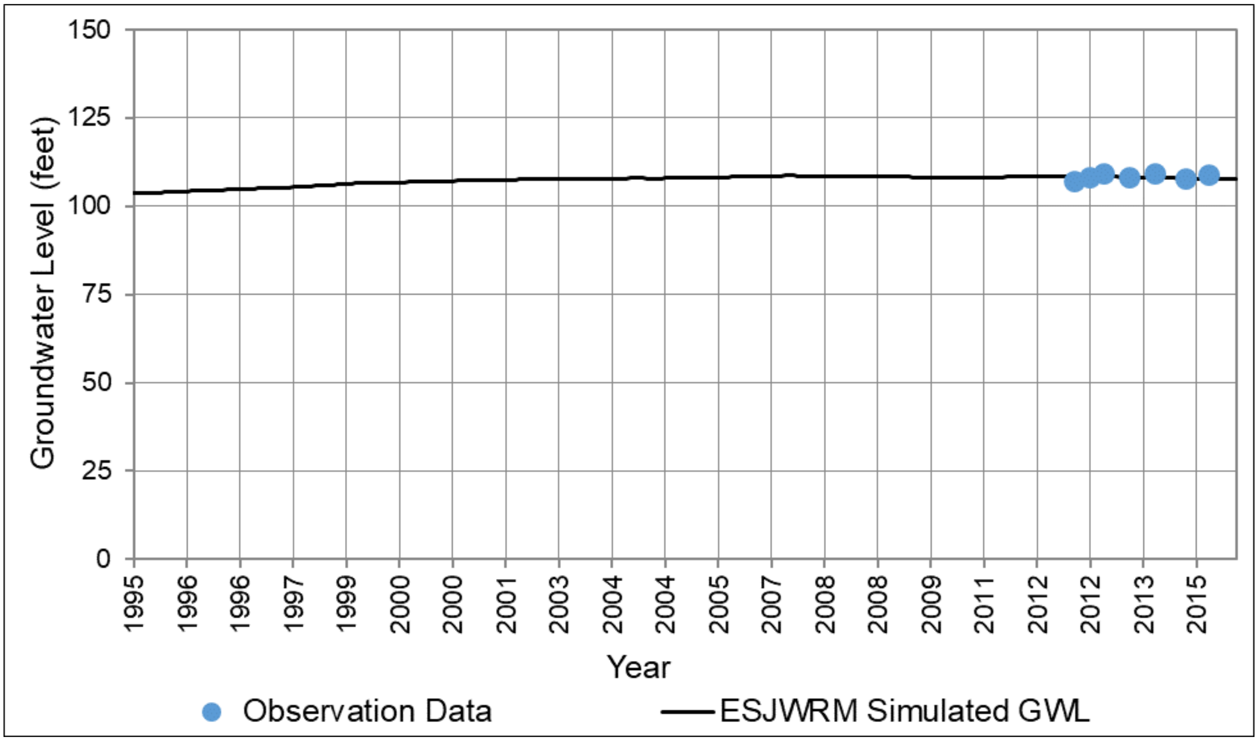


Figure 52f: ESJWRM Groundwater Level Hydrograph – Hydrograph #6

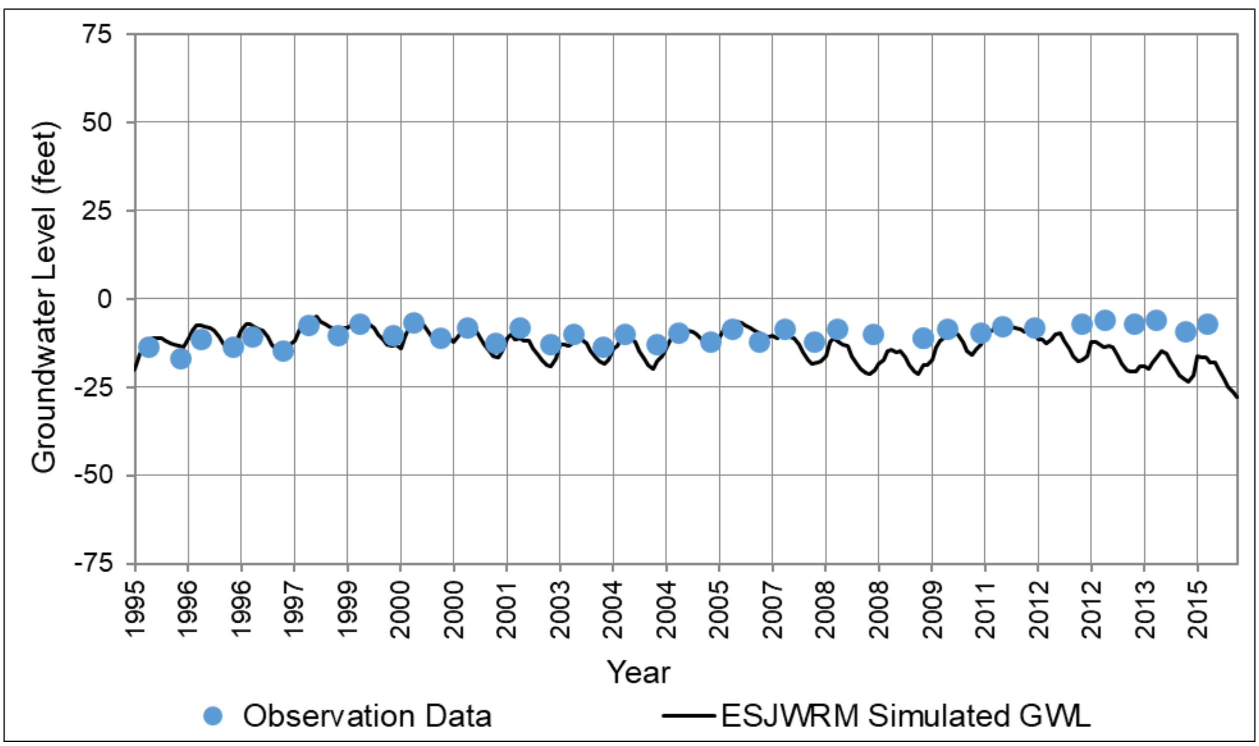


Figure 52g: ESJWRM Groundwater Level Hydrograph – Hydrograph #7

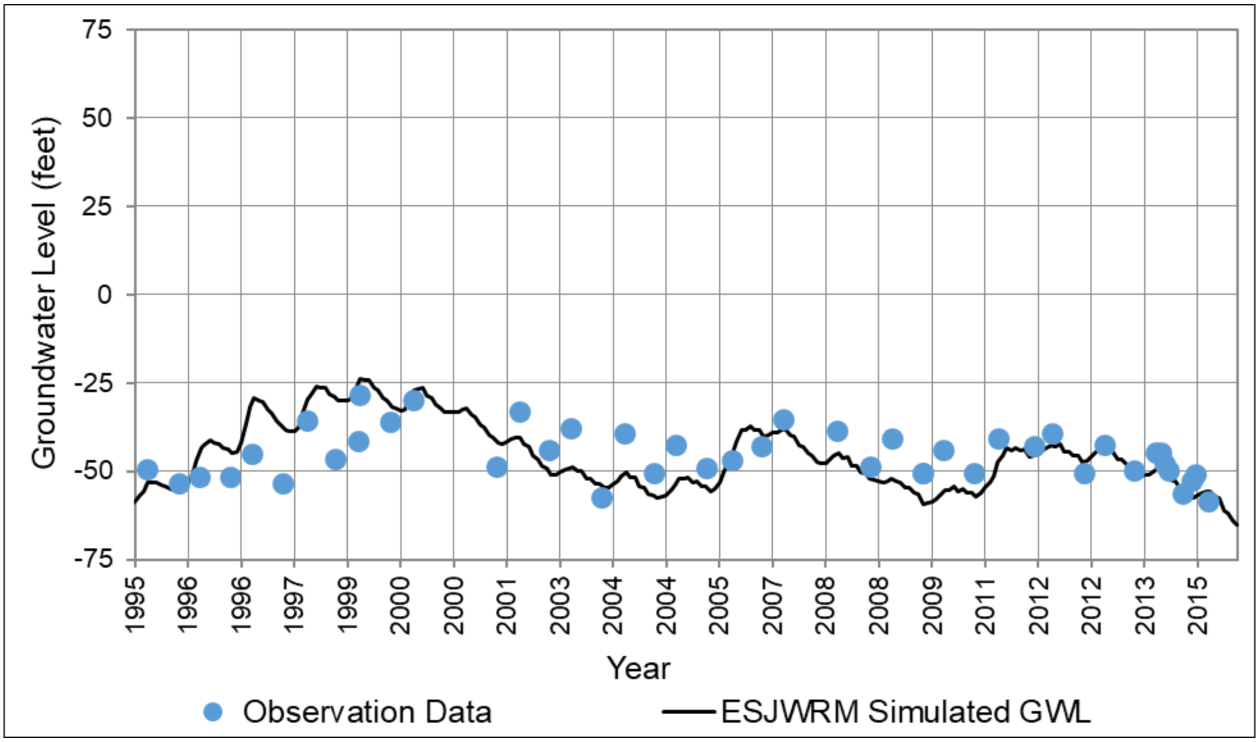


Figure 52h: ESJWRM Groundwater Level Hydrograph – Hydrograph #8

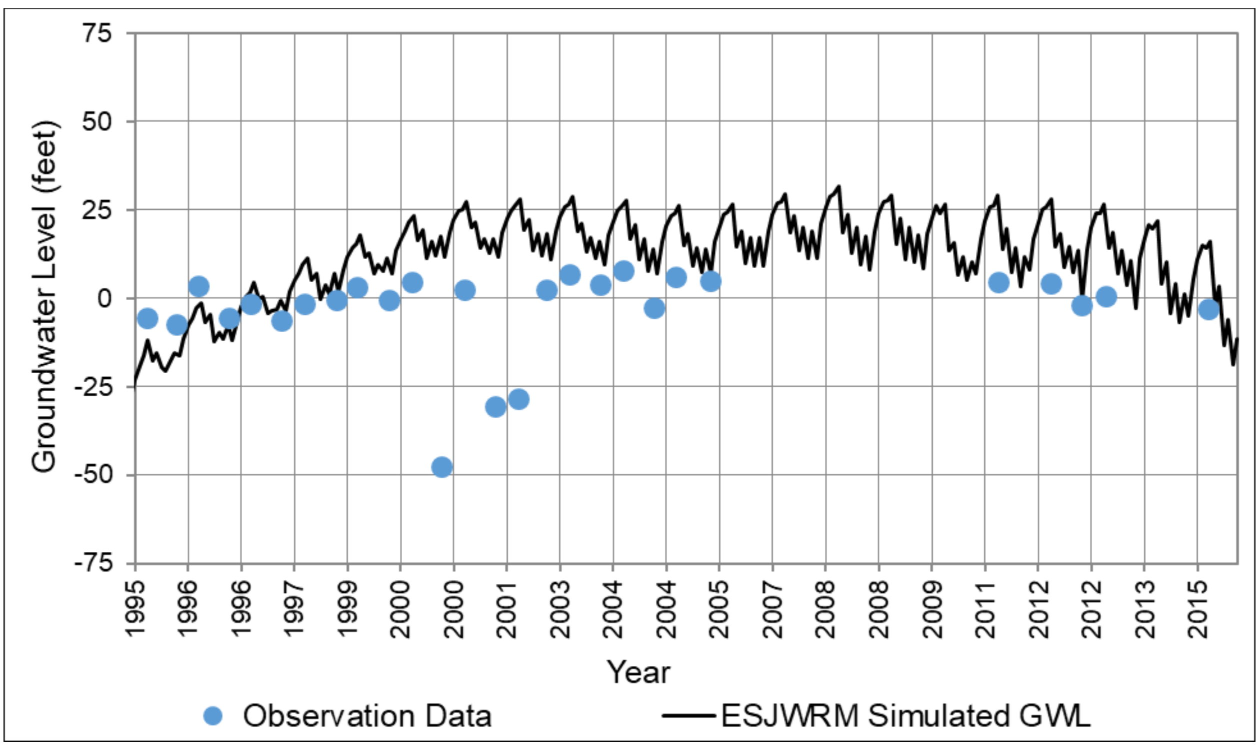


Figure 52i: ESJWRM Groundwater Level Hydrograph – Hydrograph #9

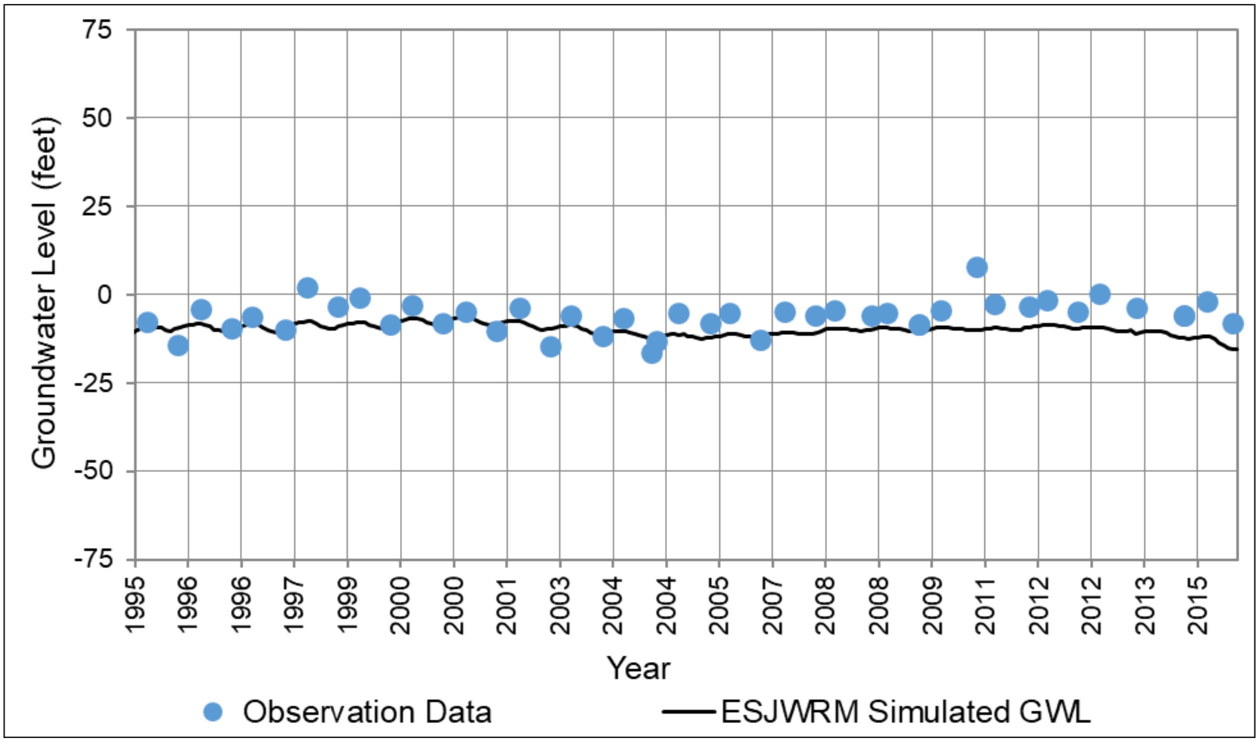


Figure 52j: ESJWRM Groundwater Level Hydrograph – Hydrograph #10

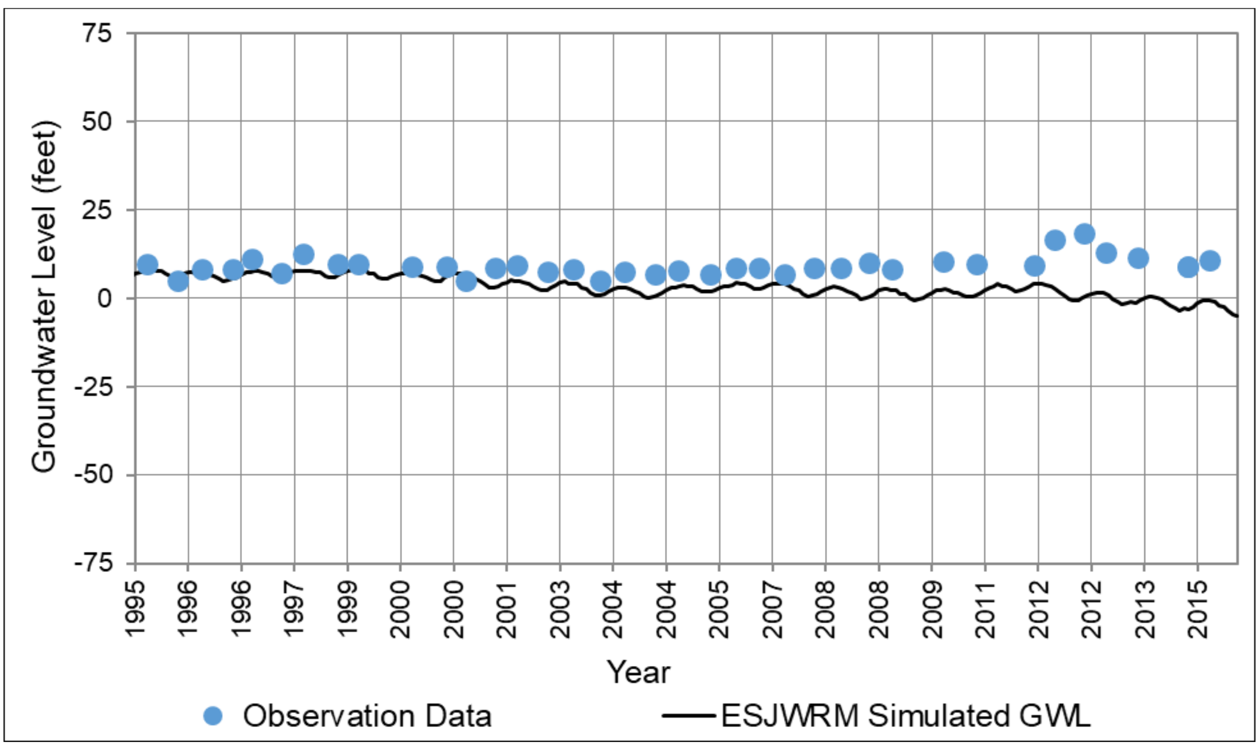


Figure 52k: ESJWRM Groundwater Level Hydrograph – Hydrograph #11

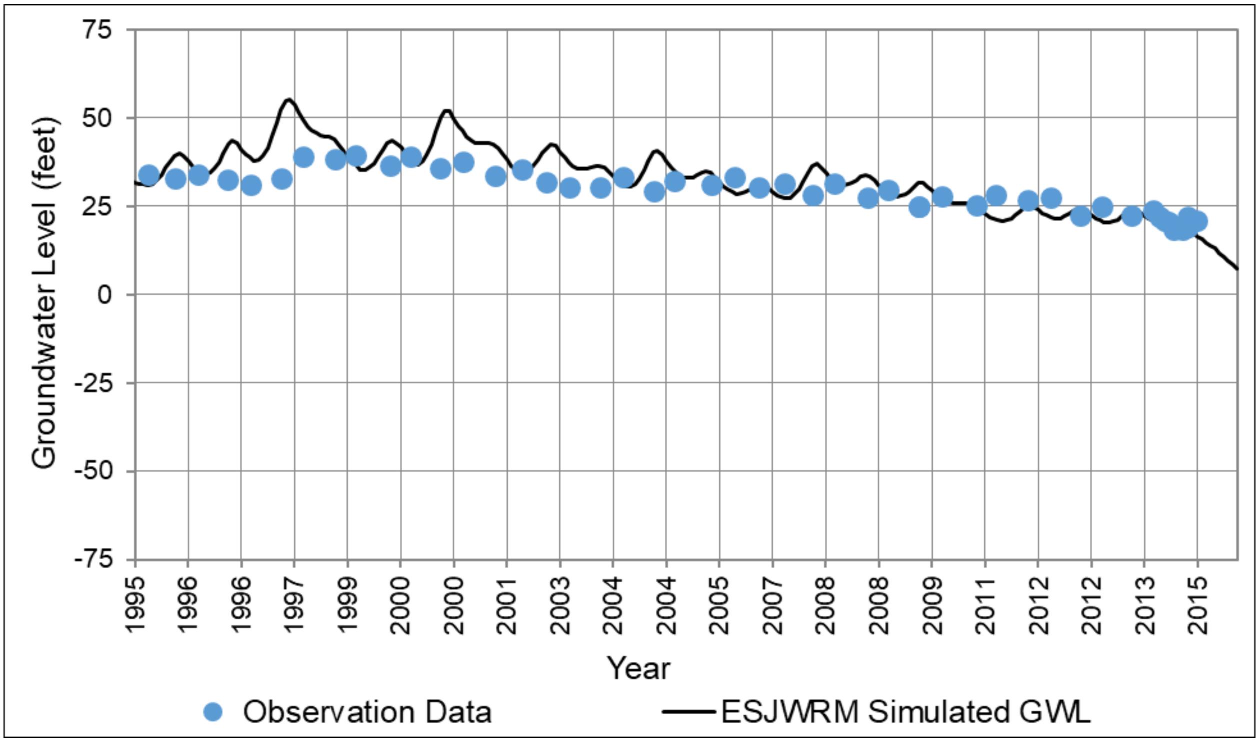


Figure 52l: ESJWRM Groundwater Level Hydrograph – Hydrograph #12

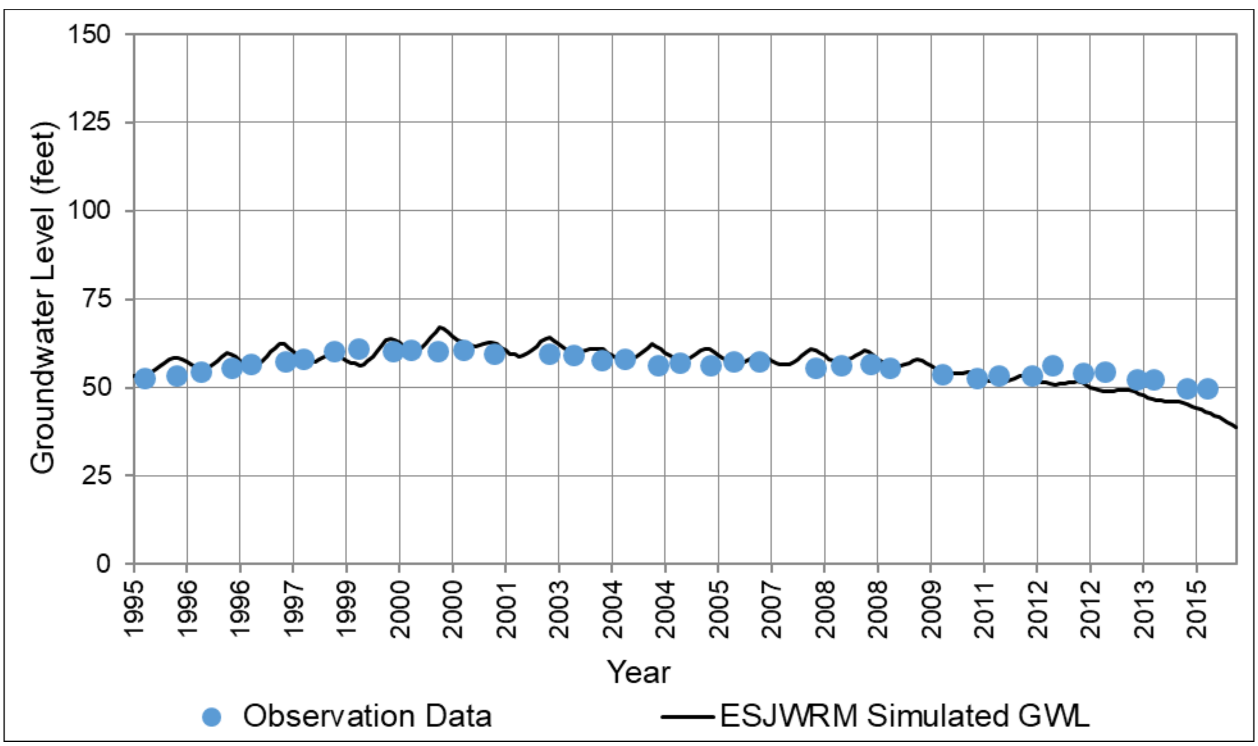


Figure 52m: ESJWRM Groundwater Level Hydrograph – Hydrograph #13

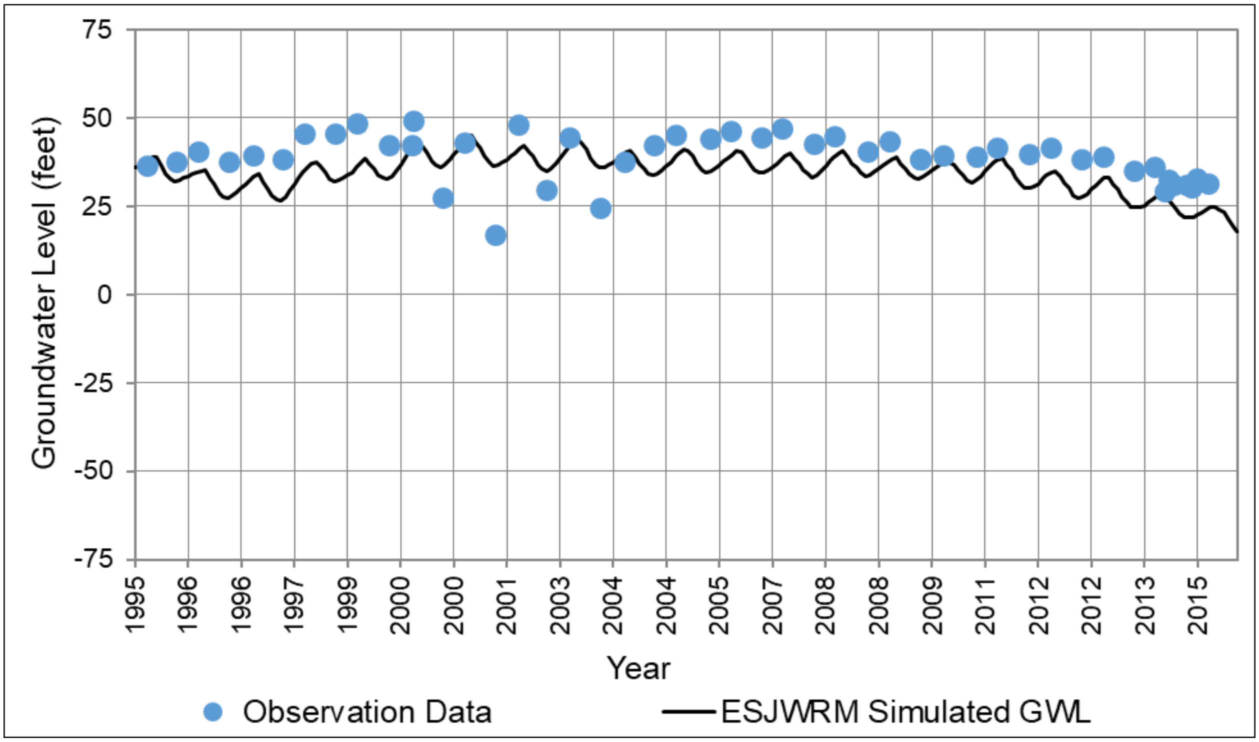


Figure 52n: ESJWRM Groundwater Level Hydrograph – Hydrograph #14

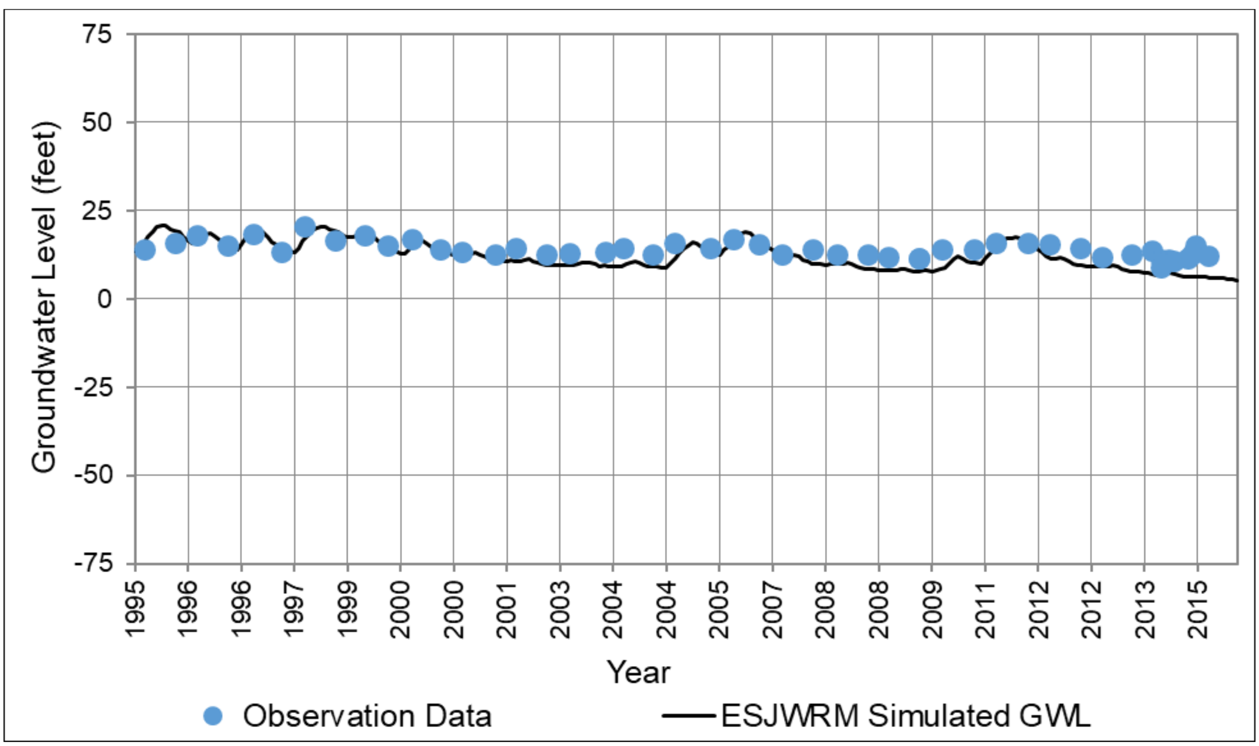


Figure 52o: ESJWRM Groundwater Level Hydrograph – Hydrograph #15

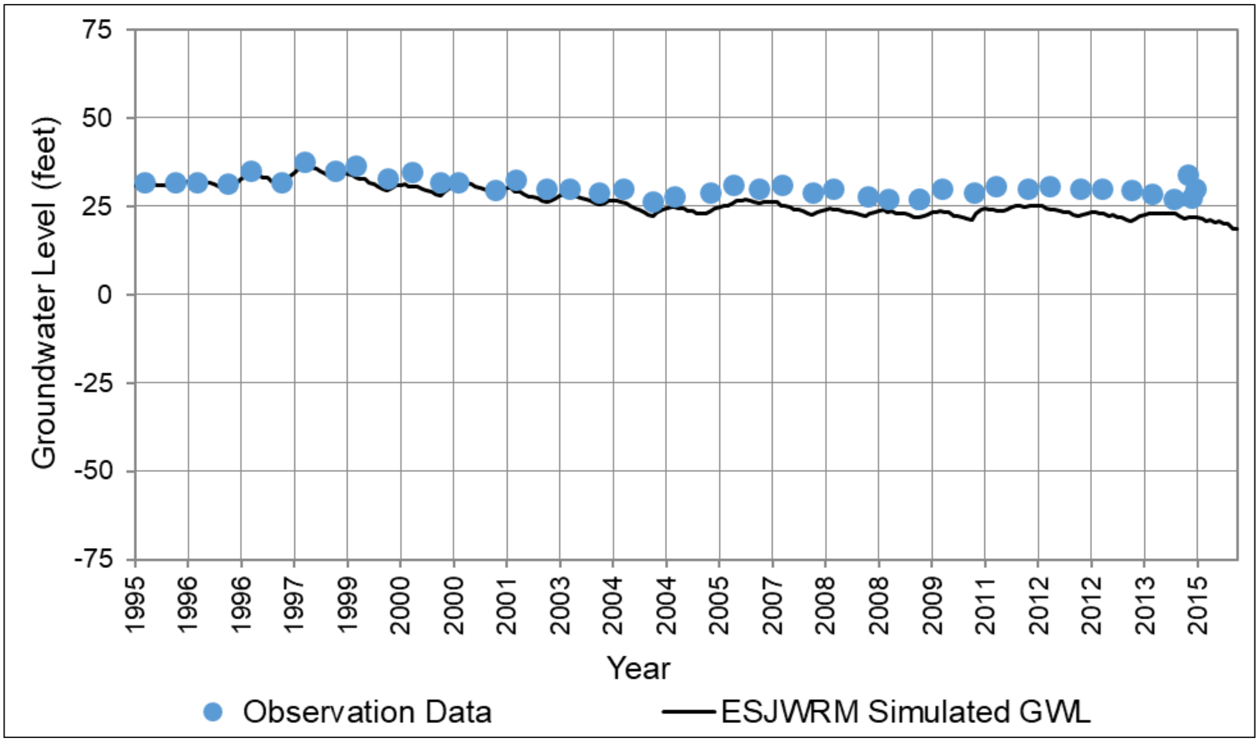


Figure 52p: ESJWRM Groundwater Level Hydrograph – Hydrograph #16

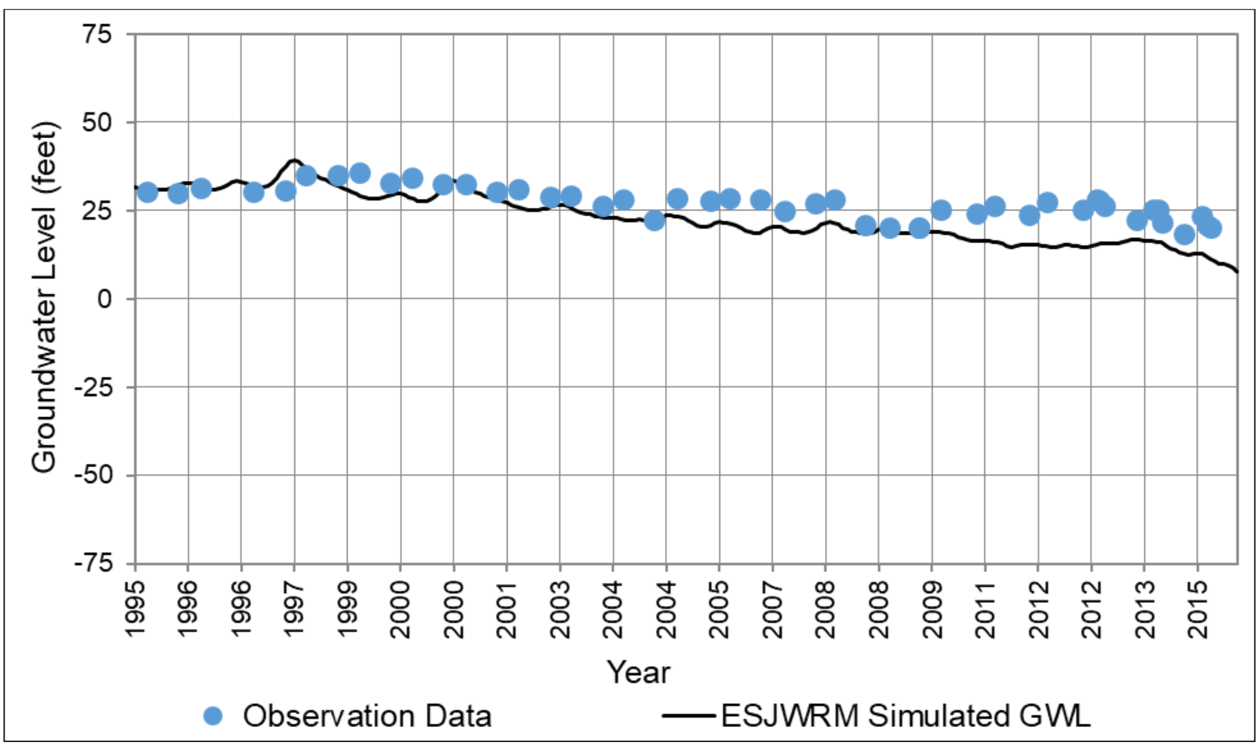


Figure 52q: ESJWRM Groundwater Level Hydrograph – Hydrograph #17

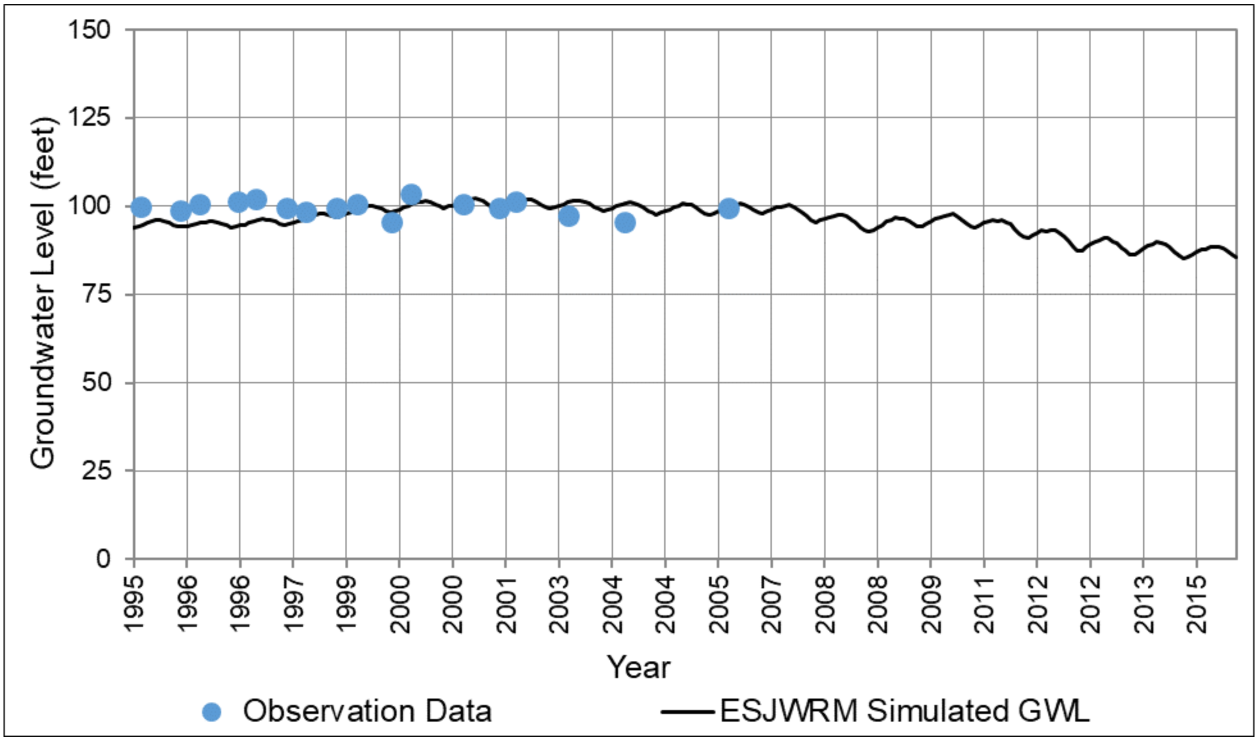


Figure 52r: ESJWRM Groundwater Level Hydrograph – Hydrograph #18

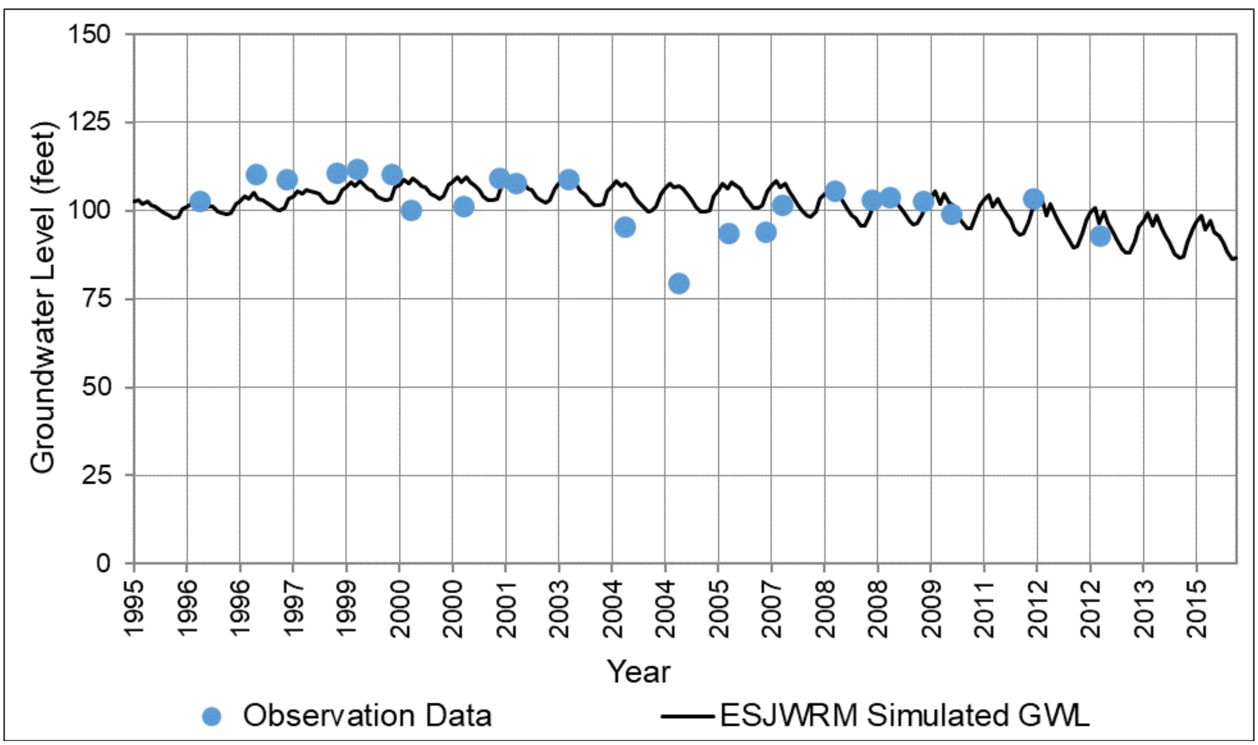


Figure 53: ESJWRM ESJ Subbasin Groundwater Level Histogram

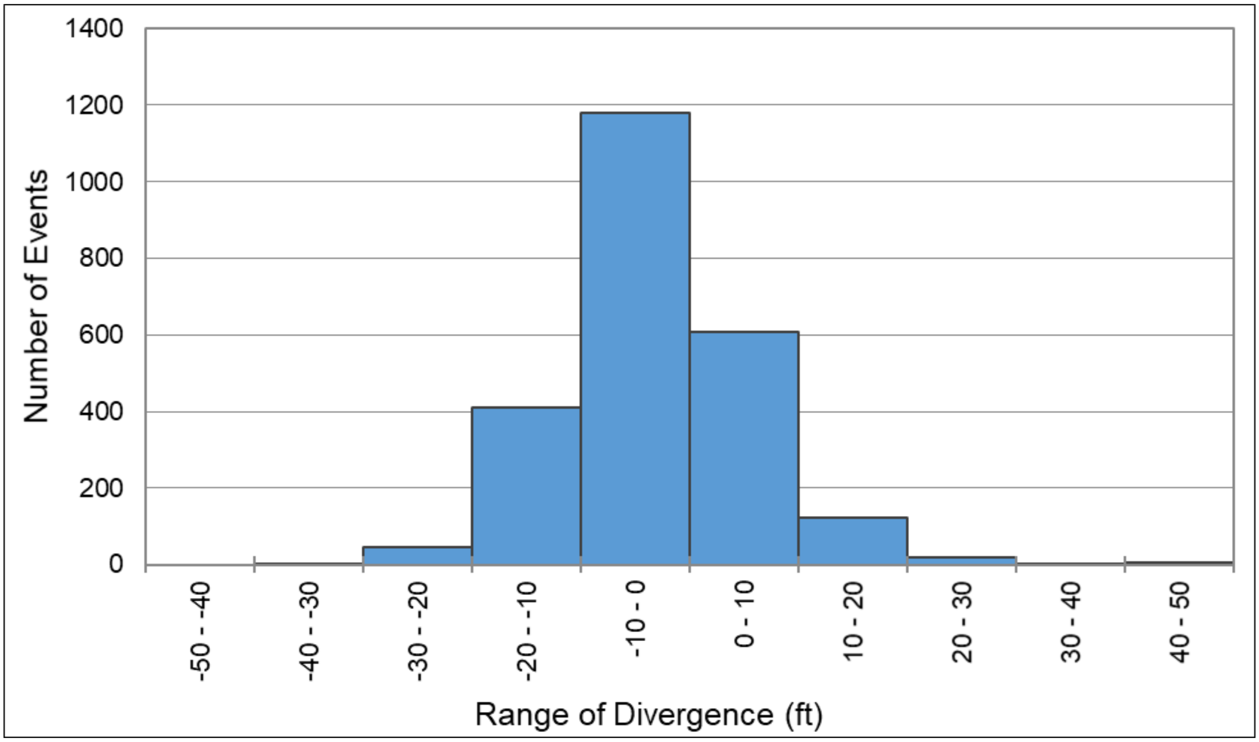


Figure 54: ESJWRM ESJ Subbasin Groundwater Level Scatter Plot

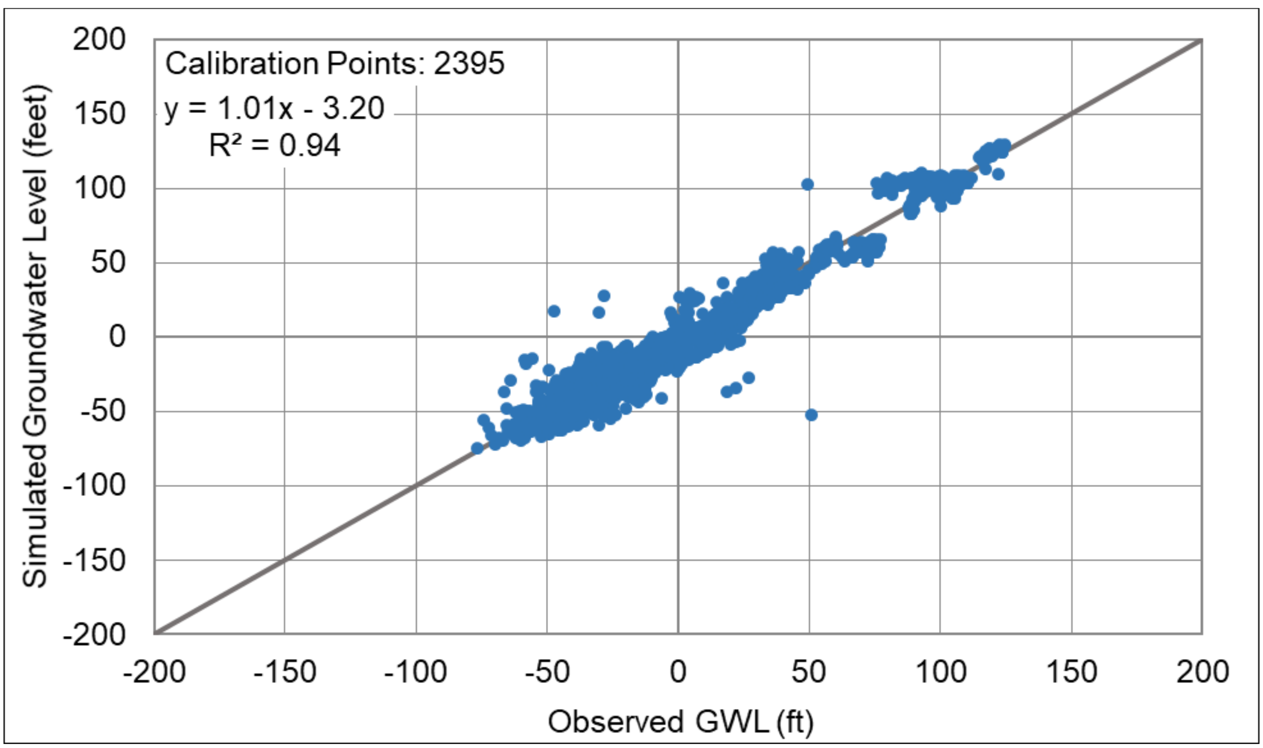


Figure 55: ESJWRM Parametric Grid

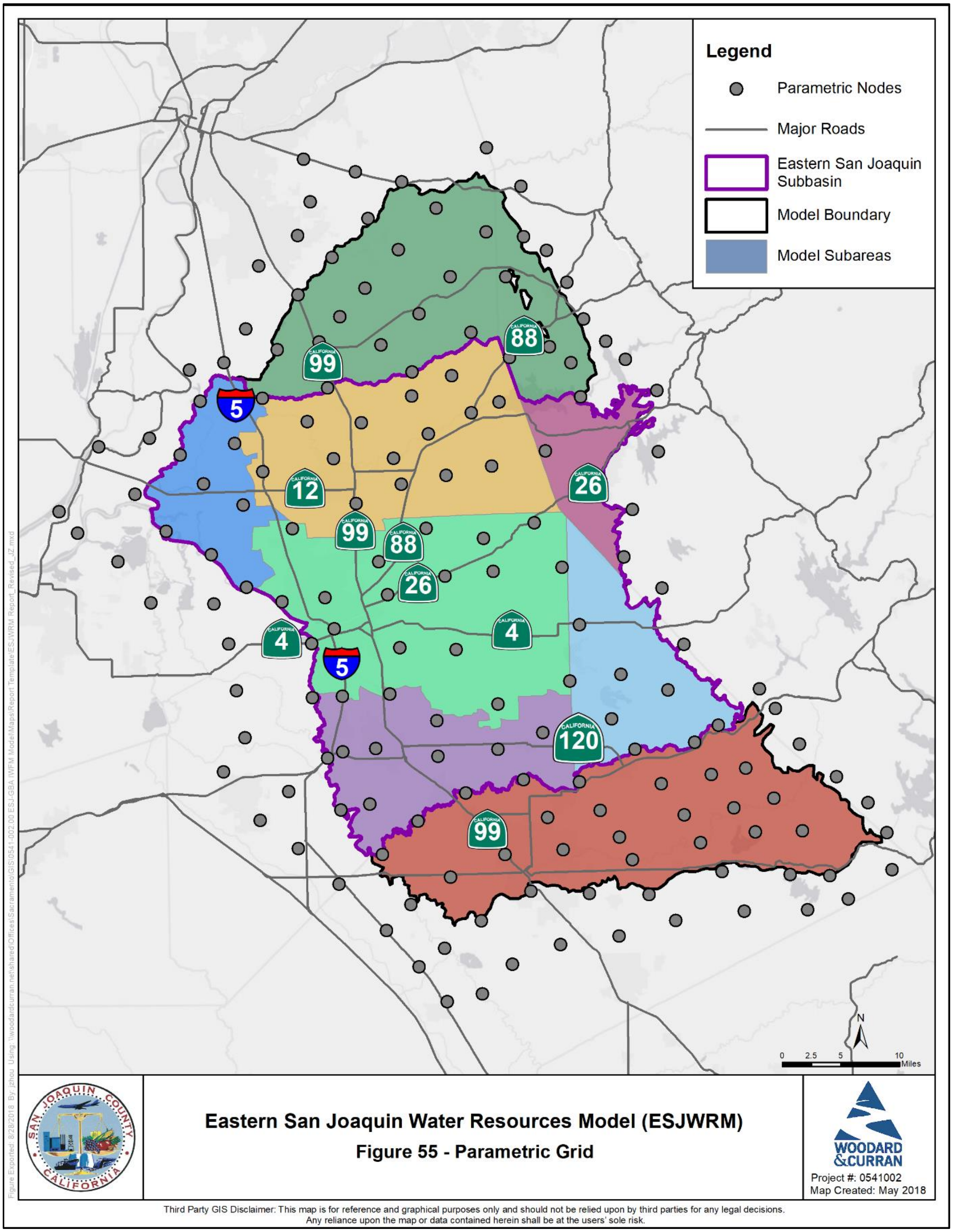


Figure 56: ESJWRM Layer 1 Horizontal Hydraulic Conductivity

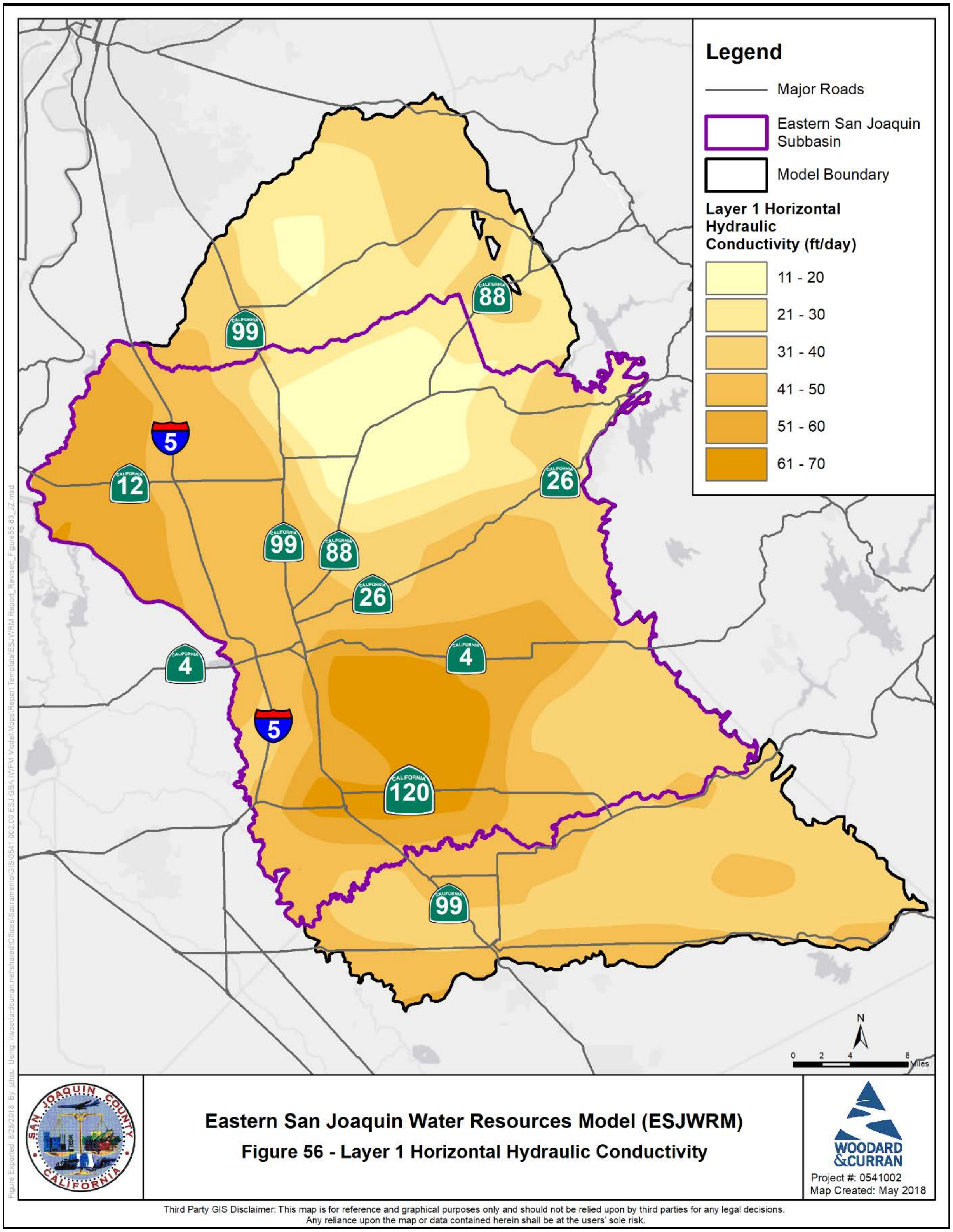


Figure 57: ESJWRM Layer 2 Horizontal Hydraulic Conductivity

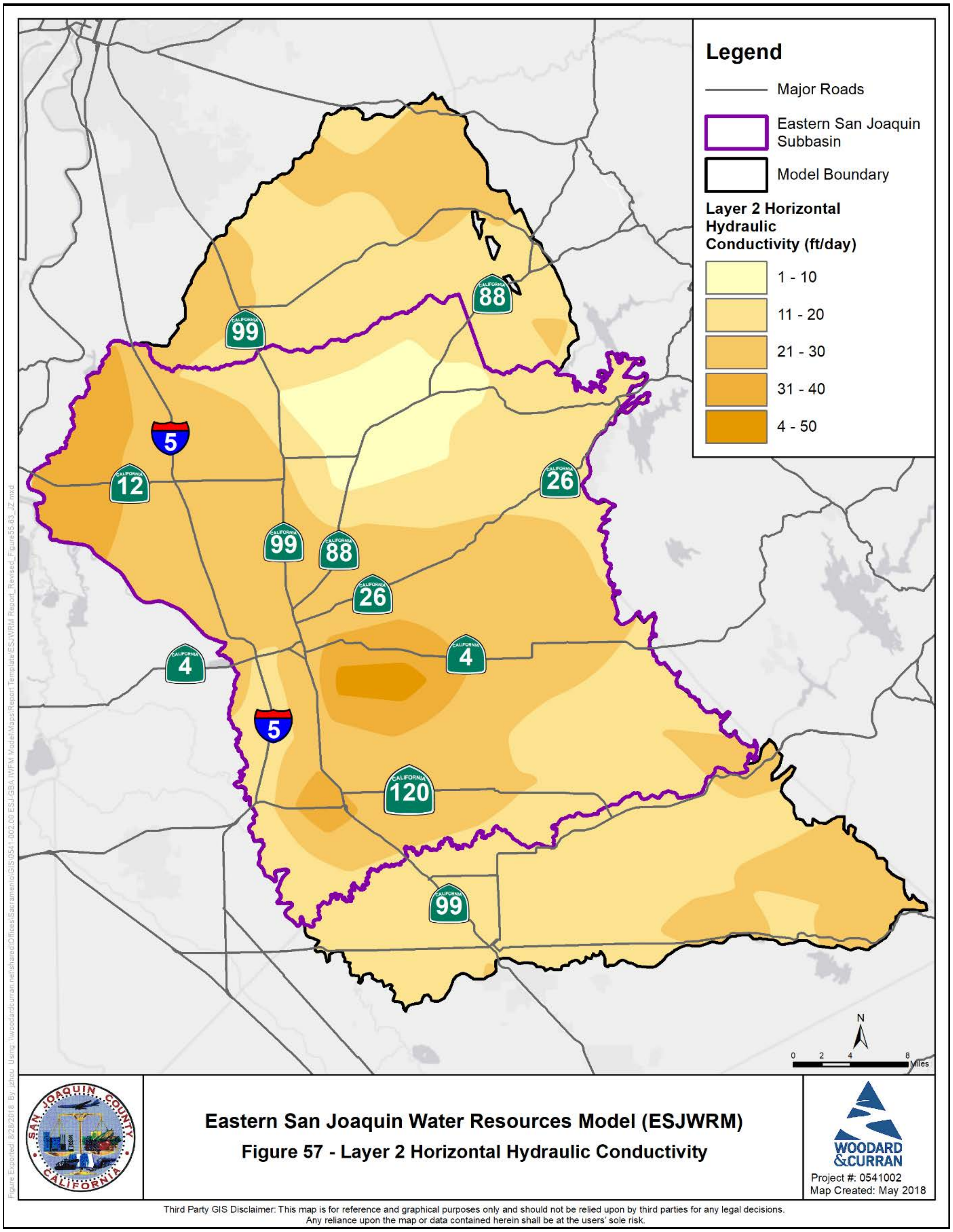


Figure 58: ESJWRM Layer 3 Horizontal Hydraulic Conductivity

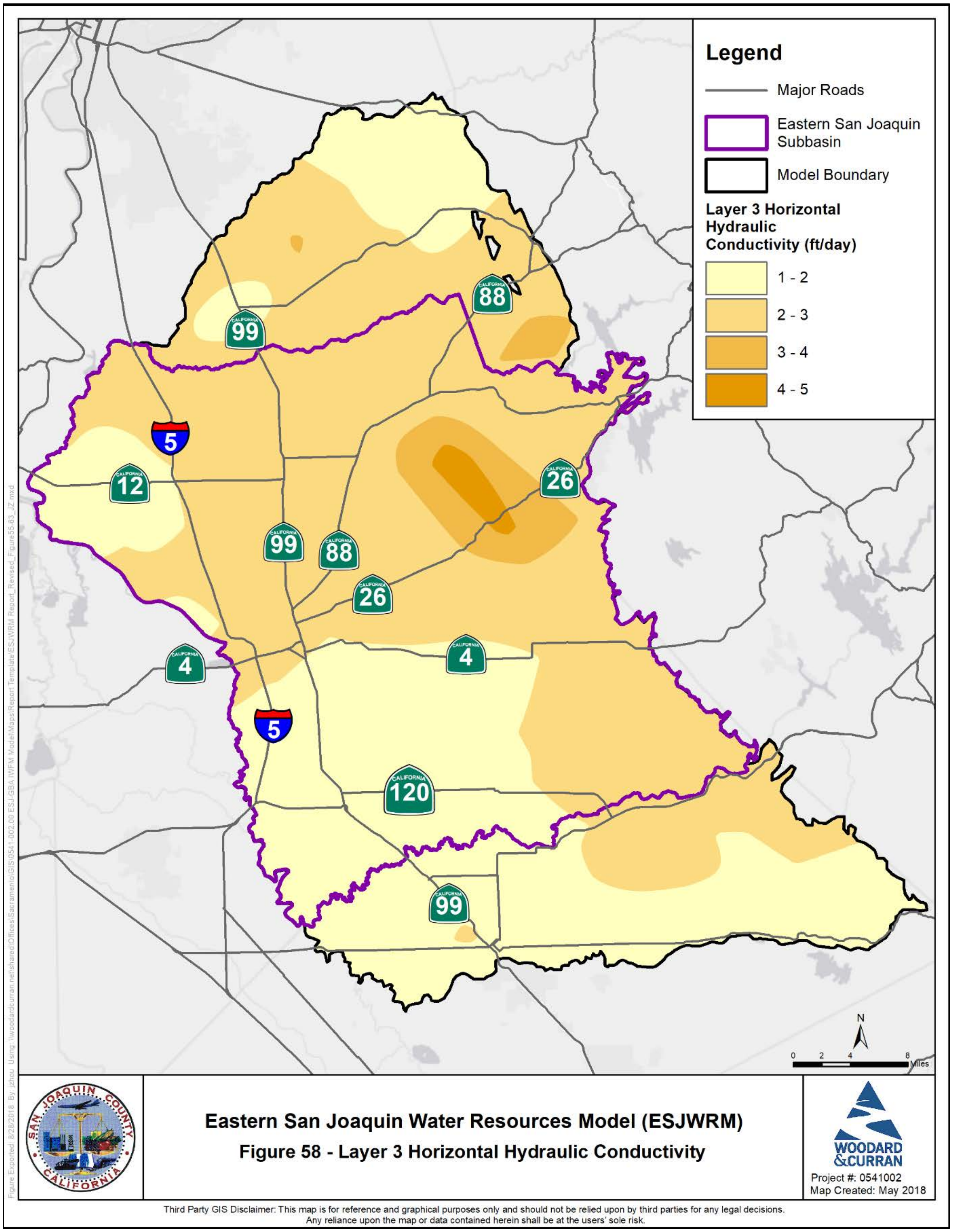


Figure 59: ESJWRM Layer 1 Specific Storage

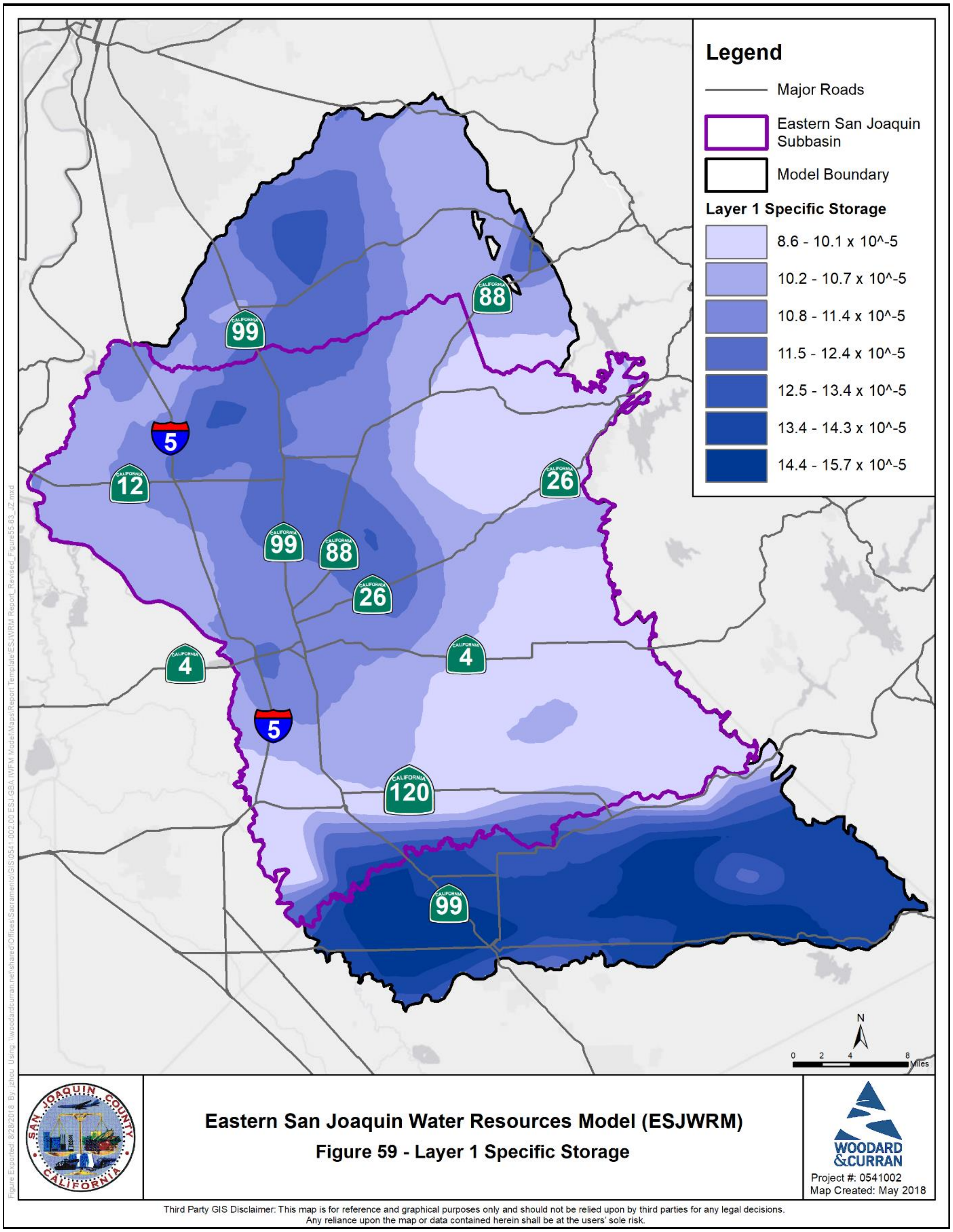
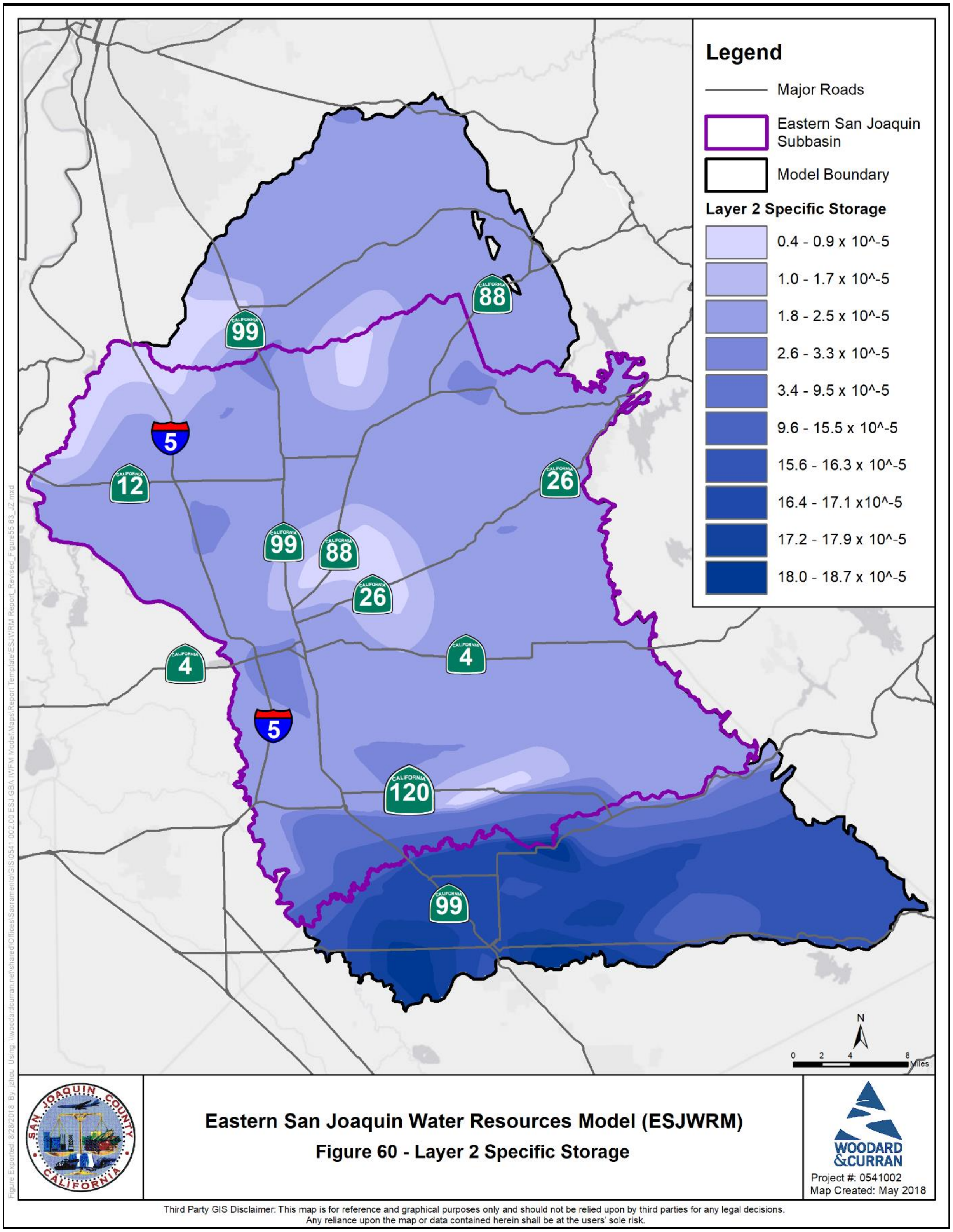


Figure 60: ESJWRM Layer 2 Specific Storage



Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk.

Figure 61: ESJWRM Layer 3 Specific Storage

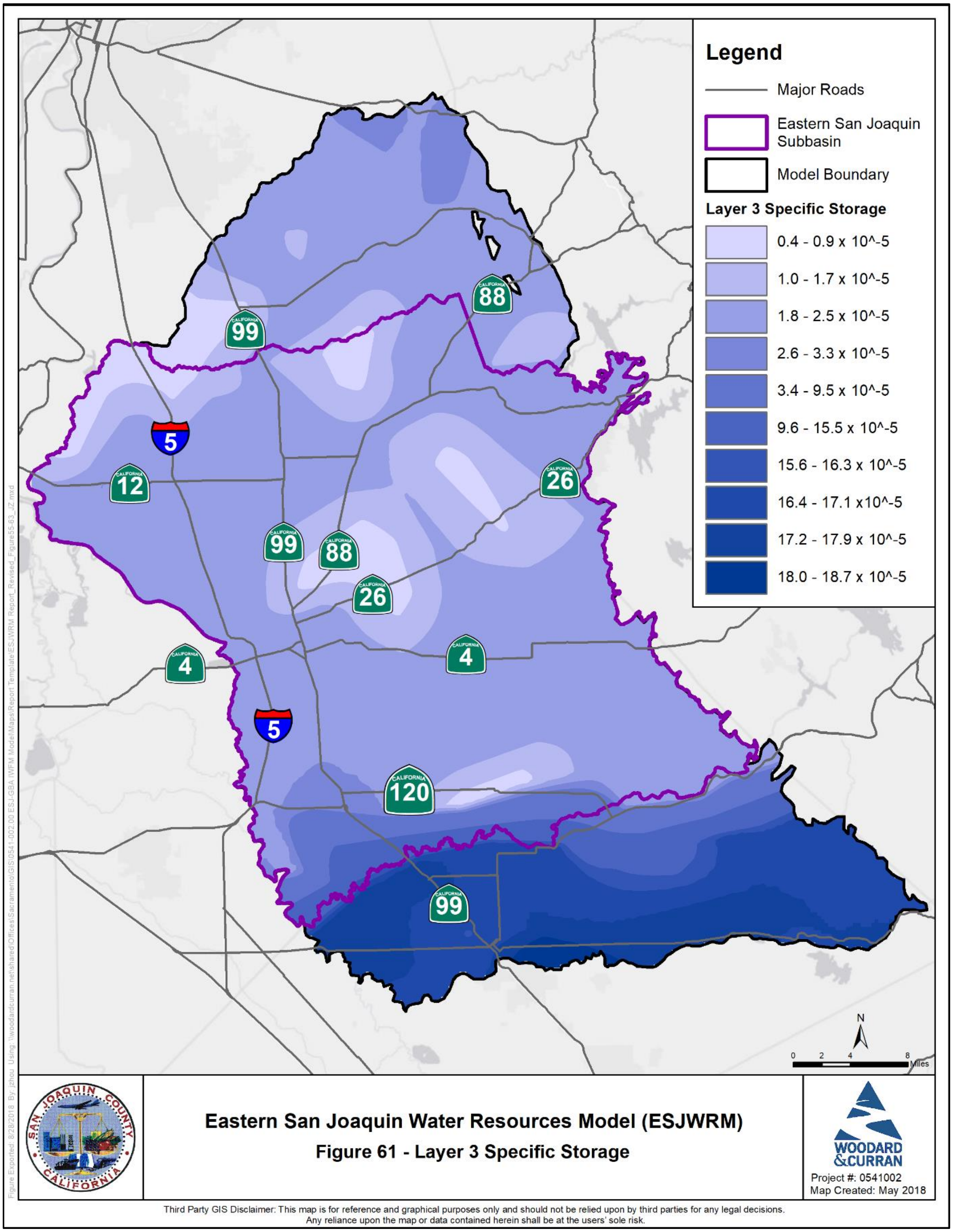


Figure 62: ESJWRM Layer 1 Specific Yield

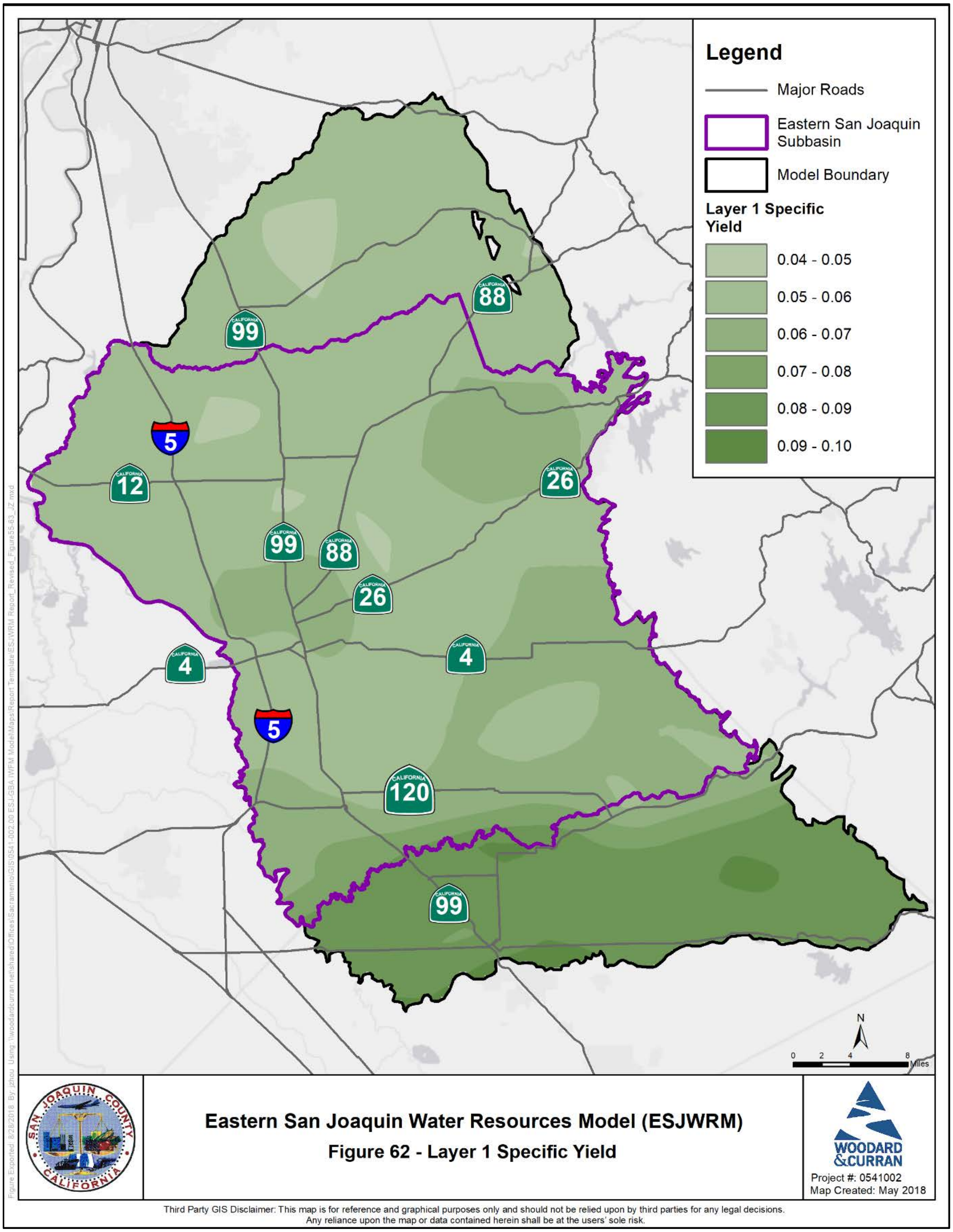


Figure 63: ESJWRM Layer 2 Specific Yield

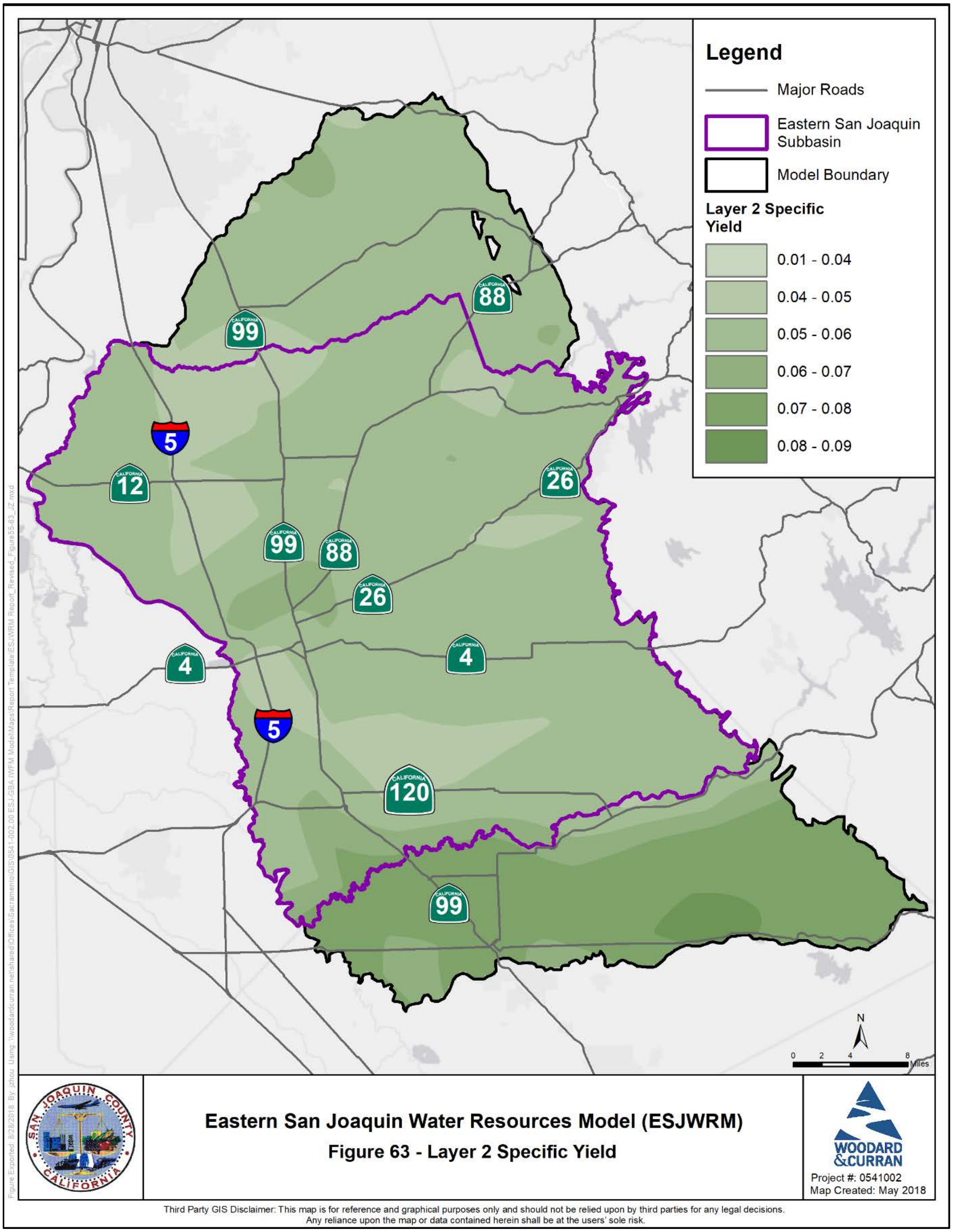


Figure 64: ESJWRM Layer 3 Specific Yield

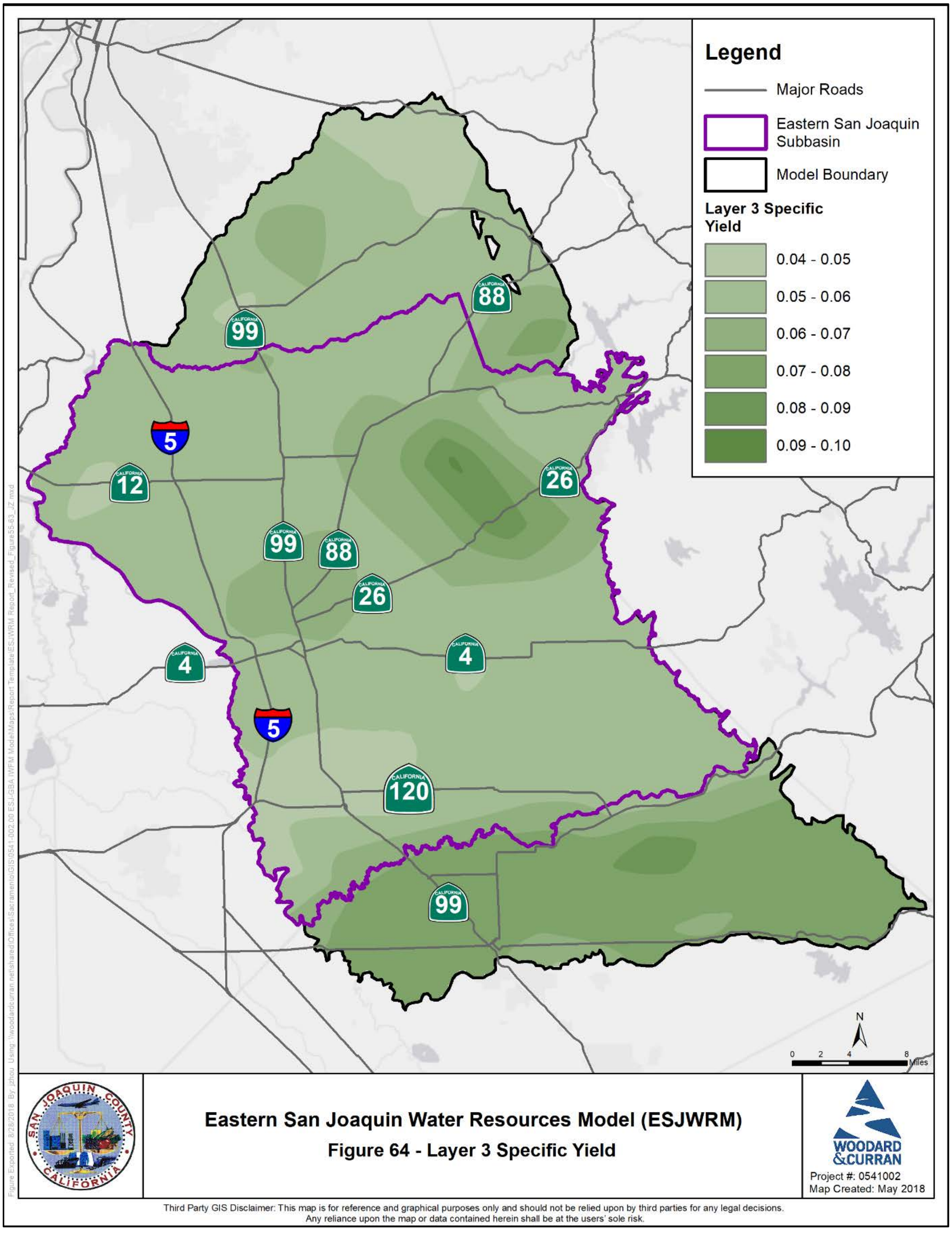


Figure 65: ESJWRM Sensitivity Analysis of Horizontal Hydraulic Conductivity – Difference in Average Groundwater Elevation (feet)

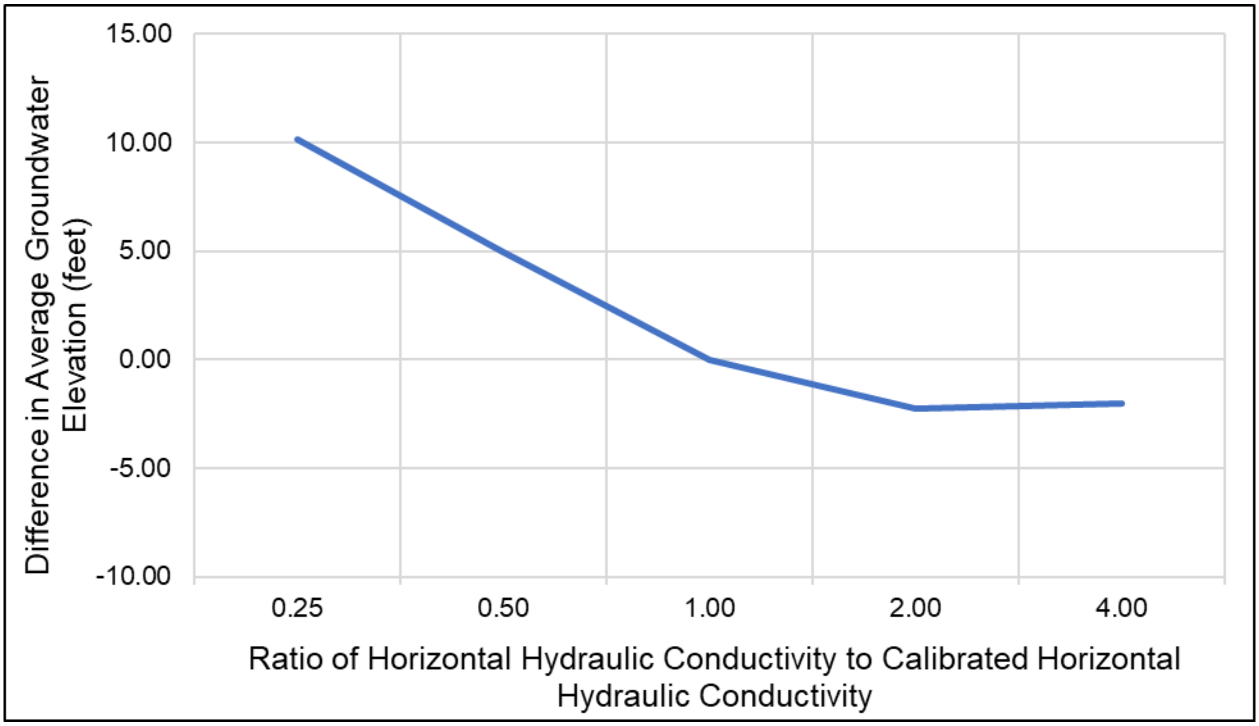


Figure 66: ESJWRM Sensitivity Analysis of Horizontal Hydraulic Conductivity – Relative Root Mean Square Error

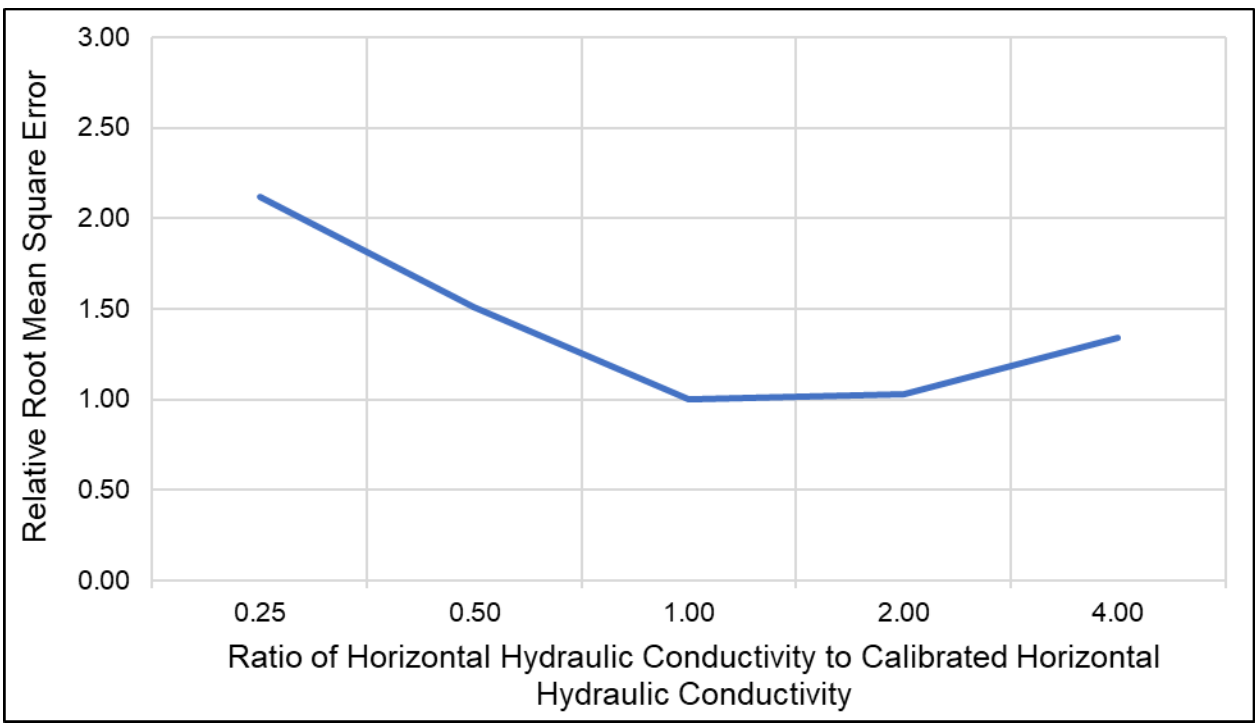


Figure 67: ESJWRM Sensitivity Analysis of Vertical Hydraulic Conductivity – Difference in Average Groundwater Elevation (feet)

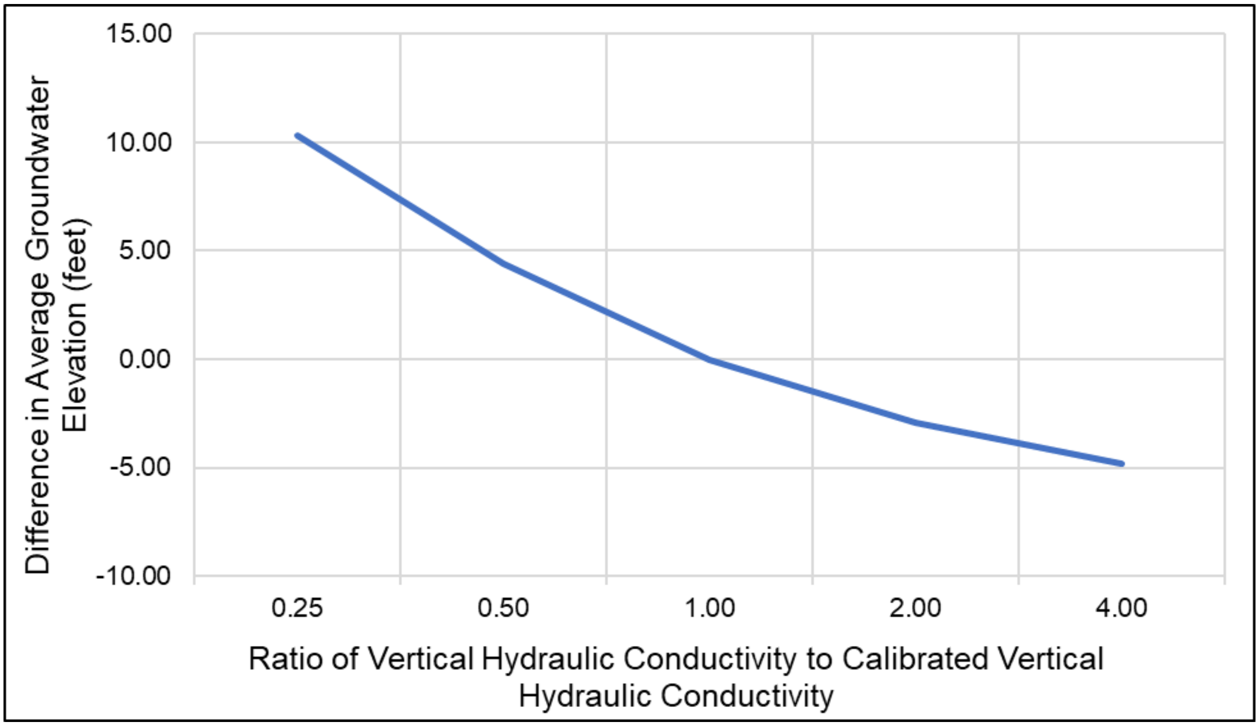


Figure 68: ESJWRM Sensitivity Analysis of Vertical Hydraulic Conductivity – Relative Root Mean Square Error

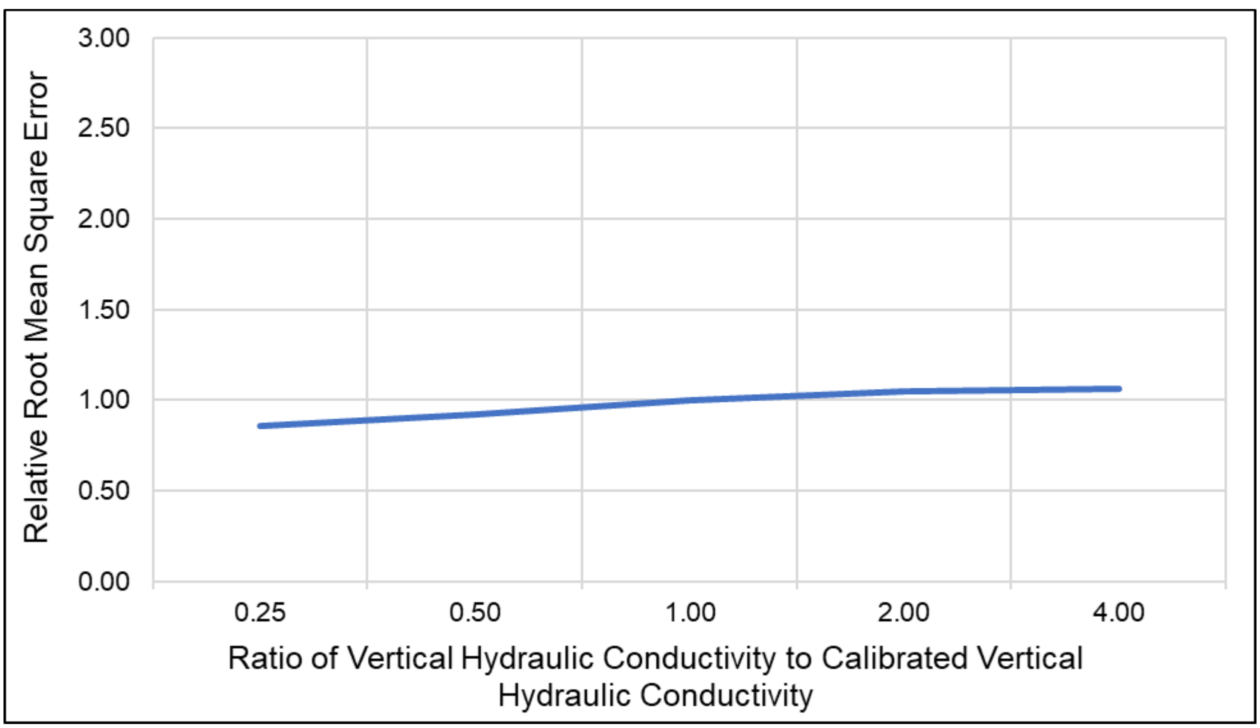


Figure 69: ESJWRM Sensitivity Analysis of Specific Storage – Difference in Average Groundwater Elevation (feet)

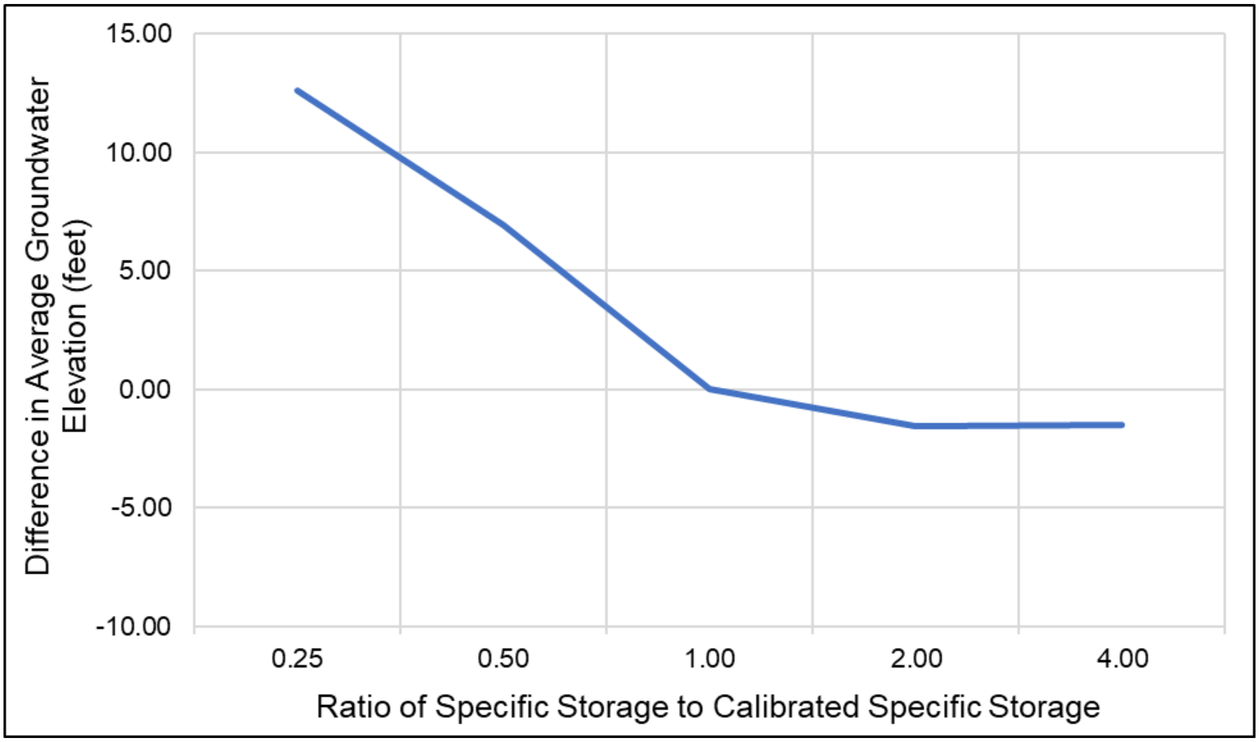


Figure 70: ESJWRM Sensitivity Analysis of Specific Storage – Relative Root Mean Square Error

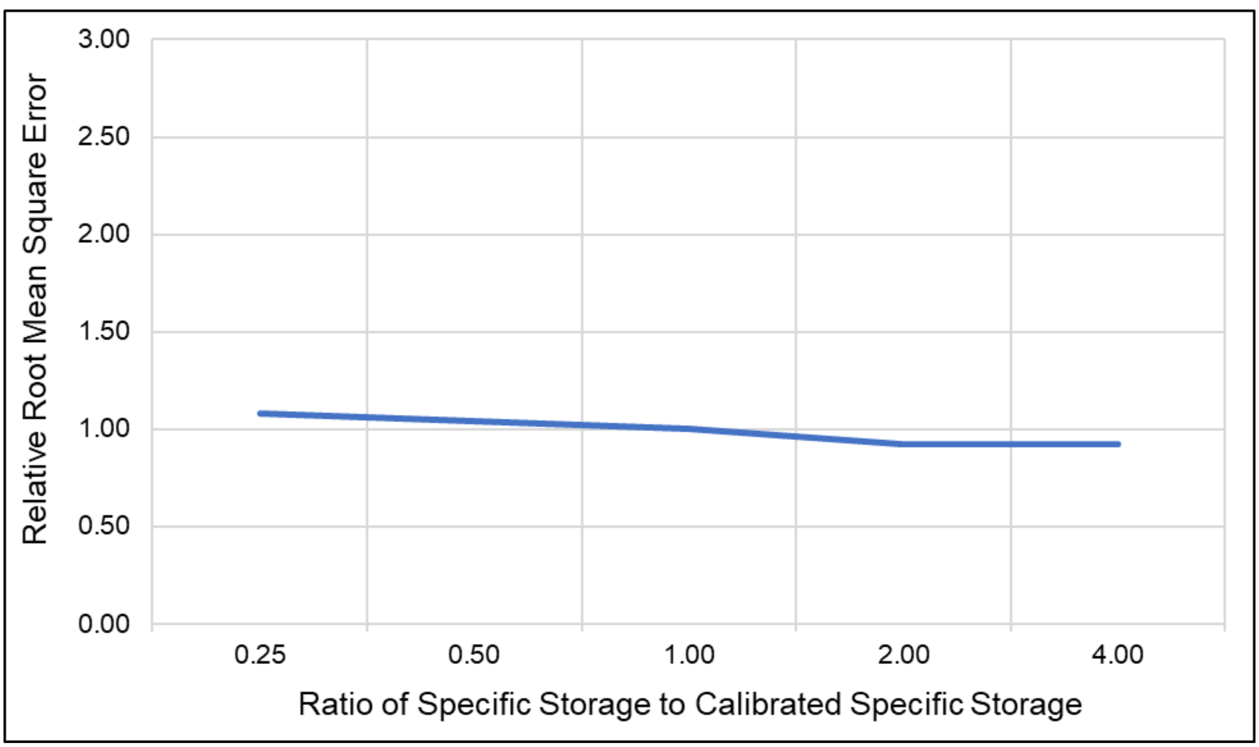


Figure 71: ESJWRM Sensitivity Analysis of Specific Yield – Difference in Average Groundwater Elevation (feet)

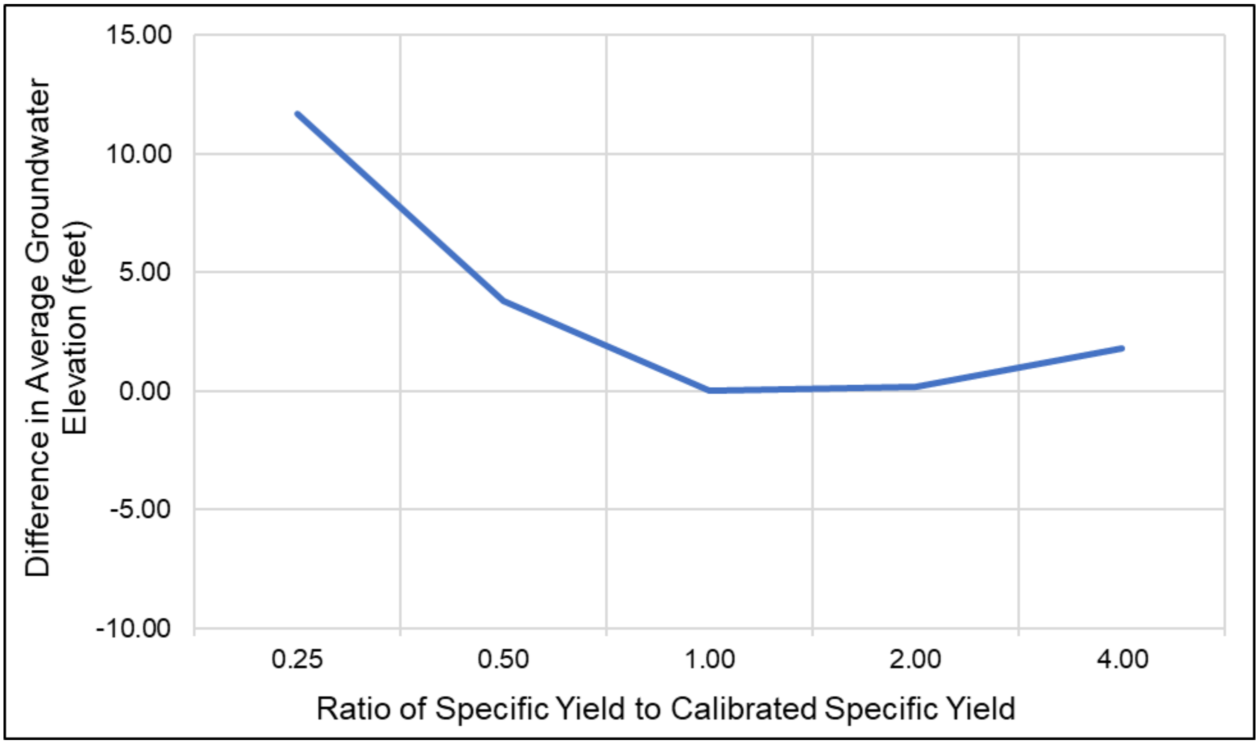


Figure 72: ESJWRM Sensitivity Analysis of Specific Yield – Relative Root Mean Square Error

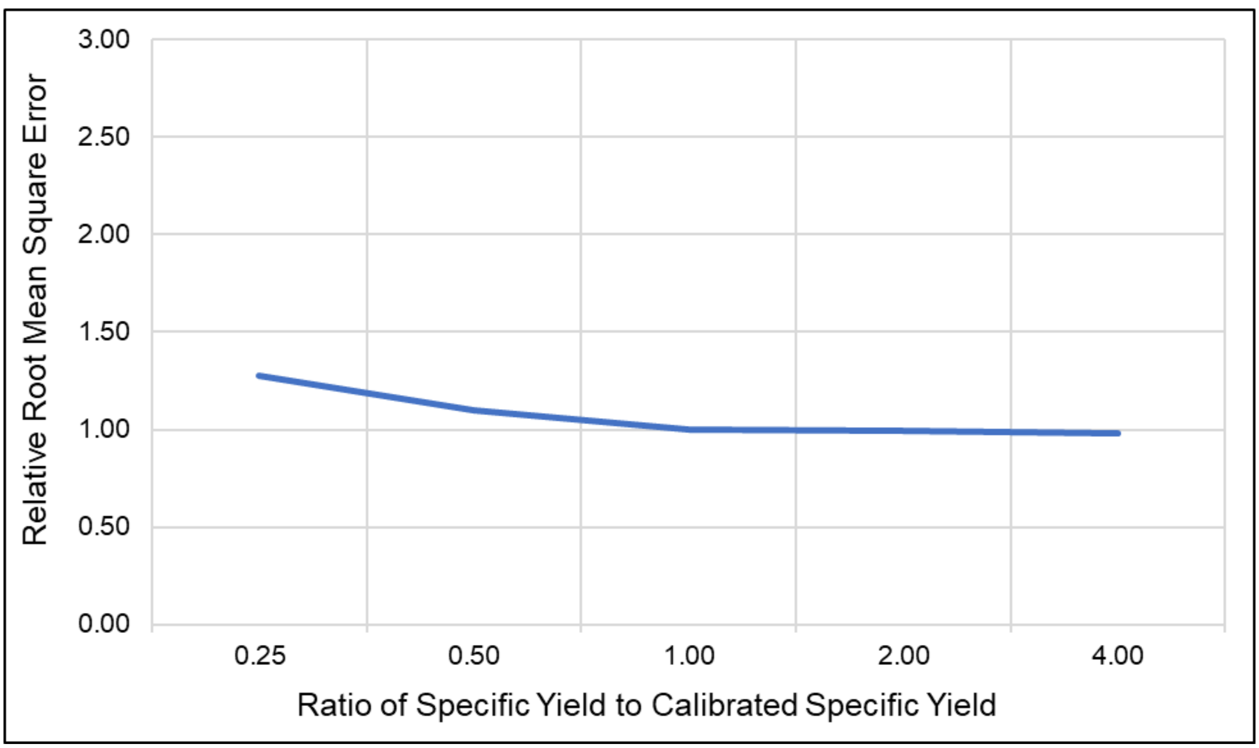


Figure 73: ESJWRM Sensitivity Analysis of Streambed Conductance – Difference in Average Groundwater Elevation (feet)

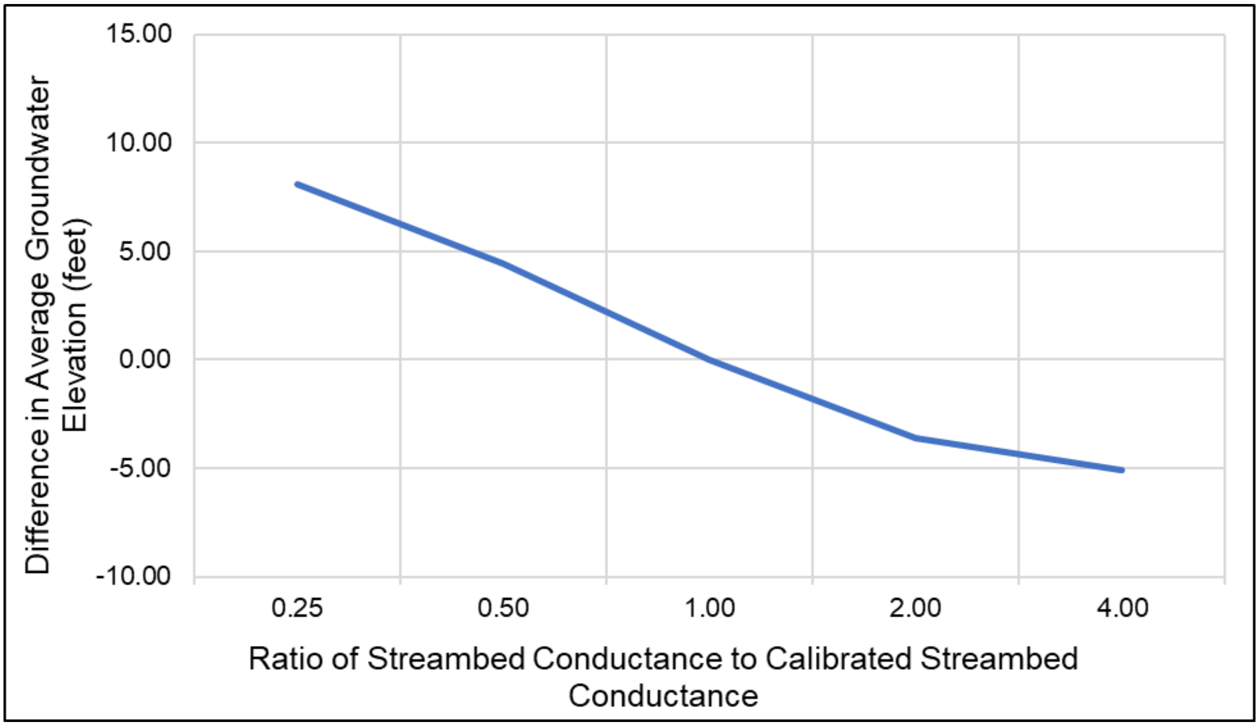
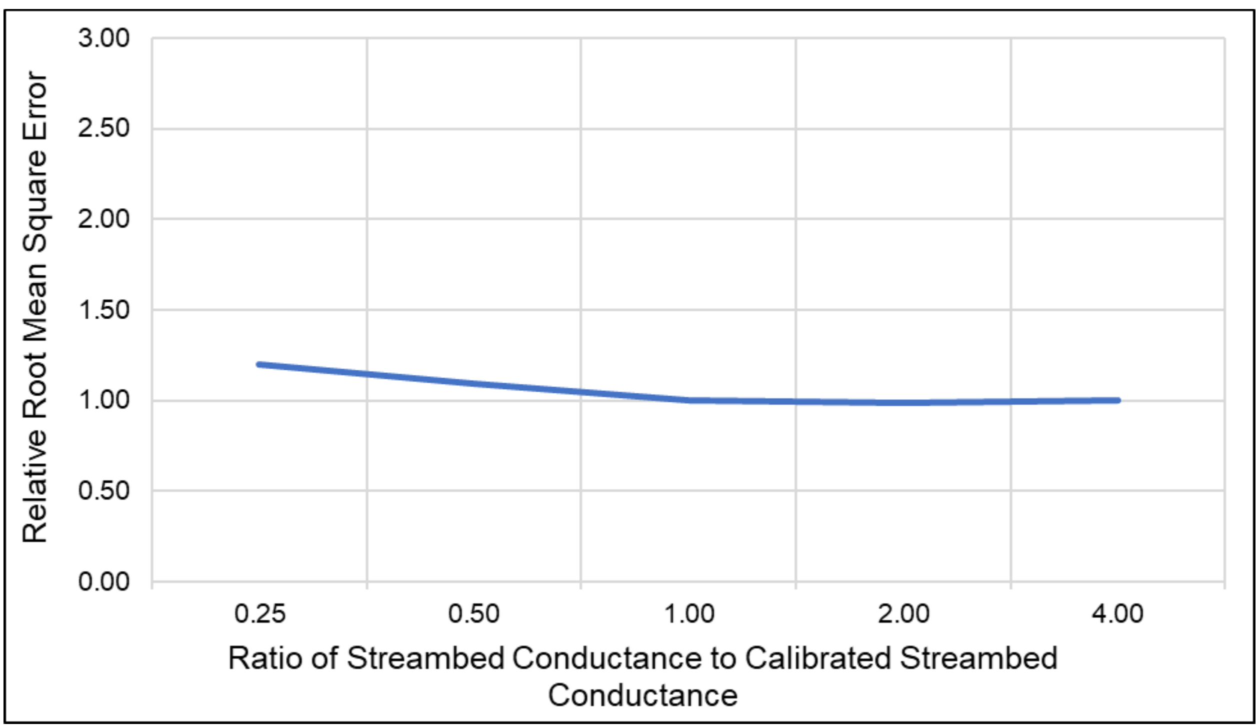


Figure 74: ESJWRM Sensitivity Analysis of Streambed Conductance – Relative Root Mean Square Error



ATTACHMENT 2

woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS

WOODARD &CURRAN

EASTERN SAN JOAQUIN WATER RESOURCES MODEL (ESJWRM)

Final Report Appendices

August 2018

APPENDIX A: PRESENTATIONS TO TECHNICAL REVIEW COMMITTEE

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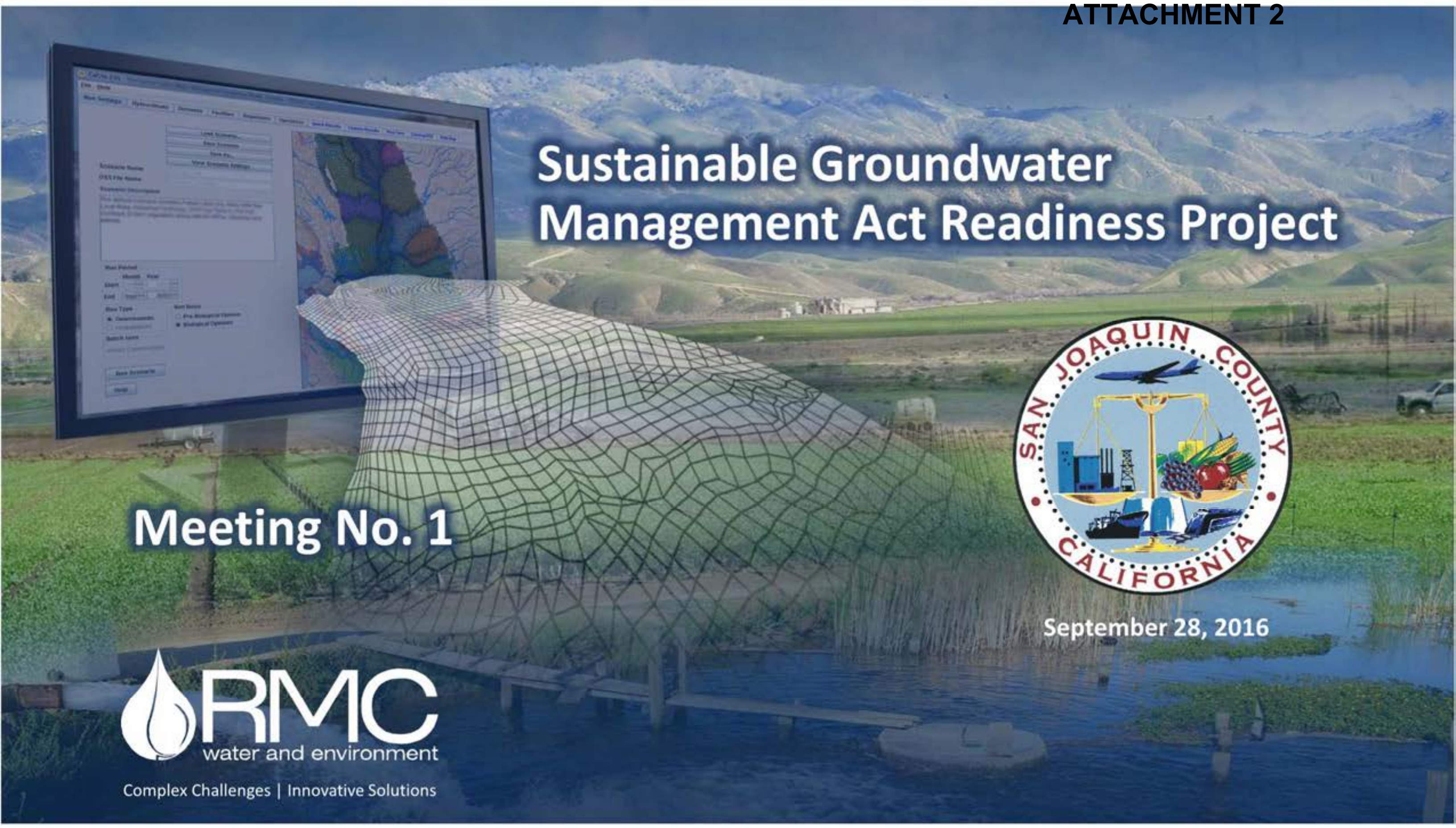

Project Kick-Off Meeting
September 28, 2016
Agenda

- **Introductions**
- **Project Logistics**
- **Schedule**
- **Work Plan Review**
- **Issues/Concerns**
- **Coordination with Other On-Going Activities**
- **Other**

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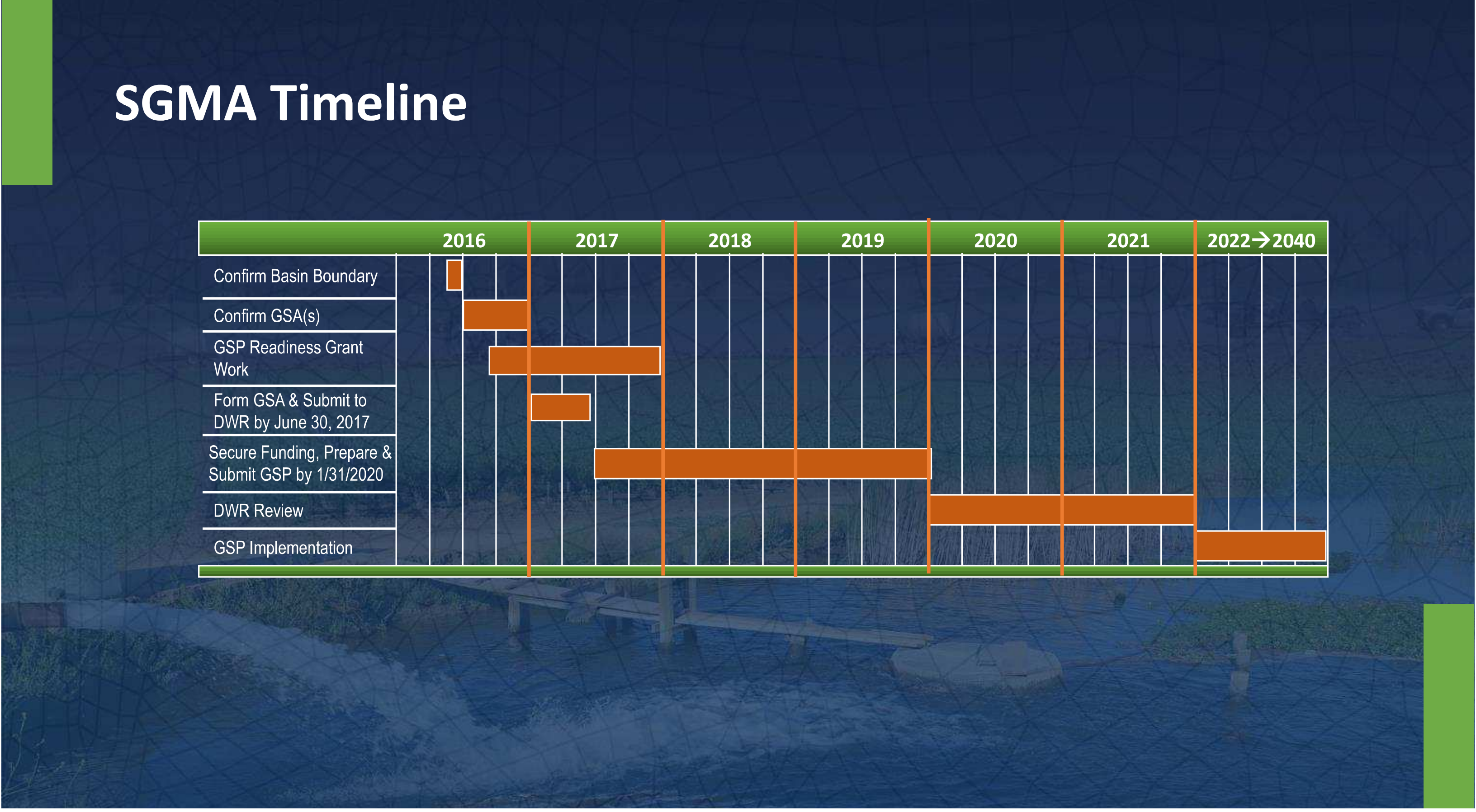

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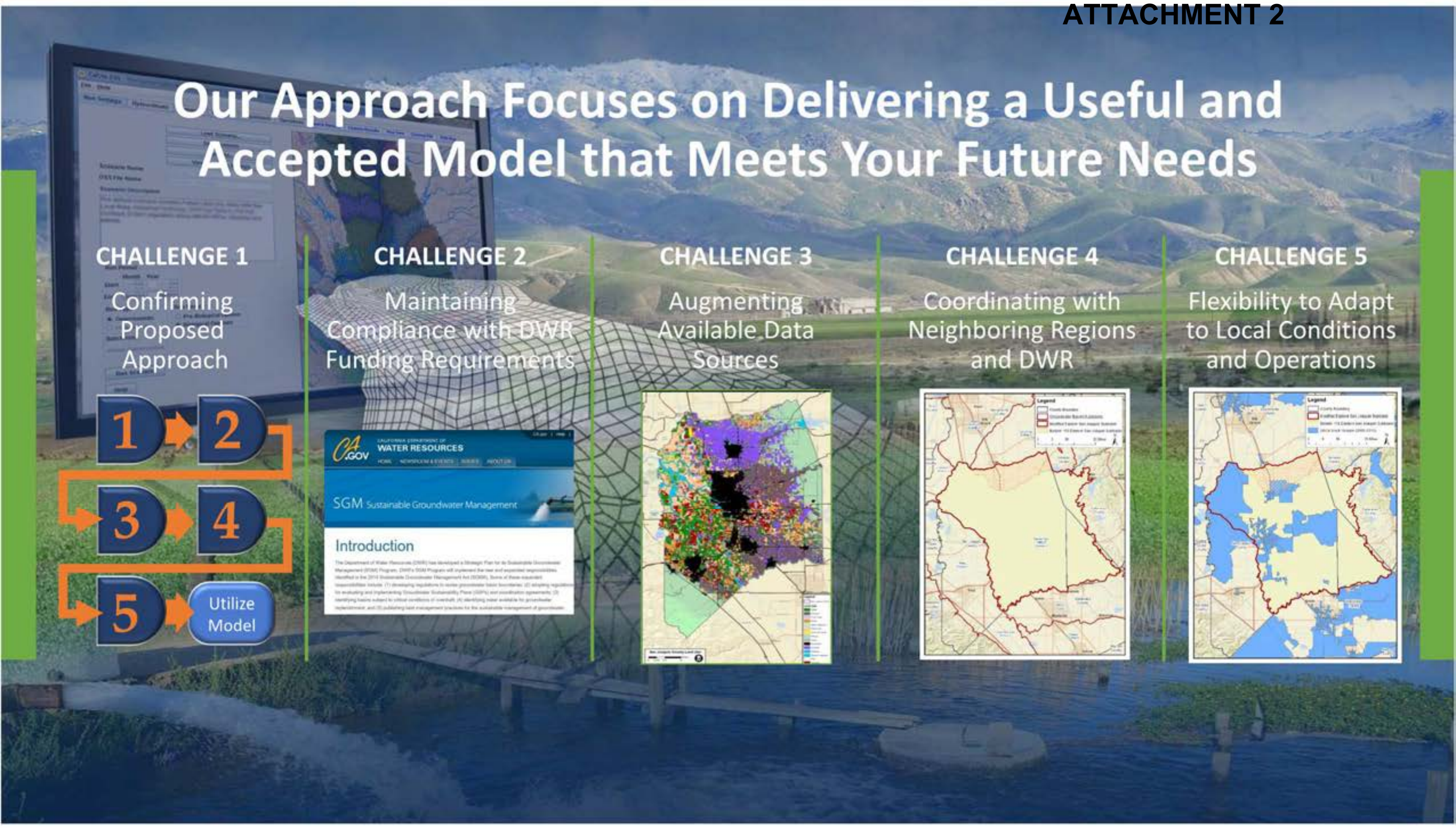
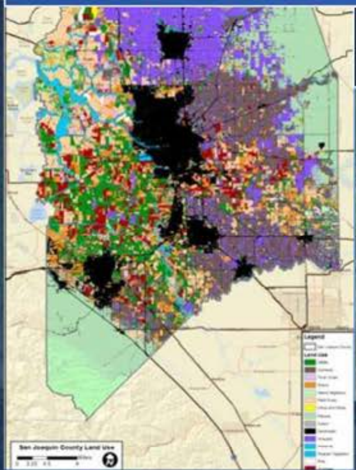


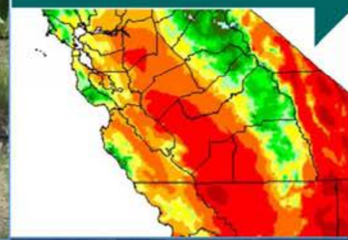
Use IDC to Estimate Agricultural Water Demand

Verify Remote Sensing Cropping Data Information Using Other Information



Confirm Irrigation Practices

Incorporate Climate and Soil Information

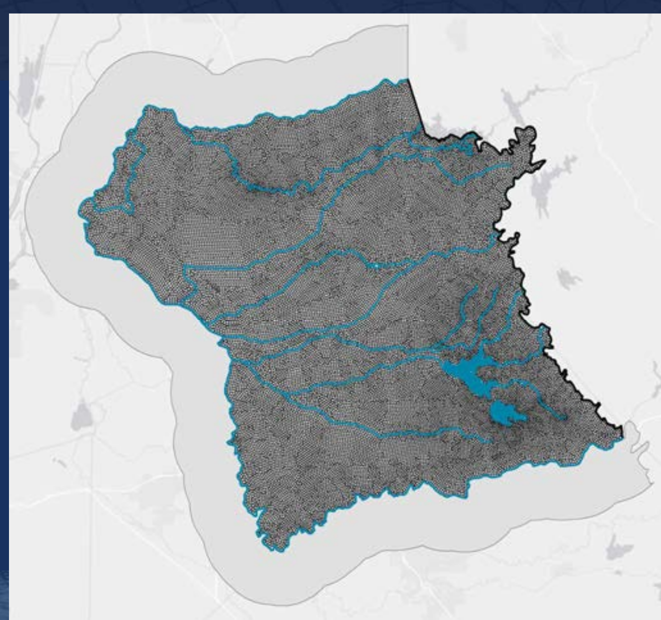


Crop Specific Water Demands

- ✓ Consumptive Use
- ✓ Groundwater Use
- ✓ Return Flows

Need to confirm foundational modeling assumptions

- Model Platform
- Model Boundaries
- Hydrogeologic Conditions
- Hydrologic Period
- Calibration Period
- Hydrologic Features
- Management Regions
- Land Use and Cropping Patterns



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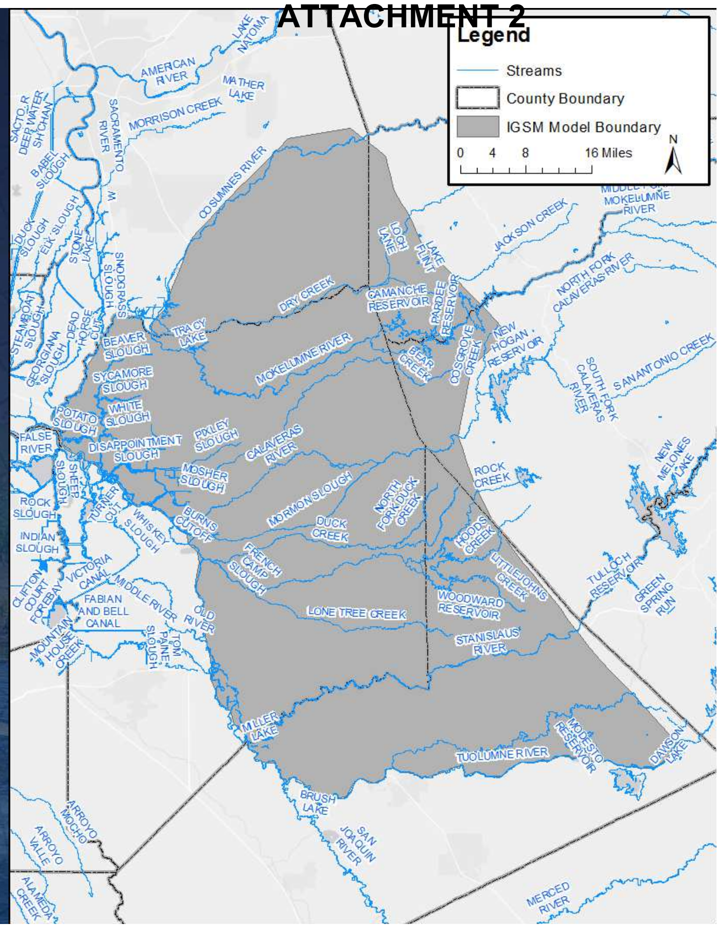
Model Features

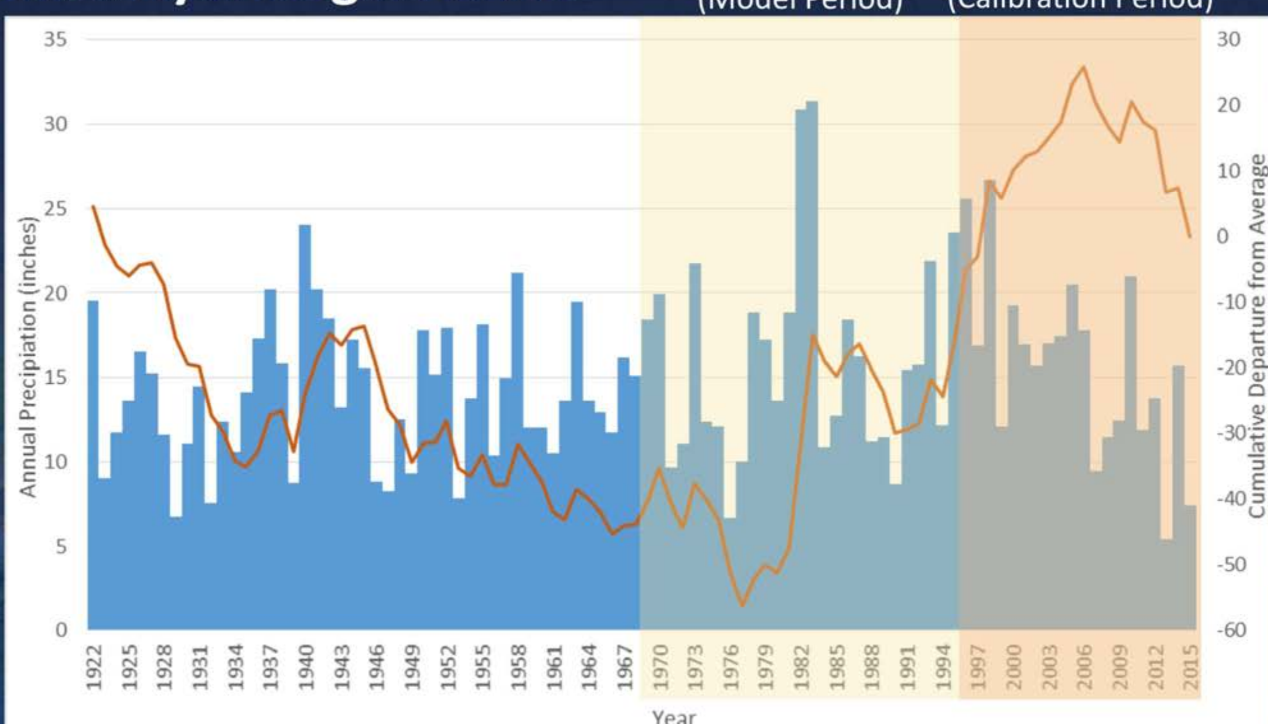
- Model Area
- ID/WD Boundaries
- GSA Boundaries
- Hydrologic Features



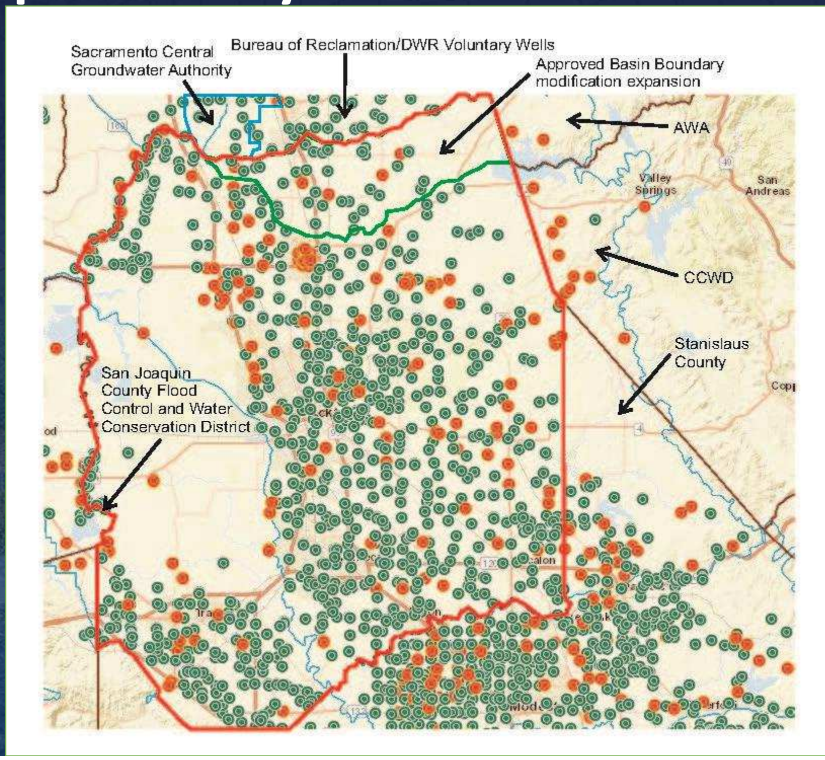
Model Hydrologic Period

1970-2015
(Model Period)

1995-2015
(Calibration Period)

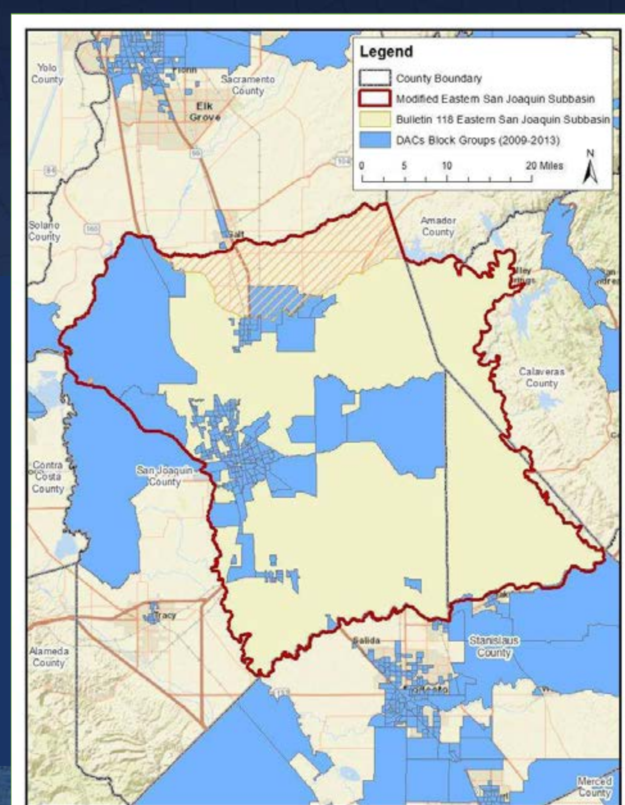


San Joaquin County CASGEM Network



Water Quality Monitoring Program for DAC areas

- Utilize existing wells – coverage over data gaps
- Sampling of wells and water quality database management



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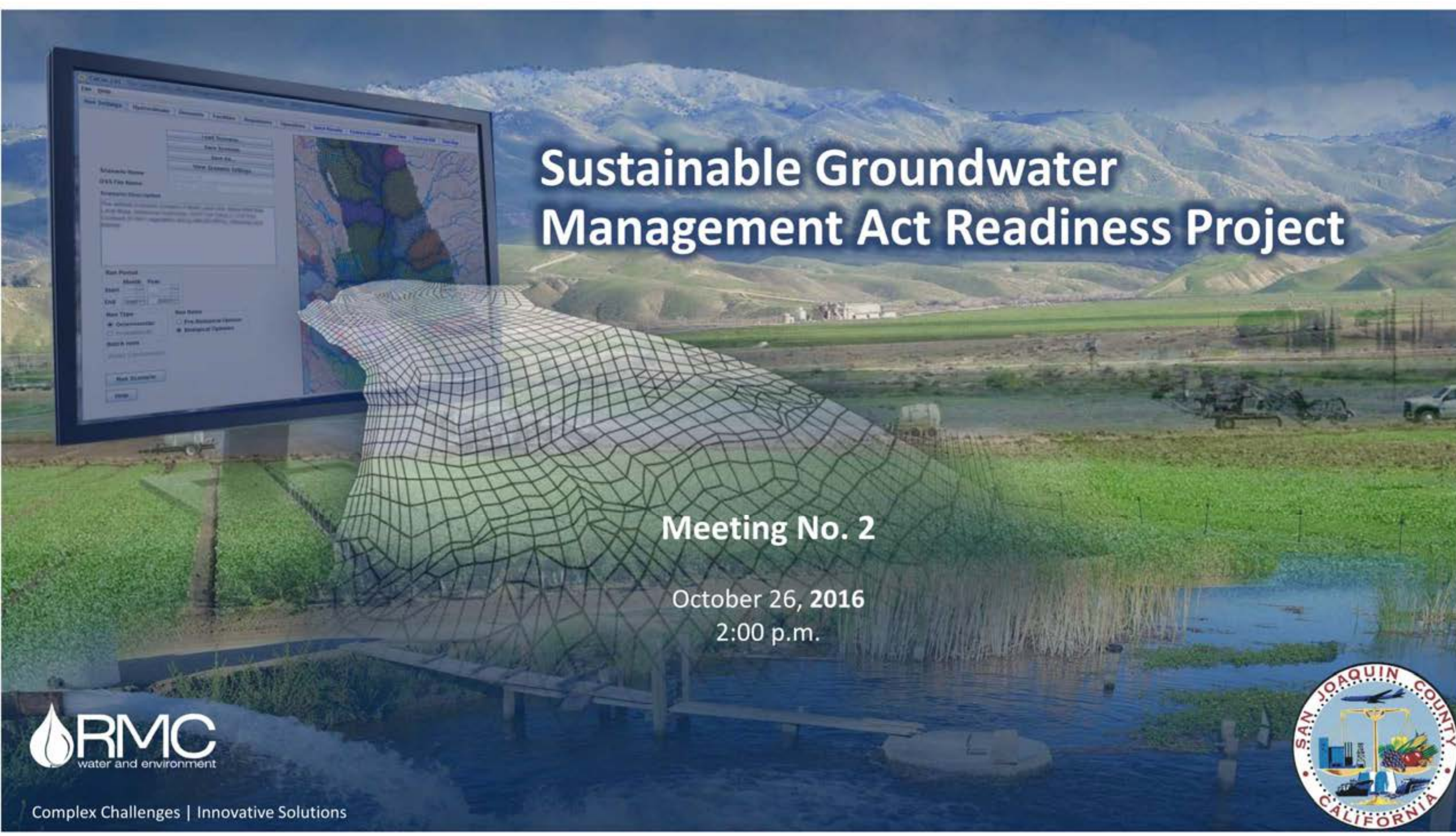
What Data can Come from Existing Models?

Major Data Items/Types	C2VSim	DYNFLOW	Other Sources	RMC Scope
Topography	✓	✓	DEM	Only Data in DynFlow and C2VSim
Geology	✓	✓	USGS texture model, drillers logs	Only Data in DynFlow and C2VSim
Aquifer Parameters	✓	✓	USGS report	✓
Stream Geometry	✓		DWR floodplain program	Only for Rivers in Dynflow and C2VSim
Stream Flows	✓		USGS stream gages	Only for Rivers in Dynflow and C2VSim
Soil Parameters	✓	✓	SSURGO, STATSGO2	✓
Rainfall	✓		PRISM, weather stations	✓
Evapotranspiration	✓		CIMIS, Merced & SSID METRIC	Scope does not include DWR ET Maps; will report back, when data is available
Surface Water Diversion	✓	✓	Water providers, SWRCB	Only Data in DynFlow and C2VSim
Groundwater Pumping	✓	✓	Local knowledge, well permits	Municipal Pumping Rates in DynFlow and C2VSim; Ag Pumping estimated by IDC (Will need assessment of Vertical and Spatial distribution of pumping)
Land Use	✓	✓	DWR (LandIQ) LU survey, CropScape, AWMPs, Ag Commissioner Reports/Map, Local District Data	Will Evaluate the level of effort for processing LandIQ data, once its available, and report back on the level of effort



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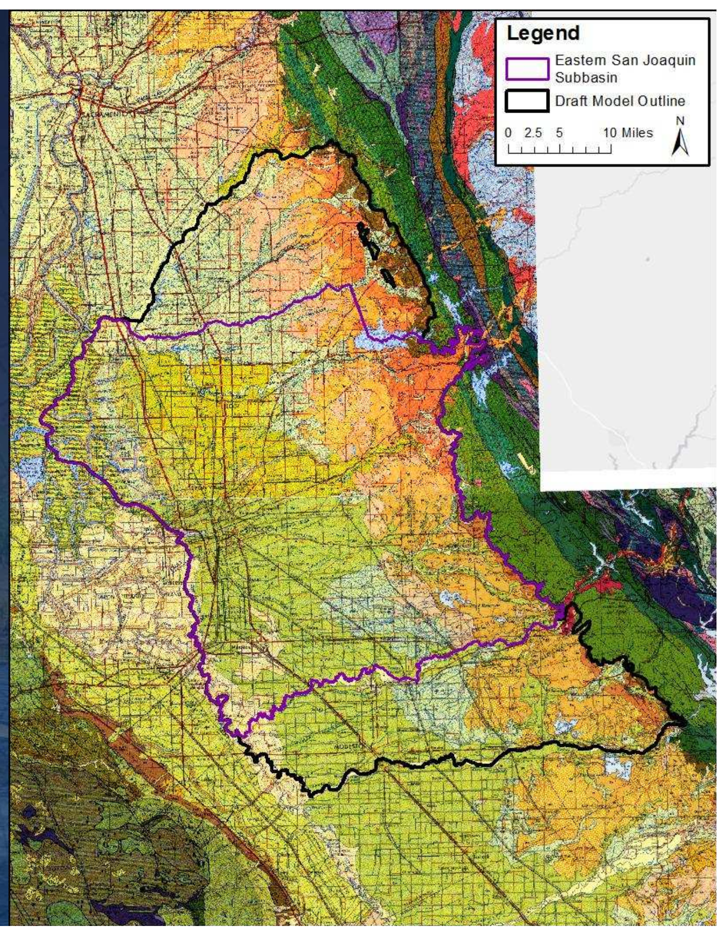
October 26, 2016
Discussion Topics

- **Model Area Boundaries**
- **Model Subregions**
- **Model Surface Water Courses**

Model Area Boundaries

- Primary Area- DWR B-118 ESJ Subbasin
  - Major Formations:
    - Alluvium and Modesto/Riverbank
    - Flood Basin Deposits
    - Laguna
    - Mehrten
- Secondary Area- Cosumnes and Modesto GW Subbasins

California Geological Survey's regional geologic maps for the Sacramento (1981) and San Francisco (1991) quadrangles



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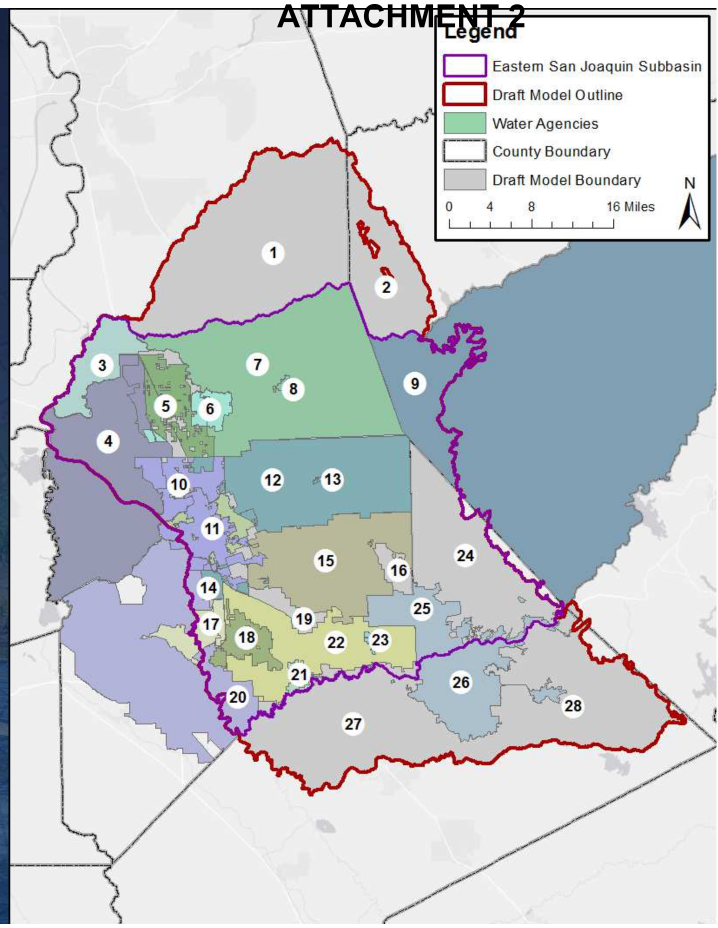
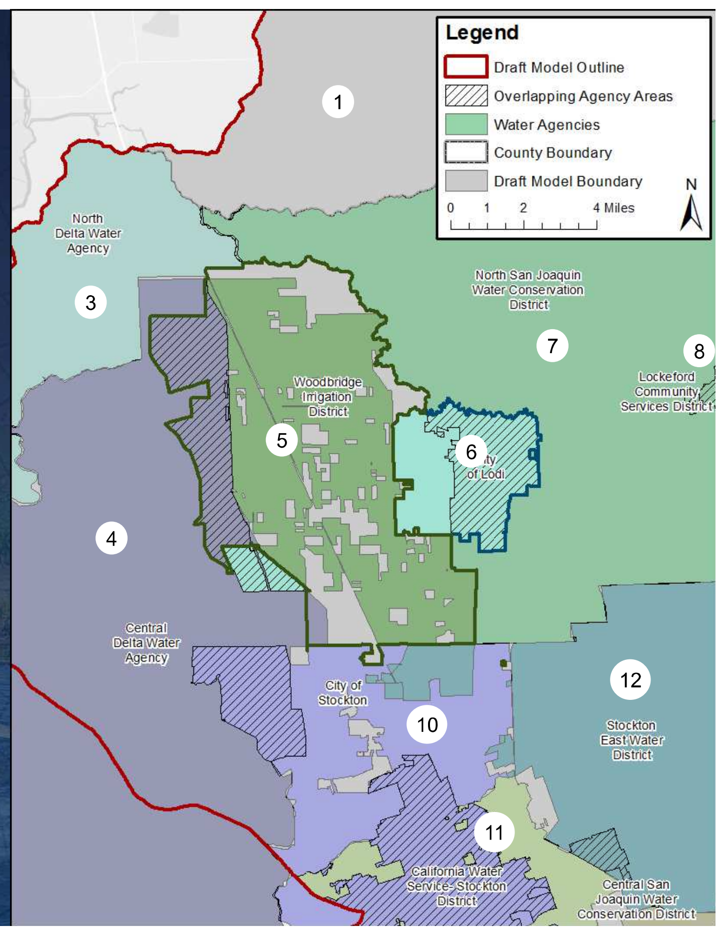
Model Subregions

- Plan to broadly delineate subregions by agency
- Issues:
  - Overlapping agencies
  - Discontinuous agency service areas, including “Swiss Cheese” areas
  - Areas of unincorporated county land



Example: Woodbridge ID Area

- Major overlaps between…
  - Central Delta Water Agency and Woodbridge Irrigation District
  - Central Delta Water Agency and City of Lodi
  - Central Delta Water Agency and City of Stockton
  - North San Joaquin Water Conservation District and City of Lodi
  - City of Stockton and California Water Service- Stockton District
- Woodbridge ID has “Swiss Cheese” exclusions in its service area
- Patches of unincorporated county land



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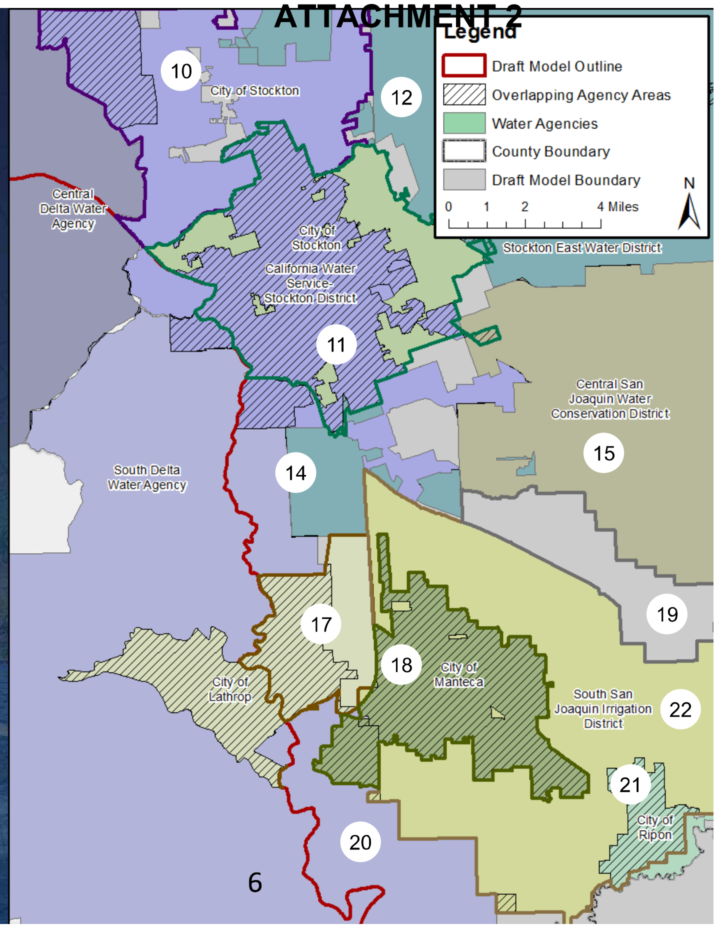
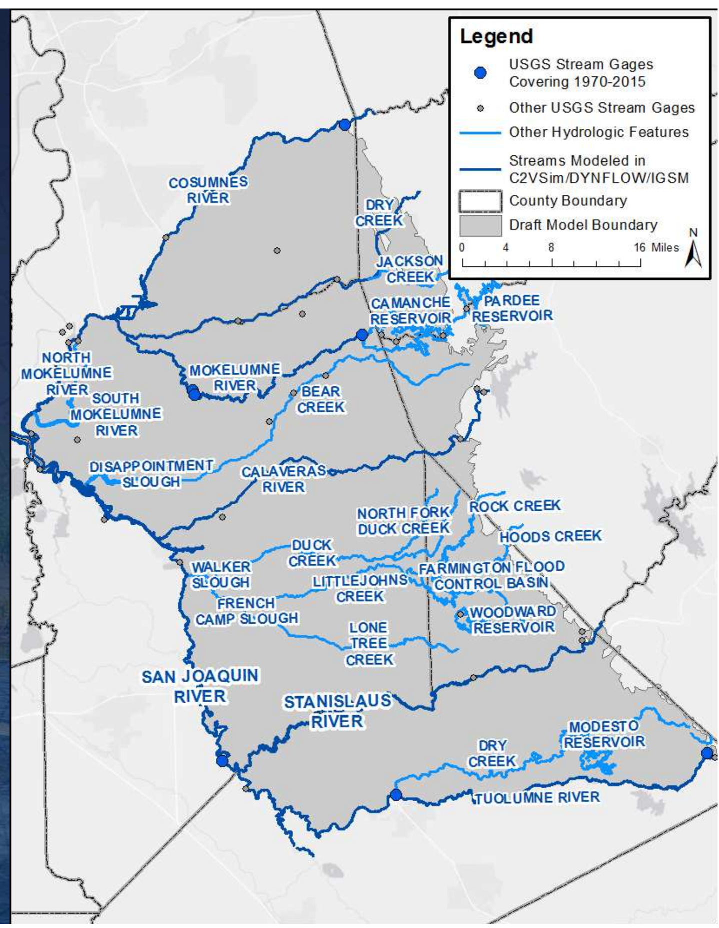
Example: South Stockton Area

- Major overlaps between…
  - California Water Service- Stockton District and City of Stockton
  - California Water Service- Stockton District and Stockton East Water District
  - California Water Service- Stockton District and Central San Joaquin Water Conservation District
  - South Delta Water Agency and City of Lathrop
  - South San Joaquin Irrigation District and City of Manteca
- Patches of unincorporated county land, including large area that could be own subregion (#19)



Streams Modeled in C2VSim, DYNFLOW, and IGSM Models

Stream Name	USGS Gage Covering 1970-2015?	Stream Geometry Available?
San Joaquin River	Yes	Yes
Cosumnes River	Yes	Yes
Dry Creek (near Mokelumne River)	No	Yes
Mokelumne River	Yes	Yes
Calaveras River	New Hogan Lake releases	Yes
Stanislaus River	Yes	Yes
Tuolumne River	Yes	Yes



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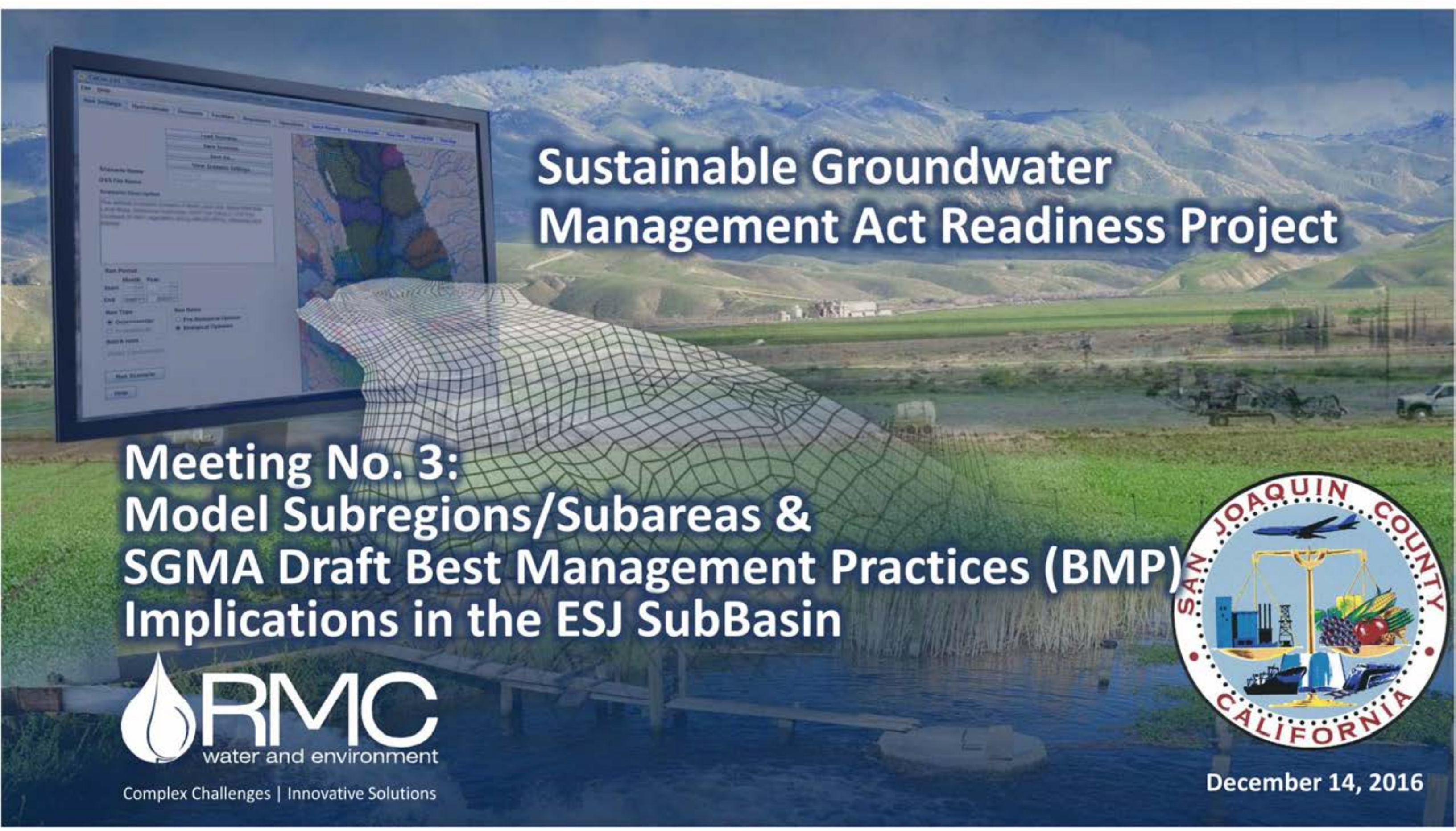
Other Hydrologic Features

- Brown and Caldwell (January 1990) manual discussed seepage estimates in IGSM model for following features:
  - Calaveras River and Mormon Slough
  - Mokelumne River
  - Camanche Reservoir
  - Little Johns, Bear, Duck, and Lone Tree Creeks
  - Woodbridge Canals
  - Oakdale ID Channels
  - Woodward Reservoir
  - Farmington Flood Control Basin
- Annual seepage from studies of seepage per wetted acre, from information obtained from agencies (e.g., EBMUD, OID, and SSJID), or estimated from known seepage of nearby rivers

Stream Name	USGS Gage Covering 1970-2015?	Stream Geometry Available?
Jackson Creek	No	No
South Mokelumne River	No	No
Disappointment Slough	No	No
Bear Creek	No	No
Walker Slough	No	No
Duck Creek	No	No
North Fork Duck Creek	No	No
French Camp Slough	No	No
Little Johns Creek	No	No
Farmington Flood Control Basin	No	No
Rock Creek	No	No
Hoods Creek	No	No
Lone Tree Creek	No	No
Dry Creek (near Tuolumne River)	No	No
Camanche Reservoir	Potentially from East Bay MUD	
Pardee Reservoir	Potentially from East Bay MUD	
Woodward Reservoir	Potentially from South San Joaquin ID	
Modesto Reservoir	Potentially from Modesto ID	



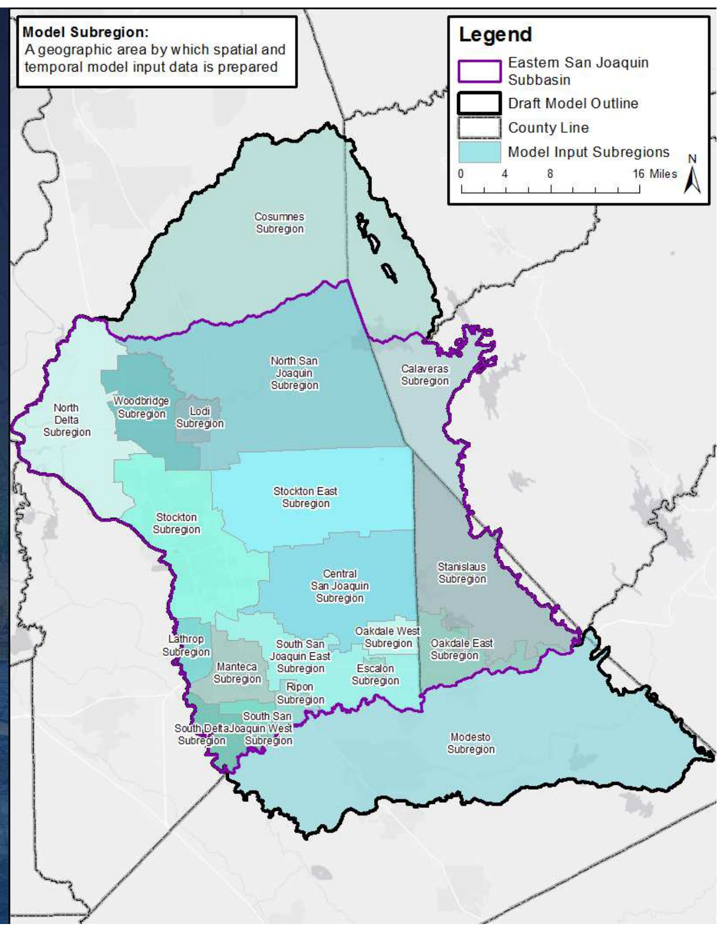
ATTACHMENT 2

Description of ESJ GW Basin Hydrologic Model Subregions & Subareas

- Model Input Subregions - Proposed boundaries in the model domain for model input data collection and preparation
- Model Output Subareas - Proposed boundaries in the model domain for reporting model results

Model Input Subregions

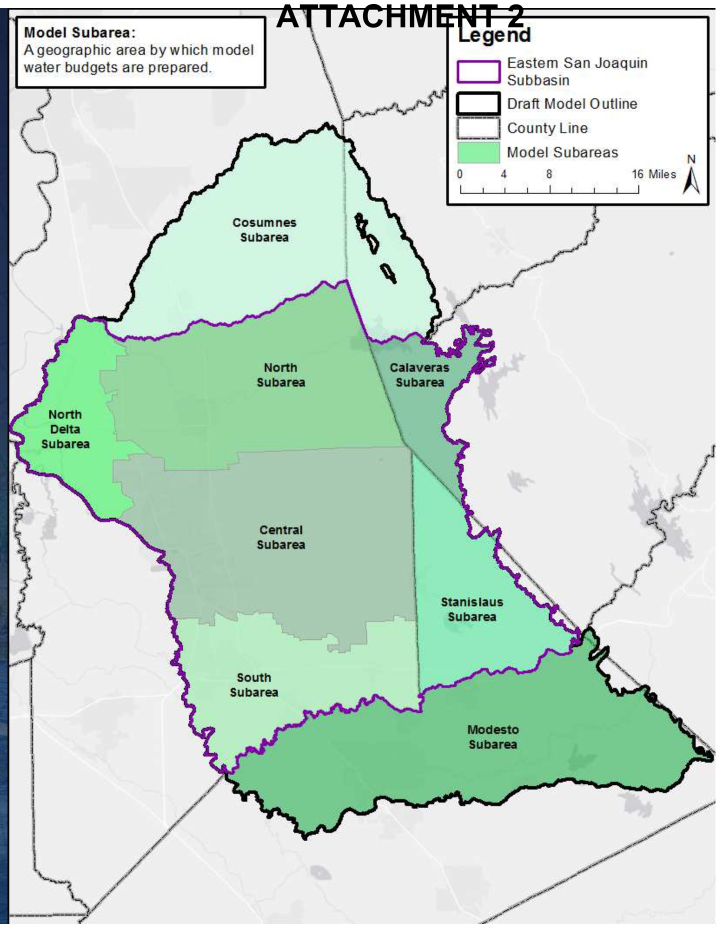
- 20 subregions
- For data collection and preparation of model input files
- Used SOI boundaries as reference for cities



ATTACHMENT 2

Model Output Subareas

- 8 subareas
- For model output and reporting of results



SGMA Draft Best Management Practices (BMP) Implications in the ESJ SubBasin

Purpose

The purpose is to present the Draft SGMA Best Management Practices (BMP) as published by the DWR and discuss how the BMPs would apply to the implementation of SGMA in ESJ GW SubBasin.

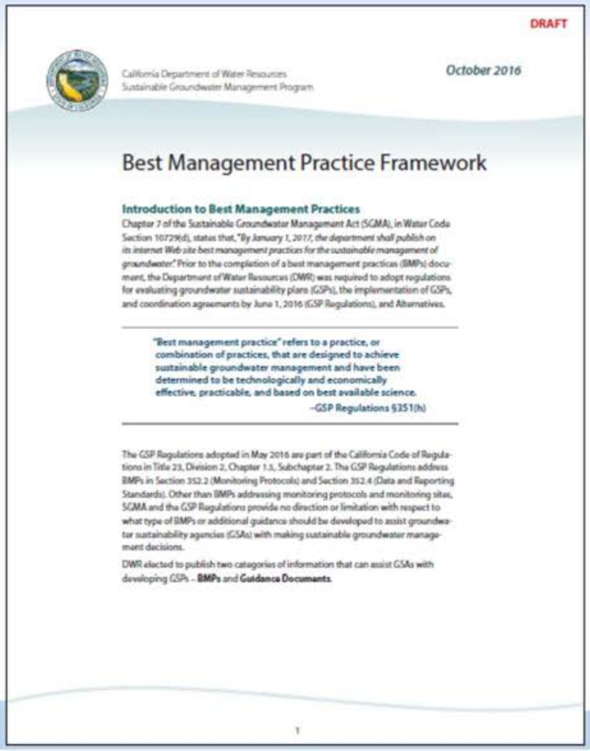
Slides in Light Blue are from DWR

Slides in Dark Blue are our interpretations for application to ESJ Basin

ATTACHMENT 2

SGMA BMP Overview
Draft BMP Framework and Intent

- Definitions
  - BMPs – DWR technical assistance
  - Guidance Documents - informational
- How to Utilize
  - Optional – do not create new requirements
  - Documents are not a substitute for GSP Regulations
- Organization/Workflow
- Identify Future Documents and Revisions
- Relationship with other BMPs



DRAFT

California Department of Water Resources
Sustainable Groundwater Management Program

October 2016

Best Management Practice Framework

Introduction to Best Management Practices

Chapter 7 of the Sustainable Groundwater Management Act (SGMA), in Water Code Section 10729(d), states that, "*By January 1, 2017, the department shall publish on its internet Web site best management practices for the sustainable management of groundwater.*" Prior to the completion of a best management practices (BMPs) document, the Department of Water Resources (DWR) was required to adopt regulations for evaluating groundwater sustainability plans (GSPs), the implementation of GSPs, and coordination agreements by June 1, 2016 (GSP Regulations), and Alternatives.

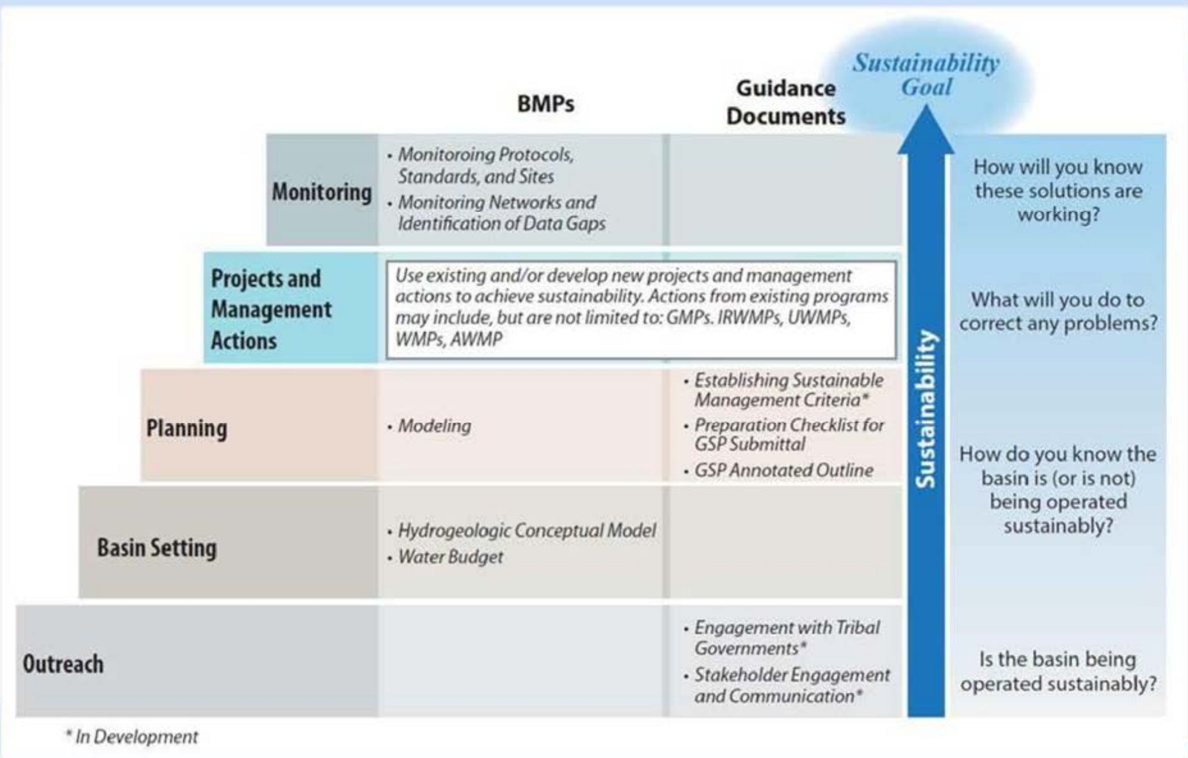
> "Best management practice" refers to a practice, or combination of practices, that are designed to achieve sustainable groundwater management and have been determined to be technologically and economically effective, practicable, and based on best available science.
>
> –GSP Regulations §351(h)

The GSP Regulations adopted in May 2016 are part of the California Code of Regulations in Title 23, Division 2, Chapter 1.5, Subchapter 2. The GSP Regulations address BMPs in Section 352.2 (Monitoring Protocols) and Section 352.4 (Data and Reporting Standards). Other than BMPs addressing monitoring protocols and monitoring sites, SGMA and the GSP Regulations provide no direction or limitation with respect to what type of BMPs or additional guidance should be developed to assist groundwater sustainability agencies (GSAs) with making sustainable groundwater management decisions.

DWR elected to publish two categories of information that can assist GSAs with developing GSPs – **BMPs** and **Guidance Documents**.

1

SGMA BMP Overview – BMP Building Blocks



ATTACHMENT 2

BMP # 1 – Monitoring Protocols, Standards, and Sites

- Protocols for:
  - Establishing Monitoring Sites
  - Measuring GW Levels
  - Sampling GW Quality
  - Monitoring Seawater Intrusion
  - Measuring Streamflow
  - Measuring Subsidence

SGMA BMP 1: How It Applies to San Joaquin County SGMA Readiness Project

- Historical County program meets the intent of the BMP
- Review monitoring site unique identifiers for GIS
  - All monitoring locations update horizontal control; long term lease or access agreement review
- Compare existing monitoring protocols to determine necessary adjustments
  - Stream and sea-water intrusion locations, water quality and subsidence assessment protocols need to be updated
- Incorporate protocols and standards into GSP development for specific elements
  - Measurable indicators of sustainability

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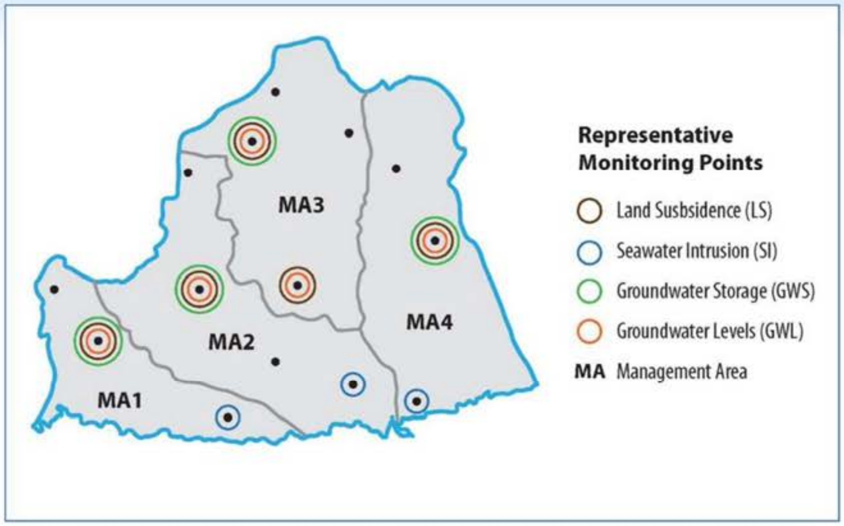
BMP # 2 – Monitoring Networks and Identification of Data Gaps

- General Monitoring Networks
  - Improvement of Monitoring Network



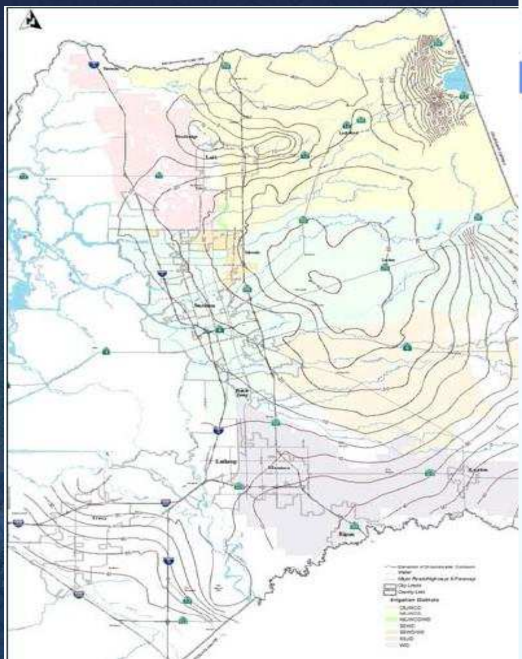
- Specific Monitoring Networks

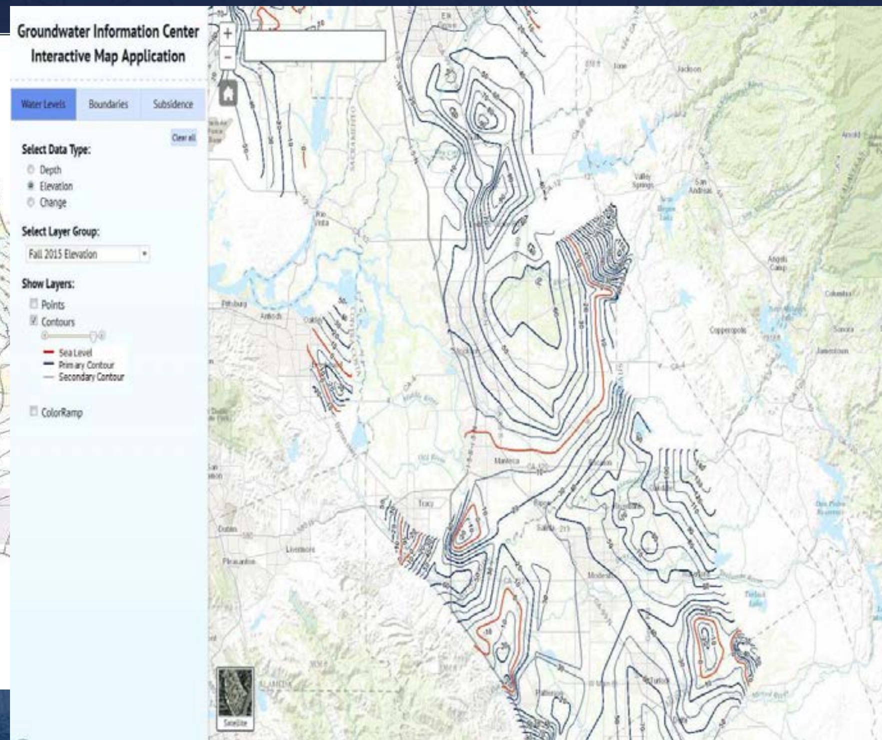
SGMA BMP 2: How It Applies to San Joaquin County SGMA Readiness Project

- Historical Network meets the intent of the BMP
  - Spacing and seasonal and long-term trends established
- Assessment of adjustments to existing monitoring networks (CASGEM and Future Hydro Model)
  - Data gaps, shallow and deep aquifers, known well construction information, installation of new monitoring wells (State funding?)
  - Expansion on approved network (County and E-Pur Data)
  - Monitoring wells are needed east and at the base of the fresh water
- Coordination with County and State agencies to acquire well log information; coordination with land owners for long-term access
- Determination of high and low gw use areas with measurable indicators (modeling coordination)

ATTACHMENT 2

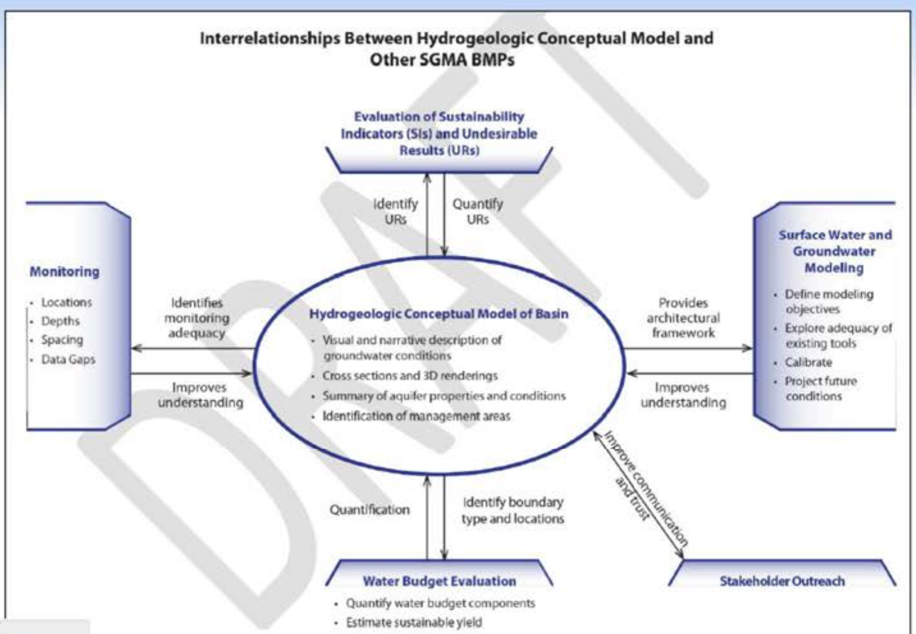
Known Data Gaps - Observed Critical Areas for Recharge and Overdraft

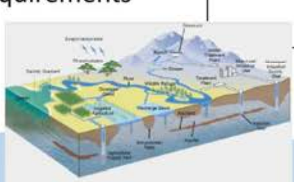


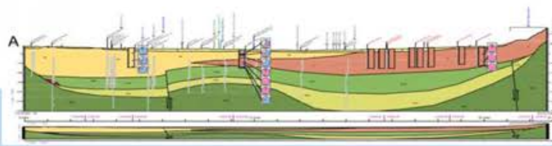


BMP # 3 – Hydrogeologic Conceptual Model

- Characterizing Physical Components
  - Geologic and structural boundaries
  - Lateral boundaries
  - Bottom of the basin
  - Principal Aquifers and Aquitards
  - Graphical Representation
- Mapping Requirements







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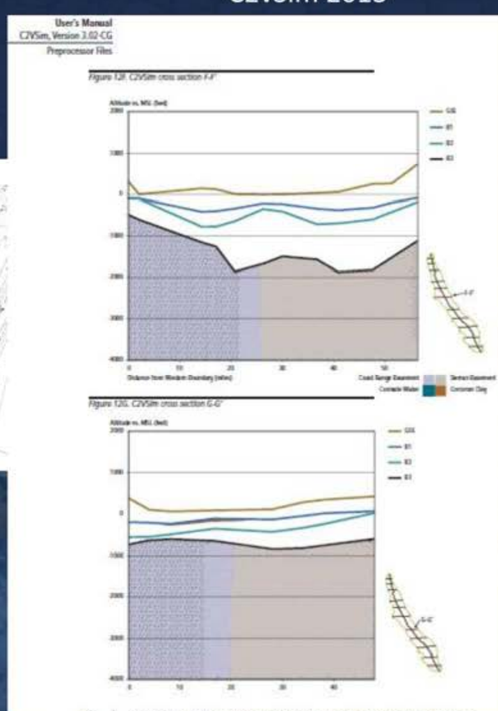
SGMA BMP 3: How It Applies to San Joaquin County SGMA Readiness Project

- Extensive base of existing knowledge for HCM
  - J.Montgomery, 1990, CH2MHill & Papadopoulous 2006, Taghavi 2000, 1967 Bulletin 146 – Great start for data from surface to ~400 feet; other known sources with well log information
- Data gaps in deep well logs and limited number of wells
  - More well logs >400 feet
  - Aquifer data, base of fresh aquifer, saline aquifer, bedrock Eastern Margin Area
- Coordination with DWR for technical assistance for guidance and direction on data acquisition (well logs)

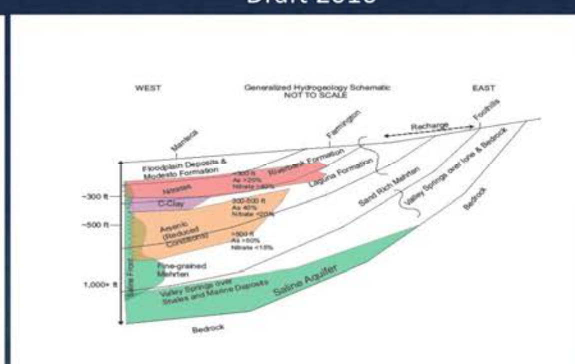
Schematic Hydrogeo Cross-Sections Compared and Refined

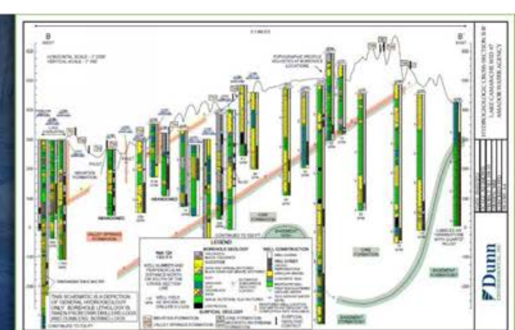
DWR 1967

C2vSim 2013



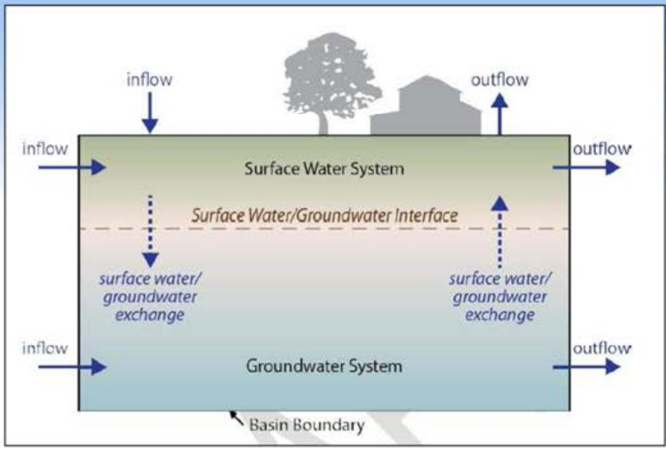
Draft 2016





BMP # 4 – Water Budget (WB)

- General WB Requirements
  - Certification
  - WB Data, Information, and Modeling Requirements
  - Defining Basin Area and Water Budget Systems
  - Accounting and Quantification of WB Components
- Tabular and Graphical Representation of WB Components
- Defining WB Time Frames
  - Current, Historical, Projected



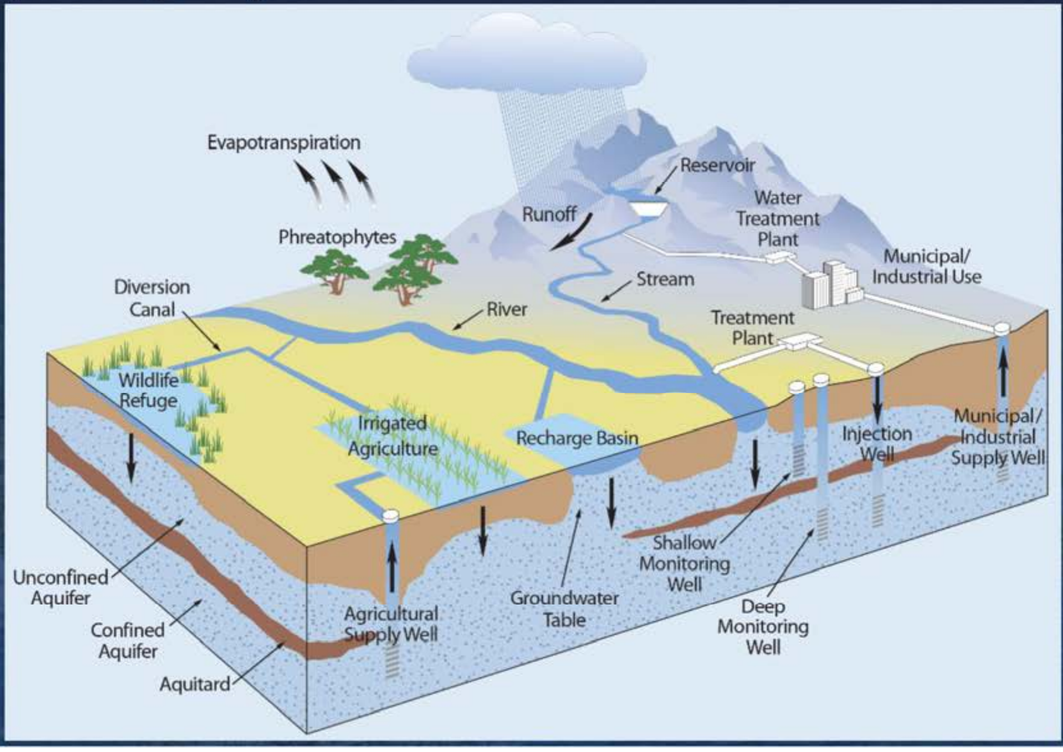
Water Year:
Water Year Type:

INFLOWS		OUTFLOWS	
Inflow Source	Volume (af/yr)	Outflow Sink	Volume (af/yr)
Surface Water Inflow[1]		Surface Water Outflow[1]	
Precipitation		Evapotranspiration[4]	
Subsurface Groundwater Inflow		Subsurface Groundwater Outflow	
Total Basin Inflow		Total Basin Outflow	
Subsurface Groundwater Inflow		Subsurface Groundwater Outflow	
Infiltration of Precipitation		Groundwater Extraction[1]	
Infiltration from Surface Water Systems[2]		Discharge to surface water systems[2]	
Infiltration of Applied Water[3]			
Total Groundwater Inflow		Total Groundwater Outflow	

Change in Surface Storage Volume	
Change in Groundwater Volume	

\1 by water source type
\2 lakes, streams, canals, springs, conveyance systems
\3 includes applied surface water, groundwater, recycled water, and reused water
\4 by water use sector

Water budget
A hydrologic systems view



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Systems Accounting

Change in storage = water entering minus water leaving

CLIMATIC SYSTEMS
ΔS = In – Out

LAND SURFACE SYSTEMS
ΔS = In – Out

RECHARGE BASINS	URBAN LAND & WATER USE	AGRICULTURAL LAND & WATER USE	MANAGED WETLANDS & WATER USE	NATIVE LAND & WATER USE

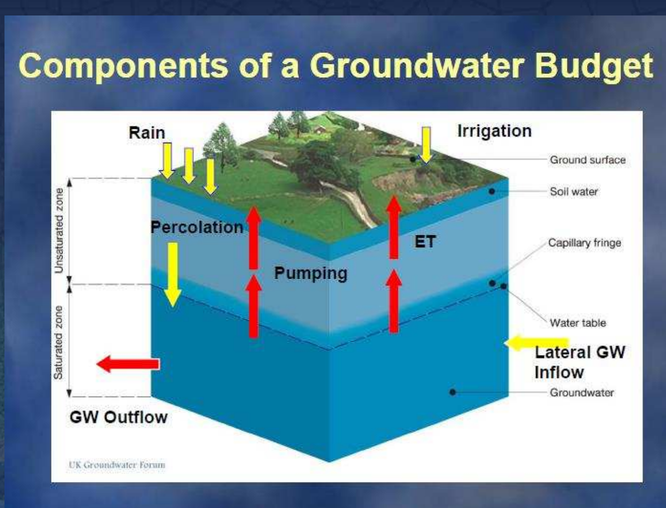
RESERVOIR

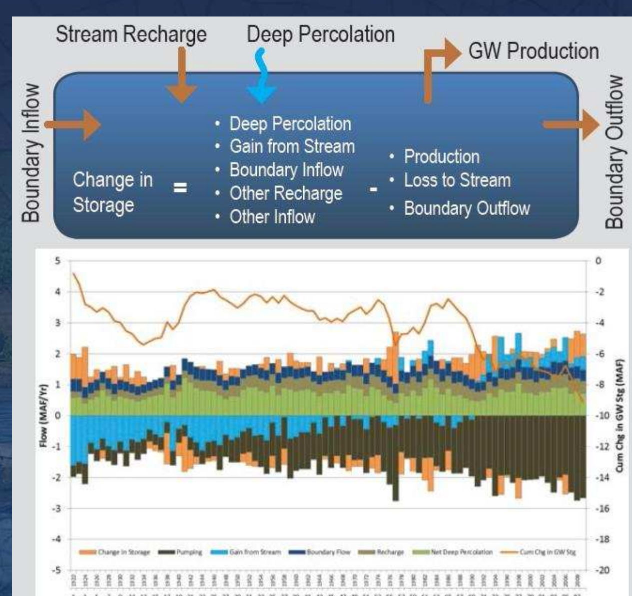
SNOWPACK

STREAM & CANAL SUBSYSTEMS
ΔS = In – Out

GROUNDWATER SYSTEMS
ΔS = In – Out

Water Budget Components





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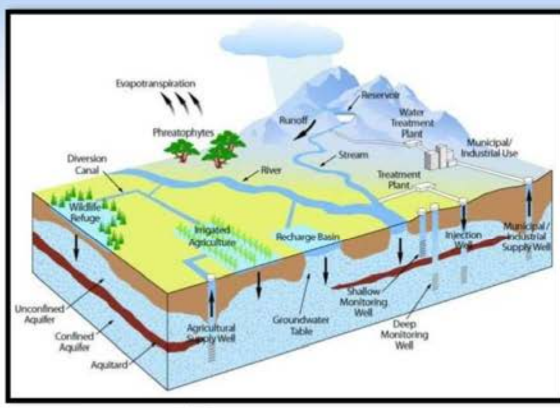
SGMA BMP 4: How It Applies to San Joaquin County SGMA Readiness Project

- Coordination with all GSPs in the basin
- Reporting WB for the basin and by subareas
- Evaluation of GW storage conditions - current and historical WB evaluations; projects/management actions for mitigation
- Sustainable yield assessment - current, historical, and projected WB conditions
- Forecasting future projected WB assessment & management actions - over 50-year planning/ implementation horizon with climate change

BMP # 5 – Modeling

Fundamentals
- Types of Models, Software, Uses
- Models Used for SGMA

Technical Assistance
- Guiding Principles For Models
- General Modeling Requirements



- Modeling Considerations
  - Addressing Sustainability Indicators

  - Developing Water Budgets
  - Forecasting Future Conditions, Projects, Actions
  - Assessing Impacts on Adjacent Basins
- Groundwater Modeling Process
- Related References and Guidance Material

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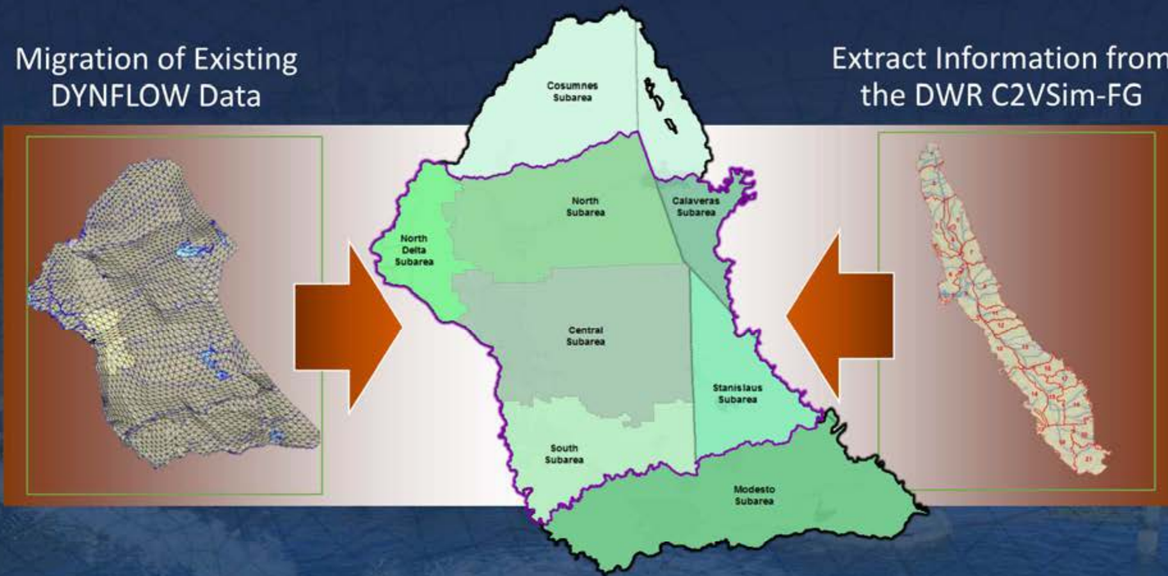
ESJ Integrated Hydrologic Model will benefit from Basin-scale models and previously developed local models and data

Migration of Existing DYNFLOW Data

Extract Information from the DWR C2VSim-FG



ESJ GW Basin Hydrologic Model Development Approach

1 Determine Modeling Needs
- Incorporate SGMA requirements
- Consider long-term sustainable GW management options
- Consider management scenarios

2 Define Objectives Select Model

Build Model based on IWFM framework

3 Build Model
- Define Model Subregions and SubAreas
- Develop IDC & Ag demand
- Develop Model data

4 Calibrate Model
- Calibrate IDC
- Calibrate to GW levels
- Calibrate to streamflows
- Develop Historical Water Budgets

5 Perform Sensitivity Analyses
- Aquifer parameters
- System Stresses
- Boundary conditions

Utilize Model
- Develop Baselines
- Perform Management scenarios
- Conduct Sustainability Analysis
- Develop Water Budgets
- Develop GW Monitoring Plan

Ad-Hoc Technical Committee Participation
Regular Reports to SGMA Workgroup
DWR Coordination

ATTACHMENT 2

Sustainable Groundwater Management Act Readiness Project

Meeting No. 4: Model Grid Development, Model Hydrologic Data, and Model Data Request

RMC water and environment

Complex Challenges | Innovative Solutions

January 25, 2017

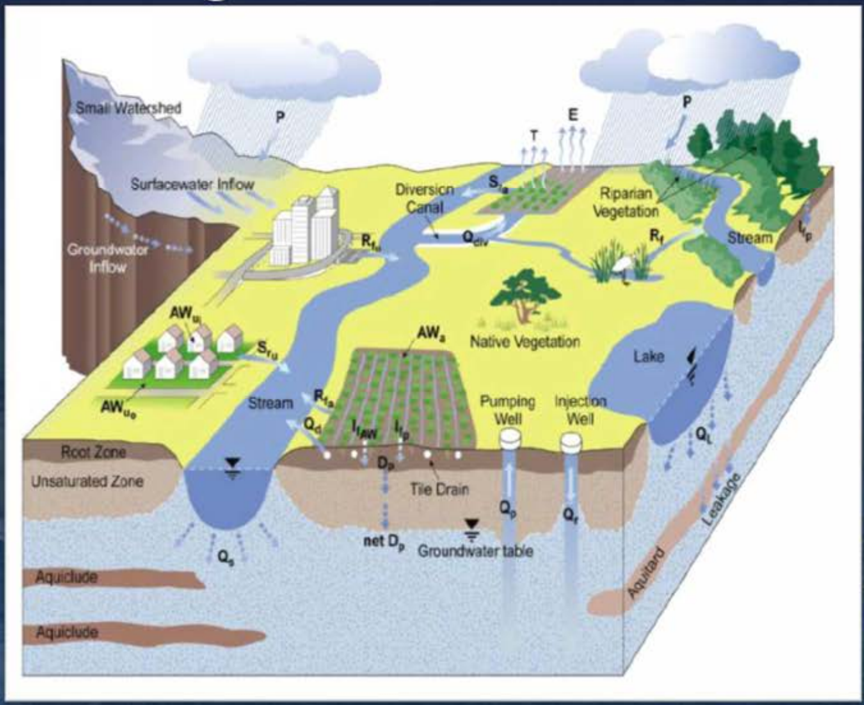
ESJ GBA AdHoc Technical Committee Meeting No. 4 January 25, 2017

Agenda

- Model grid development
- Model hydrologic period and data
- Status of data request

Integrated Hydrologic Modeling

- Land Surface Processes
- Groundwater Flow
- Streamflow
- Physical Systems Integration
- Water Balance Preservation Over time and space



Model Grid Development Goals and Process

- Include Features:
  - Groundwater Subbasin Boundaries
  - Model Input Subregions/Model Output Subareas
  - Model Hydrologic and Hydrogeologic Features
  - Surface Drainage Patterns
  - Subsurface Flow Patterns
  - Other Boundaries (e.g., current city limits)
- Other Considerations:
  - Maintain manageable number of elements/nodes
  - Optimize resolution for streamlined data analysis
  - Finer resolution along rivers to allow for better stream-aquifer interaction
  - Optimize model run time
  - Streamline model output

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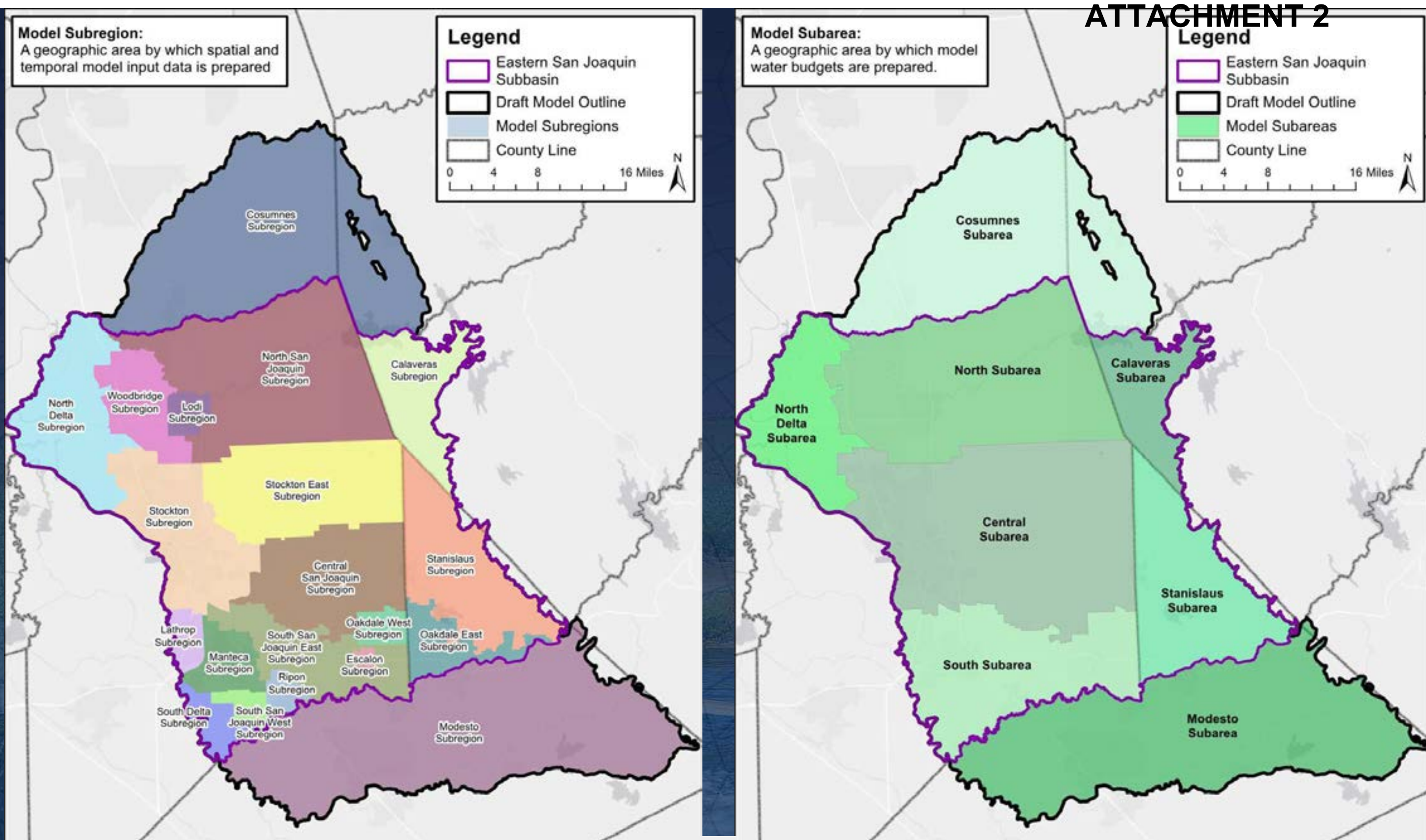
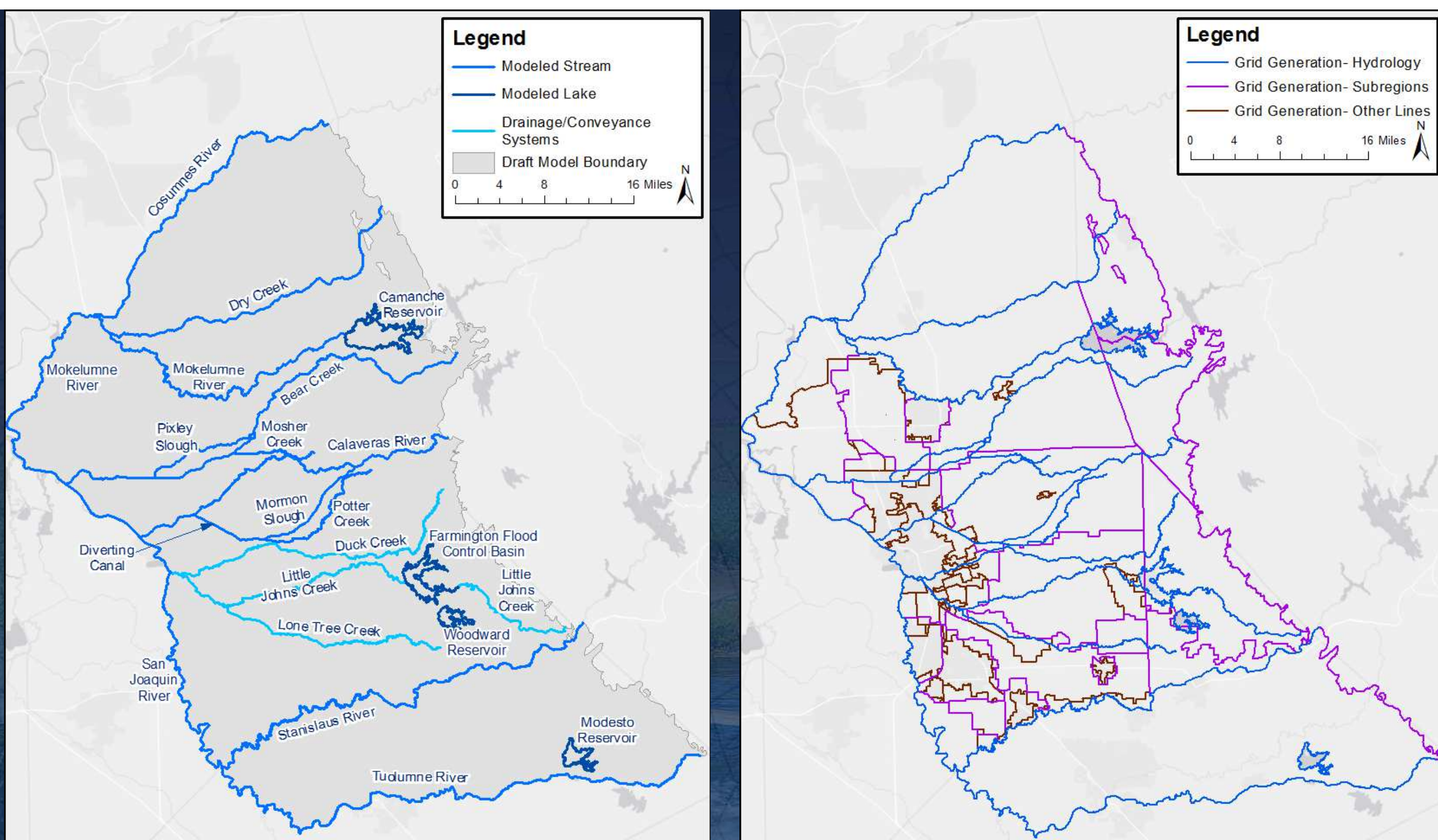


Model Input Subregions and Reporting Subareas

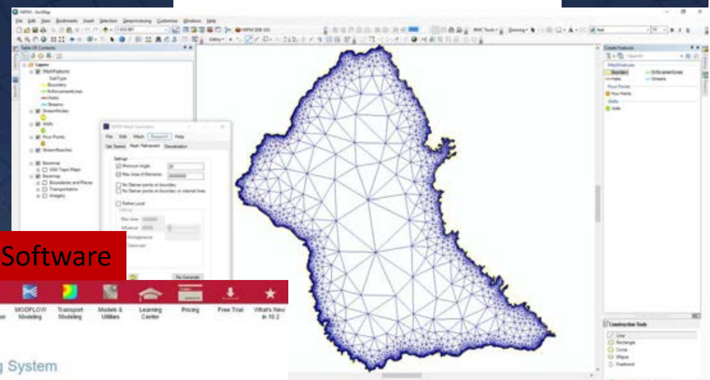


Model Hydrology and Grid Generation Lines

Tools to Develop a Model Grid

Good Old Fashion Grid Development

IWFM Grid Generator

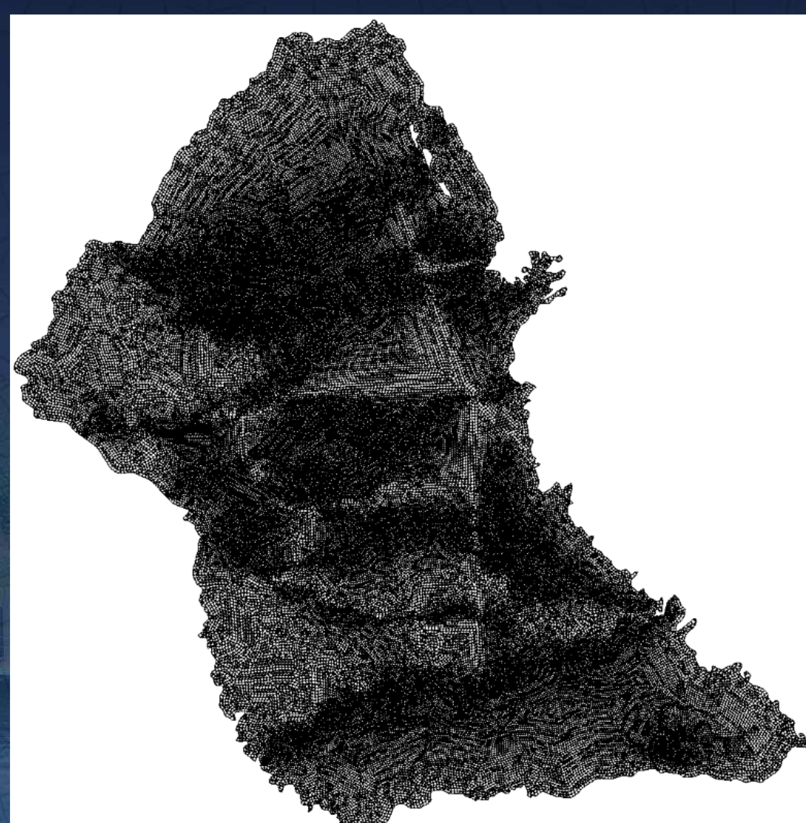


GMS Software

Grid Iteration #1

- Criteria: Hydrology and subregion lines
- Spacing:
  - Subregion lines: 0.25 miles
  - Model boundary lines (even streams): 0.25 miles
  - Other hydrology lines: 0.125 miles

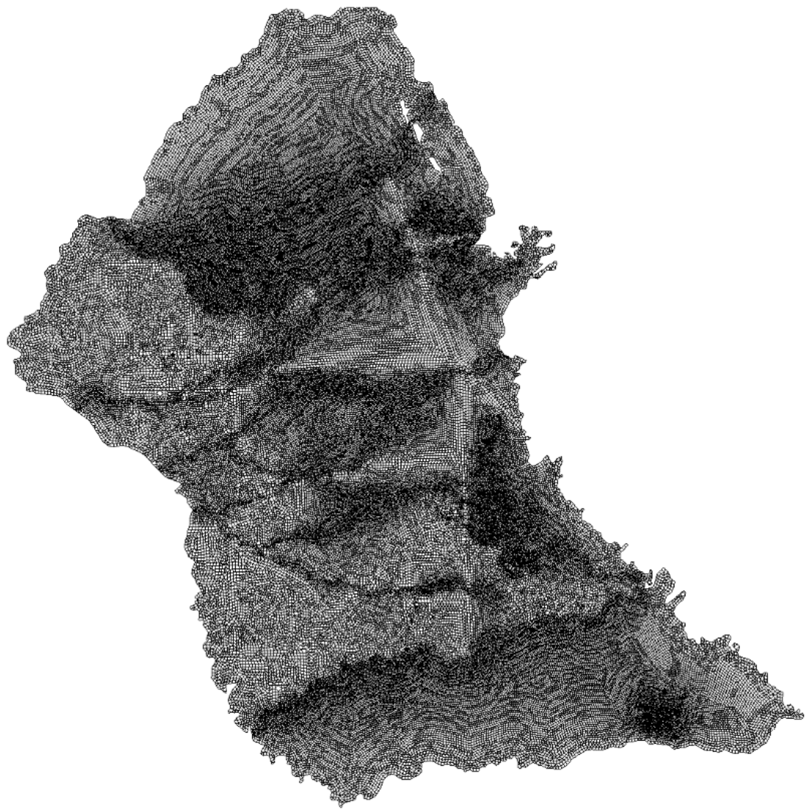
Type of Element	Number of Elements
Triangular	69,333
Quadrilateral	47,920
Total	**117,253**



Grid Iteration #2

- Criteria: Hydrology, subregion, and other features
- Spacing:
  - Subregion and other lines: 0.25 miles
  - Model boundary lines (even streams): 0.25 miles
  - Other hydrology lines: 0.125 miles

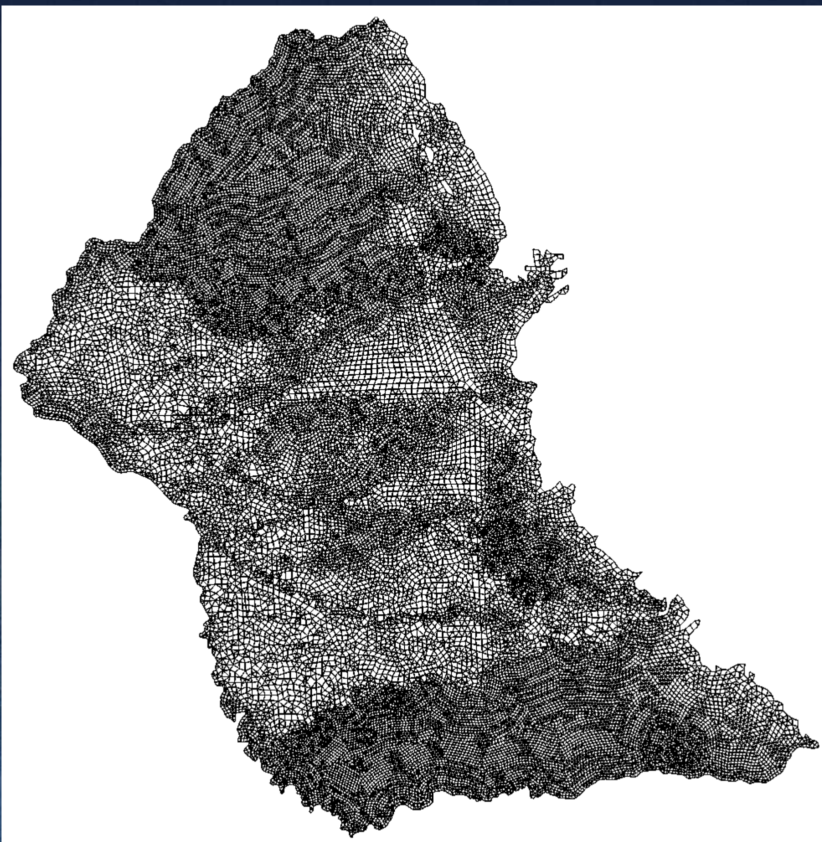
Type of Element	Number of Elements
Triangular	70,088
Quadrilateral	47,643
Total	**117,731**



Grid Iteration #3

- Criteria: Hydrology, subregion, and other features
- Spacing:
  - All subregion and other lines: 0.5 miles
  - All hydrology lines: 0.25 miles

Type of Element	Number of Elements
Triangular	23,541
Quadrilateral	15,009
Total	**38,550**

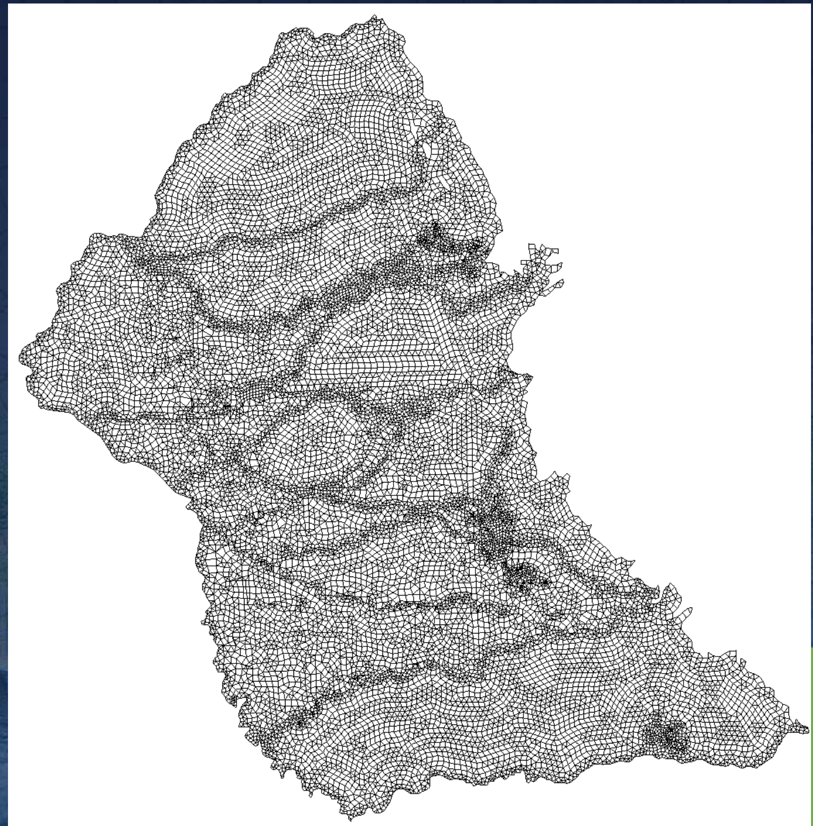


ATTACHMENT 2

Grid Iteration #4

- Criteria: Hydrology, subregion, and other features
- Buffer lines approximately 0.75 miles away from some streams
- Spacing:
  - All subregion and other lines (including stream buffers): 0.5 miles
  - All hydrology lines: 0.25 miles

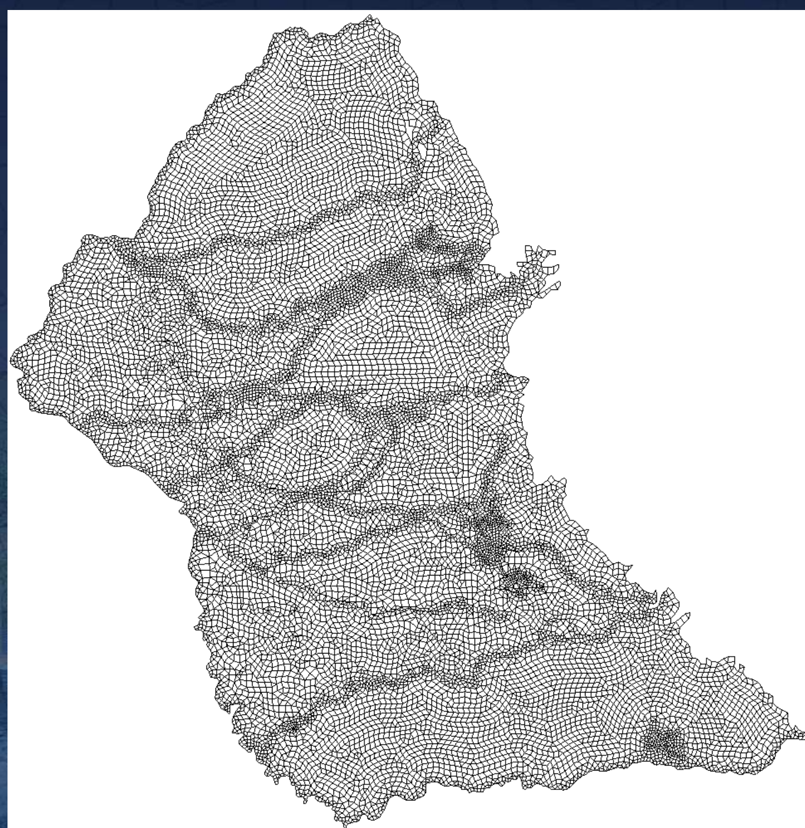
Type of Element	Number of Elements
Triangular	14,983
Quadrilateral	7,769
Total	**22,752**



Grid Iteration #5

- Criteria: Hydrology, subregion, and other features
- Buffer lines approximately 0.75 miles away from some streams
- Spacing:
  - All subregion and other lines (including stream buffers): 0.5 miles
  - All hydrology lines: 0.25 miles
- Minimum interior angle for merging triangles (gradually decreased from 65° to 15°)

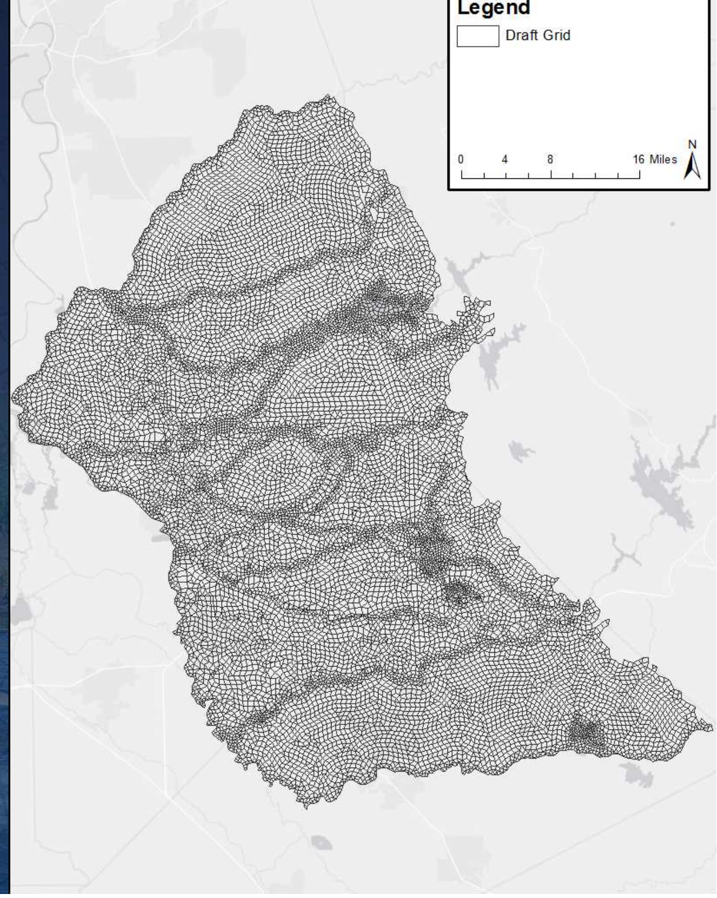
Type of Element	Number of Elements
Triangular	3,514
Quadrilateral	13,453
Total	**16,967**



ATTACHMENT 2

Draft Grid with Model Features

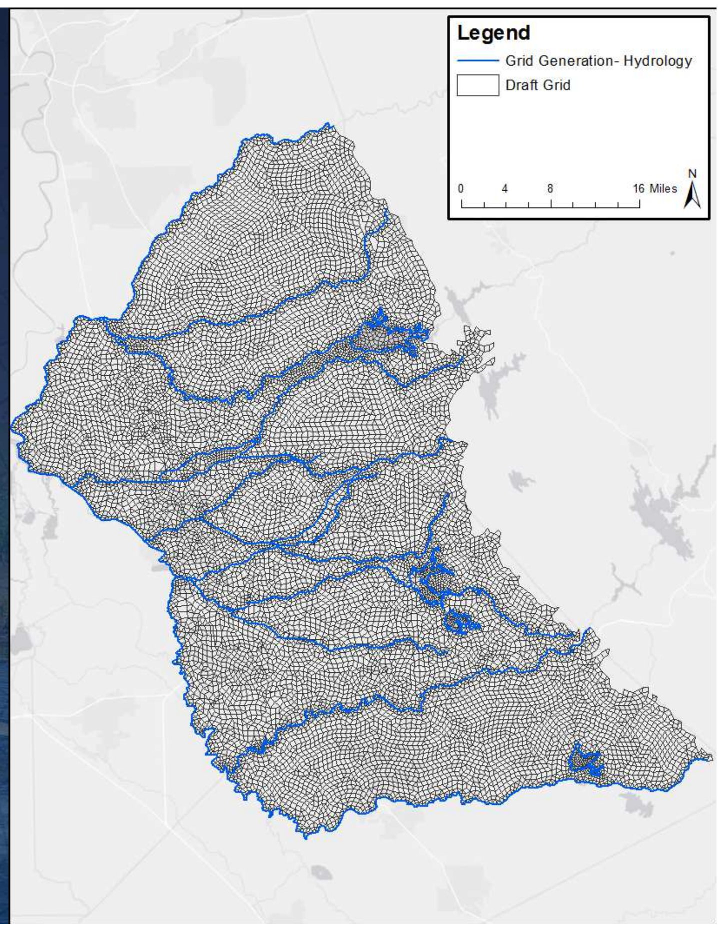
Draft Grid



Draft Grid with Model Features

Draft Grid

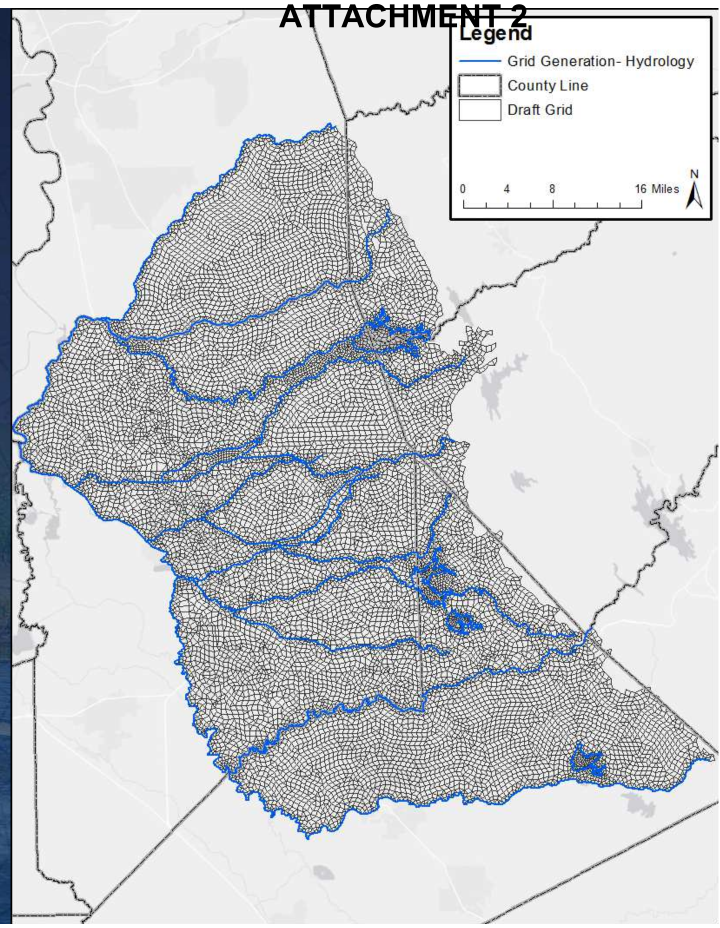
+ Hydrology



ATTACHMENT 2

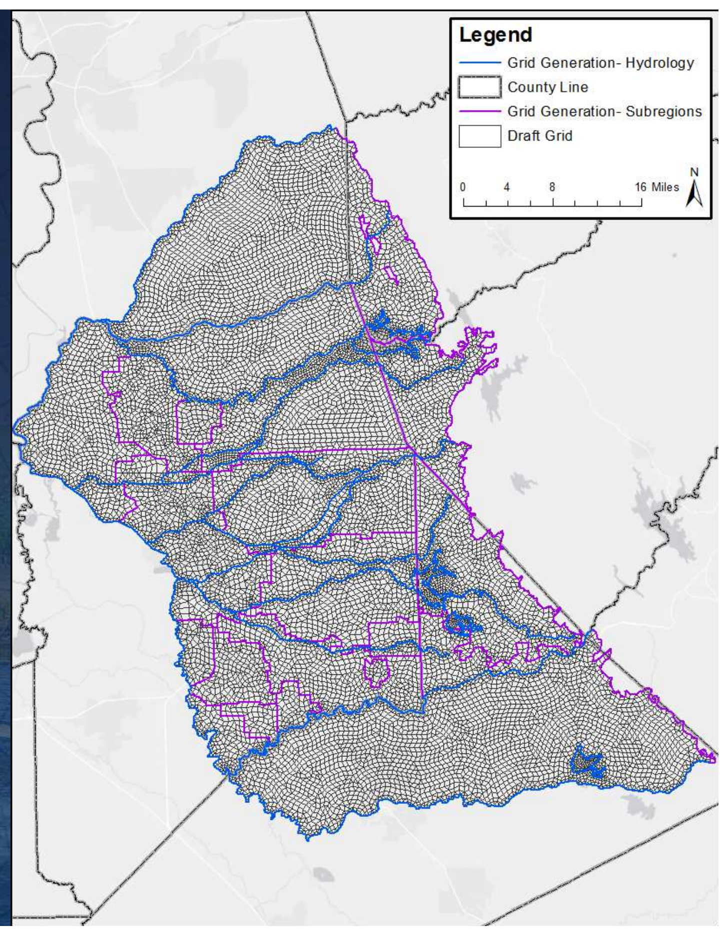
Draft Grid with Model Features

Draft Grid
+ Hydrology
+ County lines



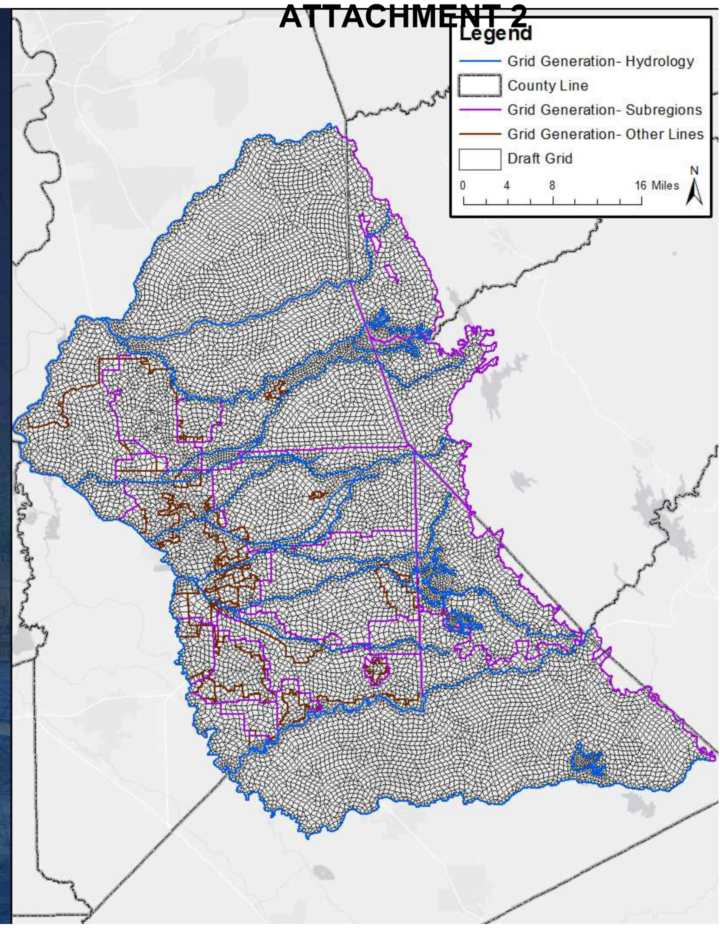
Draft Grid with Model Features

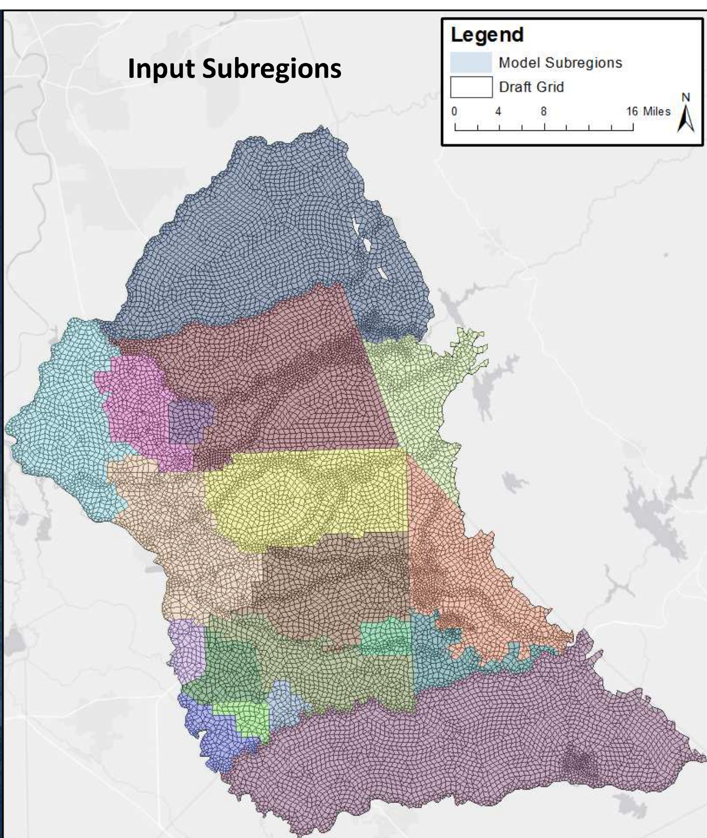
Draft Grid
+ Hydrology
+ County lines
+ Remaining subregion lines

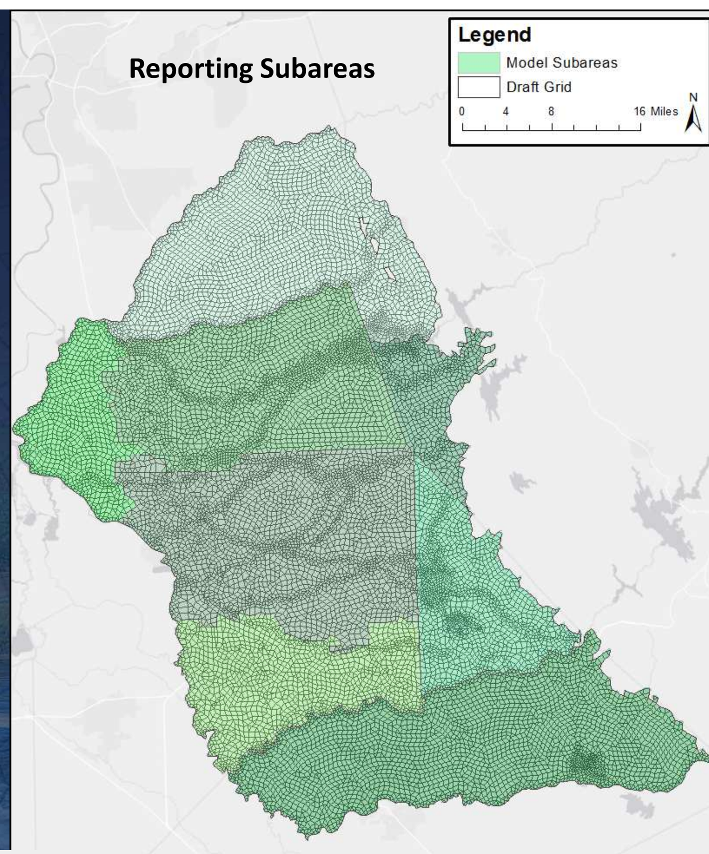


Draft Grid with Model Features

Draft Grid
+ Hydrology
+ County lines
+ Remaining subregion lines
+ Other district lines



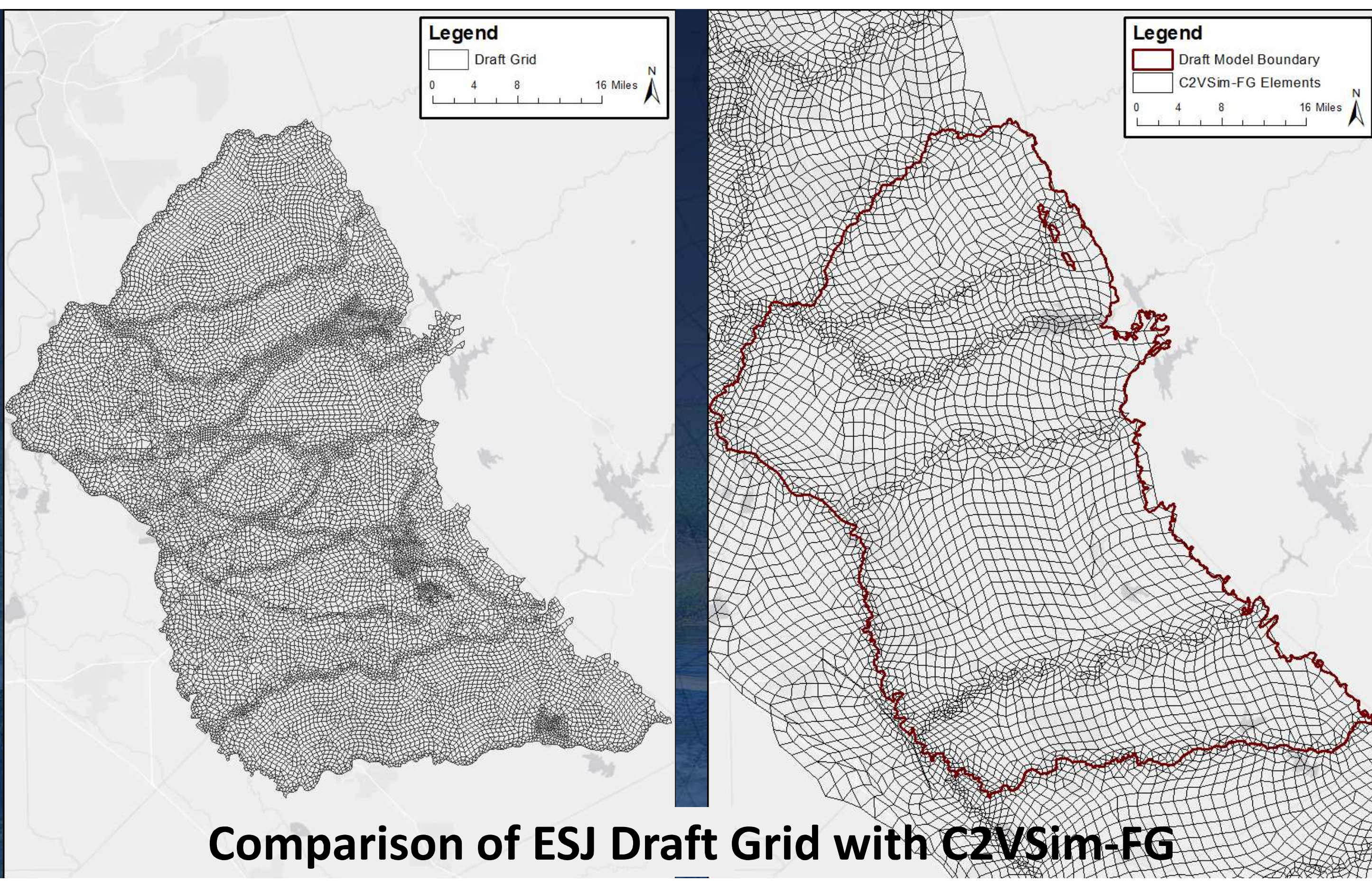




Model Input Subregions and Reporting Subareas

Comparison with Other Models

Model Name	Model Area (acres)	Number of Elements	Average Element Area (acres)	Average Stream Node Spacing	Average Other Node Spacing
Merced Water Resources Model (Merced WRM)- Merced Groundwater Region	491,000	15,441	39	0.25 miles	0.5 miles
Yuba Groundwater Model (YGM)	224,377	10,593	21	~1,000 feet (ranges 500-2,000 feet)	1,000 feet
C2VSim-FG- ESJ Subbasin (w/o Cosumnes and Modesto Subbasins)	772,376	2,093	372	0.59 miles	1.01 miles
Eastern San Joaquin Water Resources Model	**1,227,899**	**16,967**	**72**	**0.25 miles**	**0.5 miles**



Comparison of ESJ Draft Grid with C2VSim-FG

ATTACHMENT 2

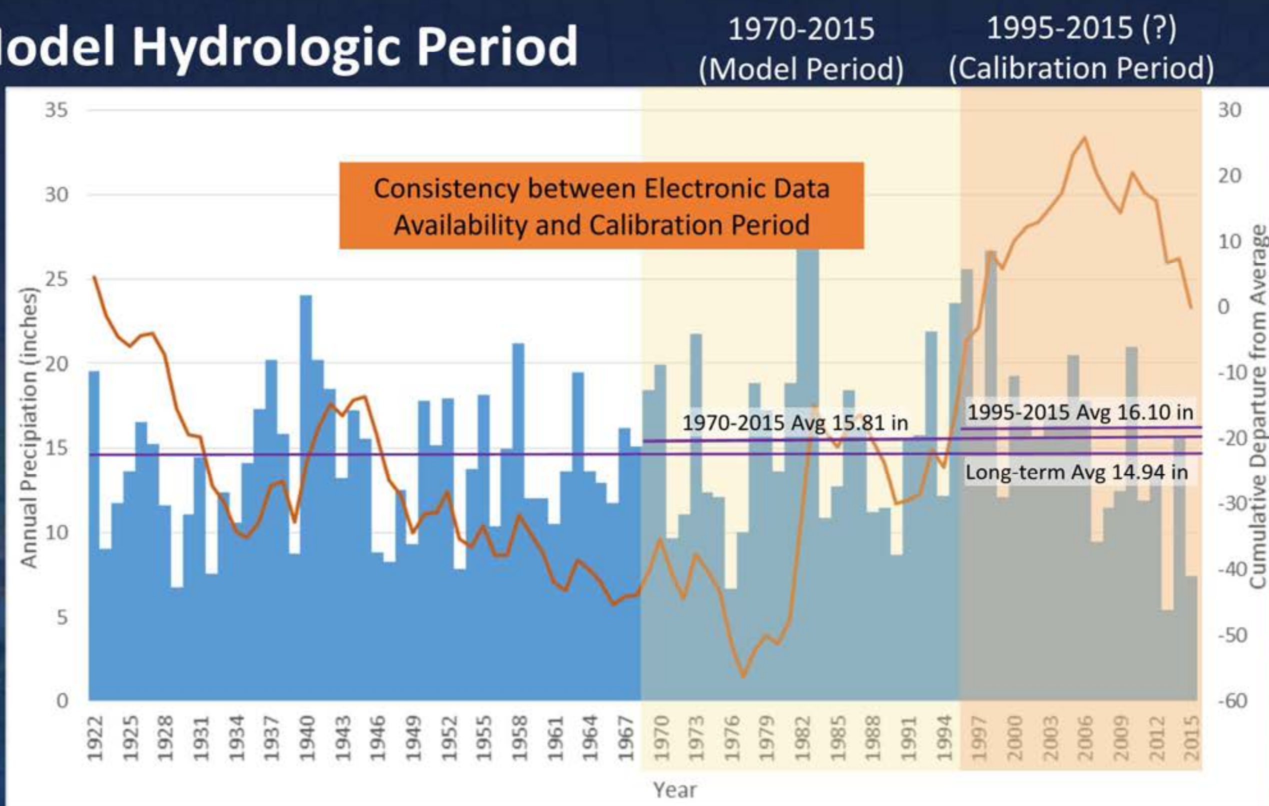
Next Steps for Finalizing Grid

- Address comments from stakeholders
- Considerations on coarser spacing in Modesto and Cosumnes subbasins
- Manual refinement to finalize grid

Model Data Categories

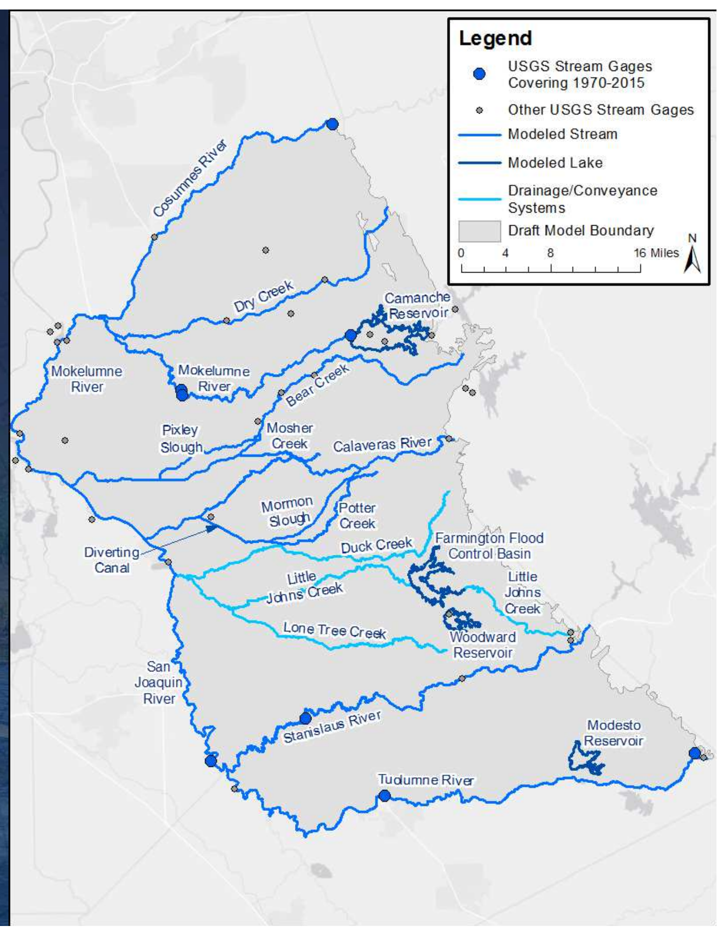
- Hydrology / Rainfall
- Geology and Hydrogeology
- Land Use and Cropping Pattern
- Ag Water Supply (SW Delivery and GW Pumping)
- Estimated Ag Demand (Applied SW or GW Pumping for Ag)
- Urban Water Use (SW, GW, and wastewater)
- GW Operations (Recharge, ASR, quality, monitoring, etc.)
- Well Information (Well IDs, locations, depths, construction, etc.)

Model Hydrologic Period



Modeled Streams

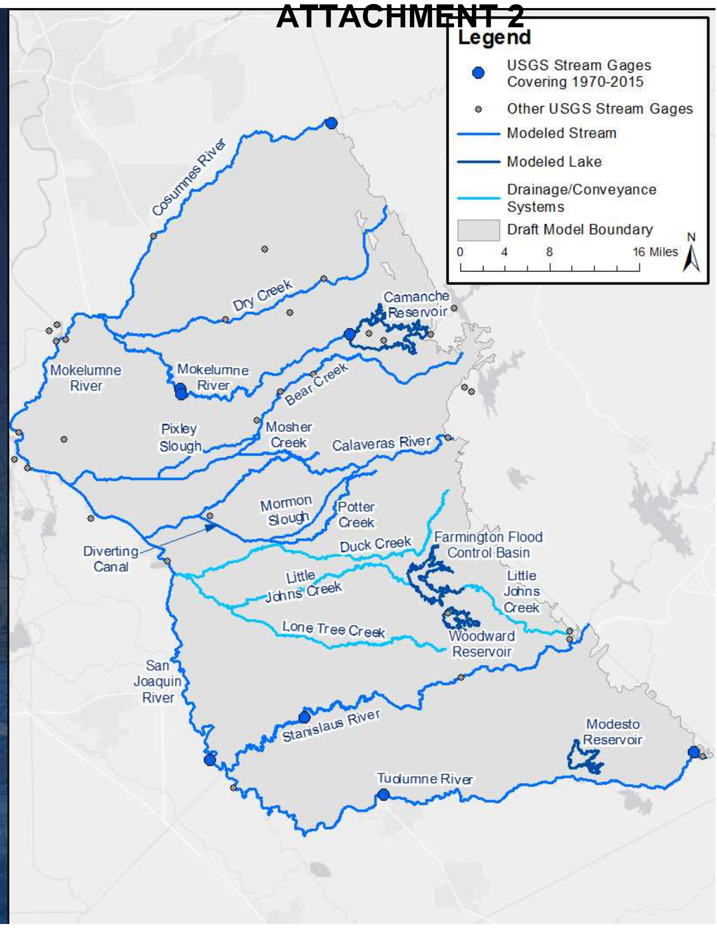
Number	Stream Name	Data Period (1970 – 2015)	Stream Geometry Available	USGS Gage
1	San Joaquin River	Yes	Yes	11303500
2	Cosumnes River	Yes	Yes	11335000
3	Dry Creek	N/A	Yes	C2VSim
4	Mokelumne River	Yes	Yes	11323500 11325500 11325000
5	Calaveras River	Yes	Yes	USACE New Hogan Lake releases
6	Stanislaus River	Yes	Yes	11303000
7	Tuolumne River	Yes	Yes	11290000 11289000



ATTACHMENT 2

Additional Modeled Features

	Additional Modeled Features	Geometry	Flow
	Model Streams		
8	Bear Creek	TBD	Rainfall/Runoff + Conveyance
9	Pixley Slough	TBD	Rainfall/Runoff + Conveyance
10	Mosher Creek	TBD	Rainfall/Runoff
11	Mormon Slough	TBD	Rainfall/Runoff + Conveyance
12	Potter Creek	TBD	Rainfall/Runoff + Conveyance
13	Diverting Canal (connects Mormon Slough back to Calaveras River)	TBD	Rainfall/Runoff + Conveyance
	Model Reservoirs		
14	Camanche Reservoir	N/A	CDEC
15	Farmington Flood Control Basin	N/A	USACE
16	Woodward Reservoir	N/A	SSJID
17	Modesto Reservoir	N/A	CDEC



Status of Data Request

- Land Use and Cropping Pattern
- Ag Water Supply (SW Delivery and GW Pumping)
- Estimated Ag Demand (Applied SW or GW Pumping for Ag)
- Urban Water Use (SW, GW, and wastewater)
- GW Operations (Recharge, ASR, quality, monitoring, etc.)
- Well Information (Well IDs, locations, depths, construction, etc.)

ATTACHMENT 2

Sustainable Groundwater Management Act Readiness Project

Meeting No. 5: Integrated Water Resources Model Development Update

RMC water and environment

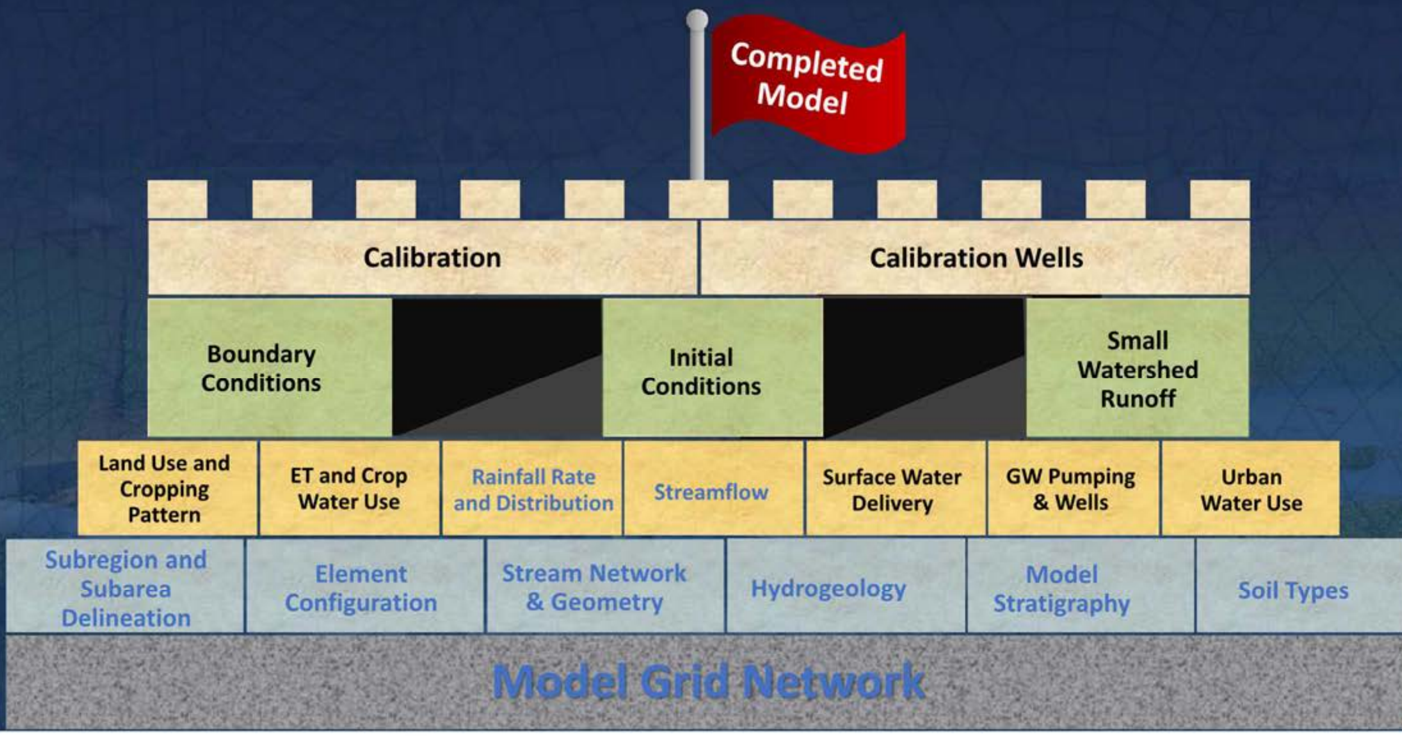
Complex Challenges | Innovative Solutions

April 26, 2017

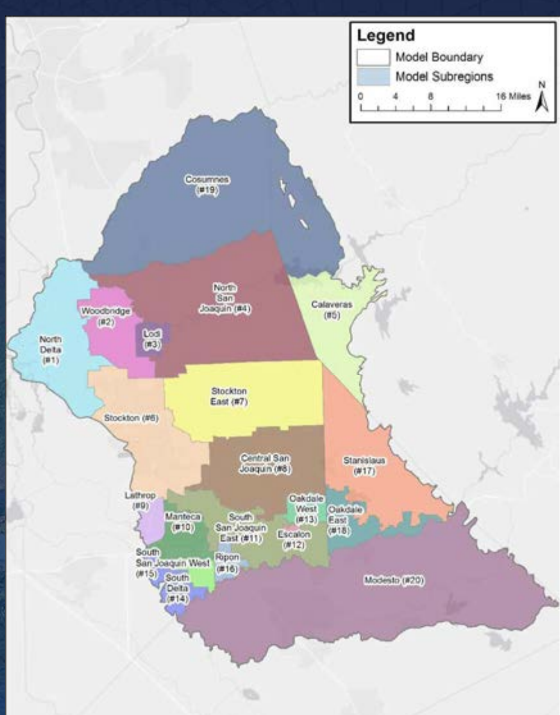
Agenda

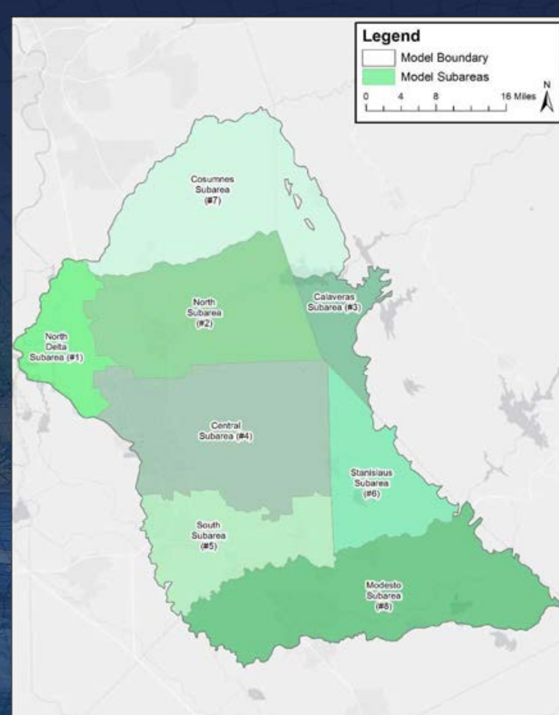
- Model Stratigraphy
- Land Use Processing Update
- Data Development for IDC Model
  - Soil
  - Precipitation
- Agency Data Compilation
  - Groundwater Pumping
  - Urban Demand
- Next Steps

Integrated Model Construction



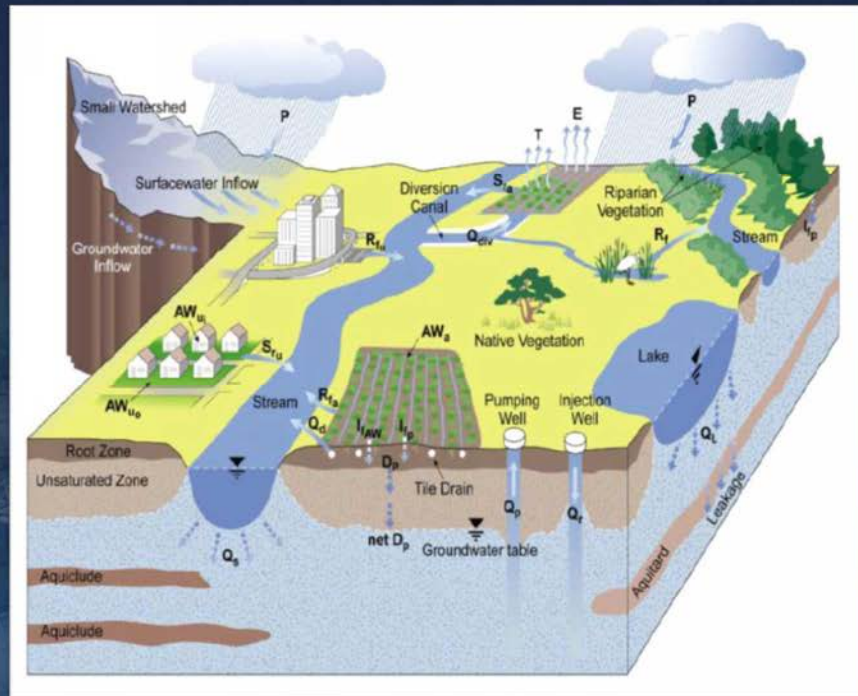
Completed Model Component: Model Boundary and Subregions





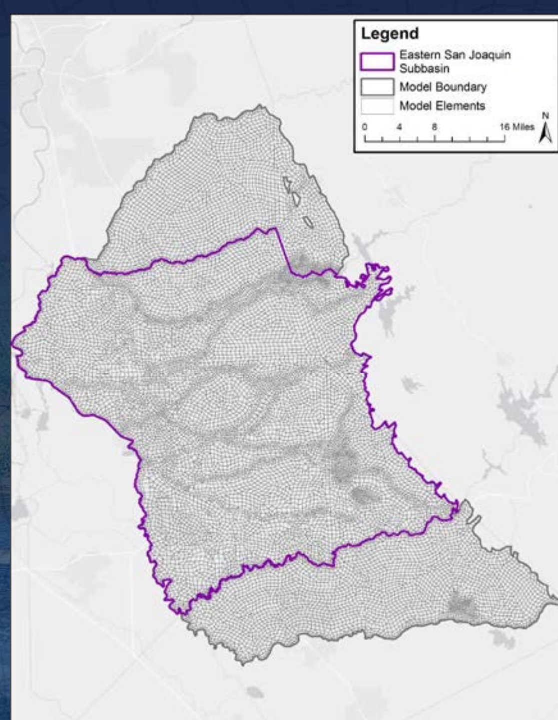
Integrated Water Resources Modeling

- Land Surface Processes
- Groundwater Flow
- Streamflow
- Physical Systems Integration
- Water Balance Preservation Over time and space



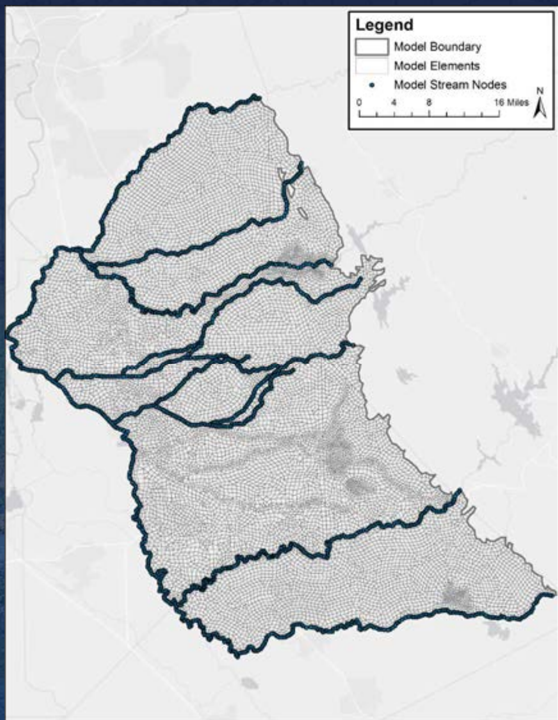
Completed Model Component: Elements and Node Configuration

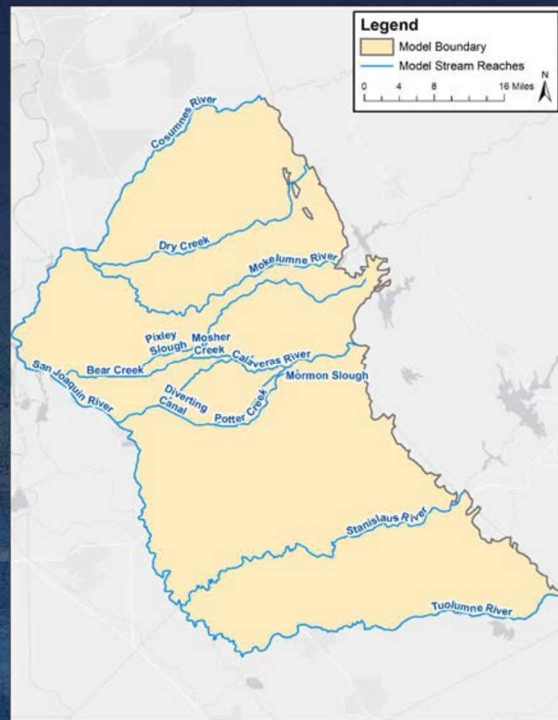
- Model Grid
  - 16,054 elements
  - 15,302 nodes
- Covering Cosumnes , Eastern San Joaquin, and Modesto Groundwater Subbasins



ATTACHMENT 2

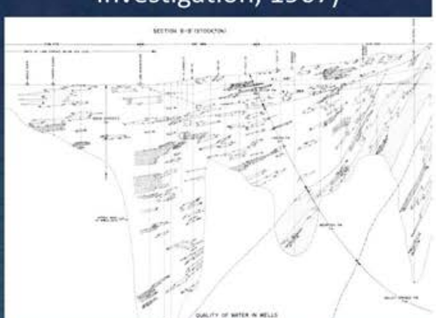
Completed Model Component: Stream Hydrology



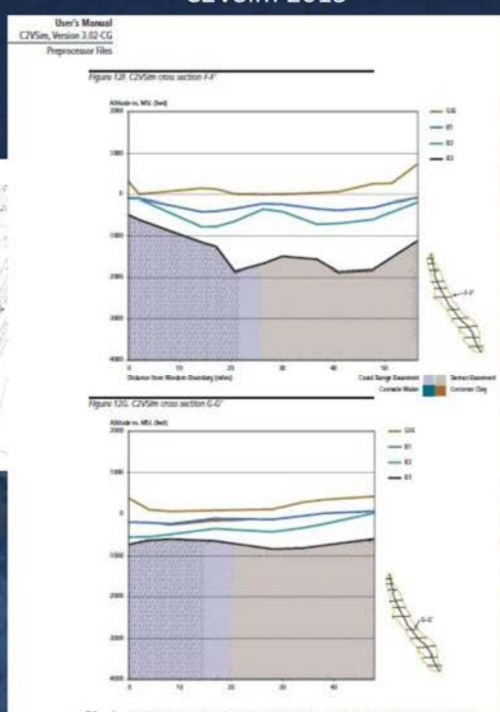


Schematic Hydrogeological Cross-Sections Compared and Refined

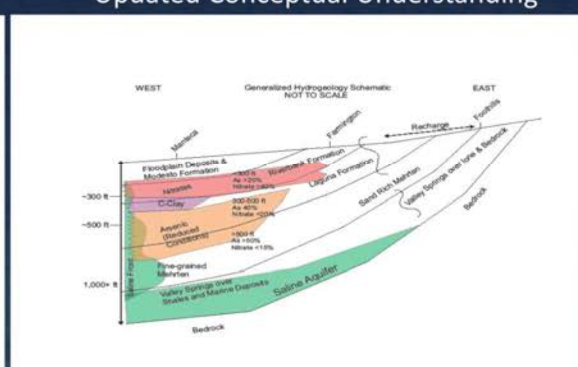
DWR (San Joaquin County Ground Water Investigation, 1967)

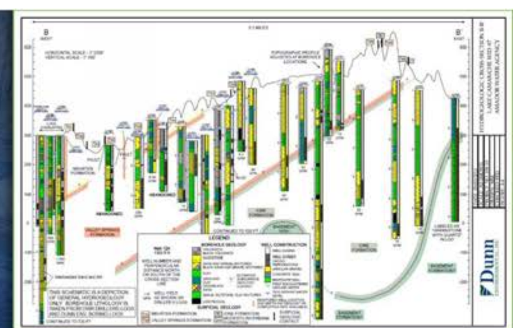


C2VSim 2013



Updated Conceptual Understanding





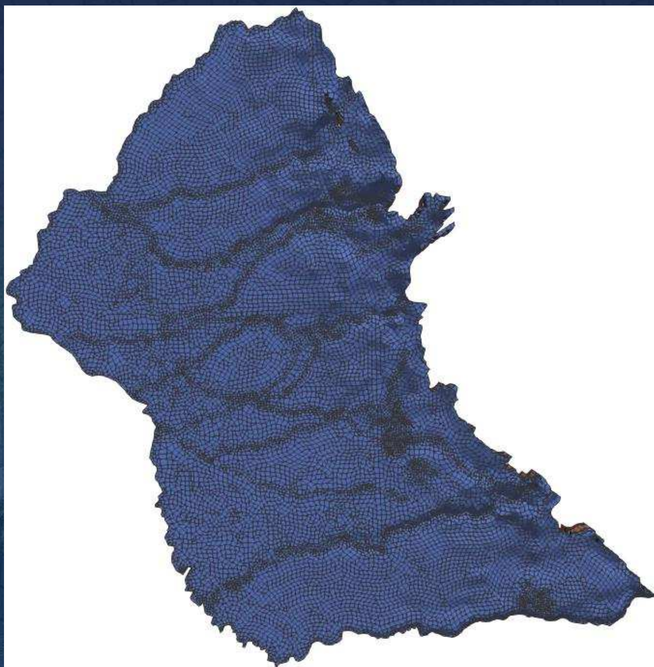
Basis for Model Stratigraphy

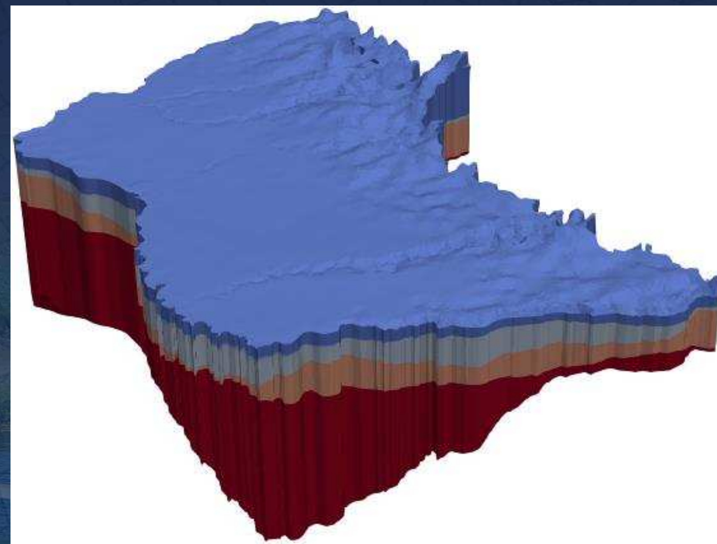
- Based on C2VSim-FG updated 4-layer stratigraphy:
  - Ground Surface Elevation: National Elevation Dataset (USGS, 10 meter DEM)
  - Bottom of Layers 1 and 2
    - From latest available version of C2VSim (DWR, Development and Calibration of the California Central Valley Groundwater-Surface Water Simulation Model, 2013)
    - Bottom of Layer 1 represents top of Corcoran Clay in areas with Corcoran Clay (USGS, CVHM Texture Model)
  - Bottom of Layer 3- Base of Freshwater
    - DWR North Central Regional Office (Sacramento Valley) (Pers. Comm. Steven Springhorn)
    - DWR South Central Regional Office (San Joaquin Valley) (Pers. Comm. Christopher Olvera)
    - Williamson 1989 D43 (USGS, Williamson et al., Ground-Water Flow in the Central Valley California, 1989)
    - Latest available version of C2VSim
  - Bottom of Layer 4- Bottom of Continental Deposits
    - Base and Thickness of the Post Eocene Continental Deposits in Sacramento Valley (USGS, Page, 1974)
    - Williamson 1989 D11 Thickness of Aquifer (USGS, Williamson et al., Ground-Water Flow in the Central Valley California, 1989)
    - Latest available version of C2VSim

C2VSim: Sample Cross-Section Through ESJ Model Area

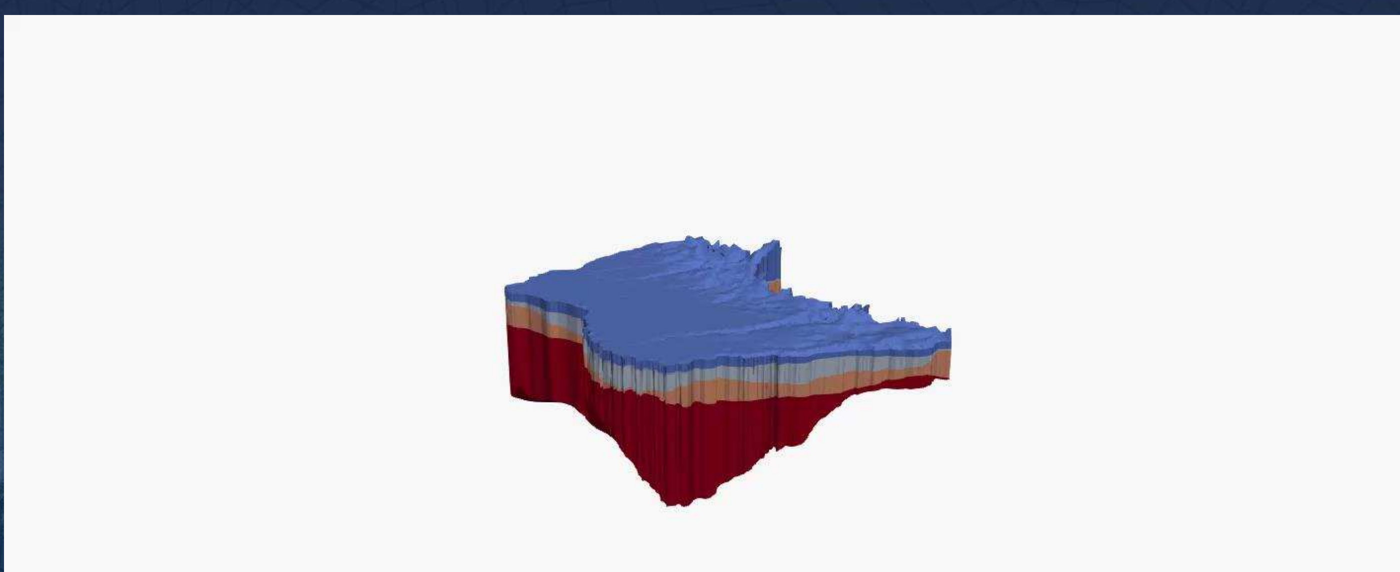
ATTACHMENT 2

Model Stratigraphy



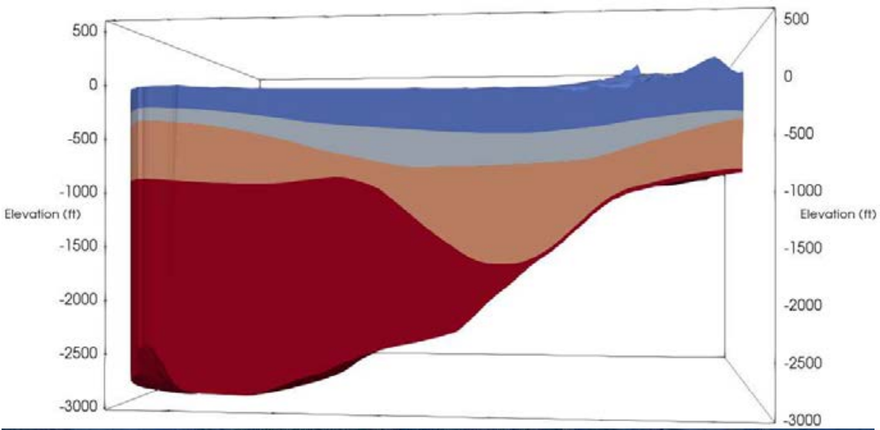


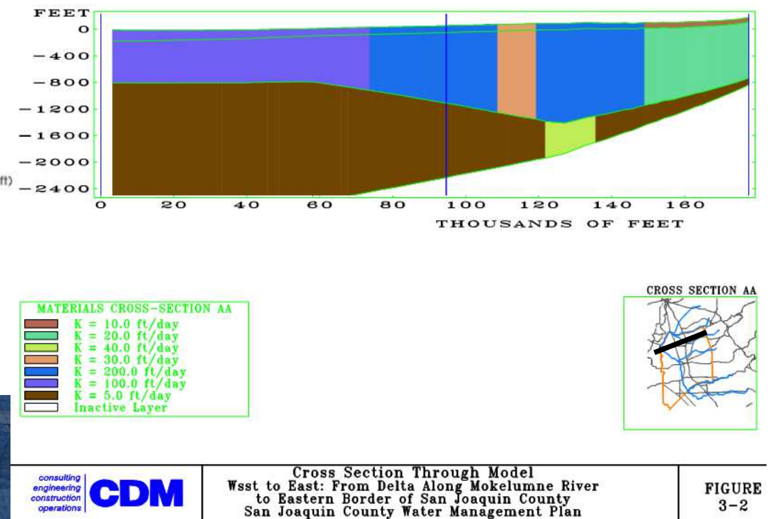
Model Stratigraphy: Rotation Around Model Edges



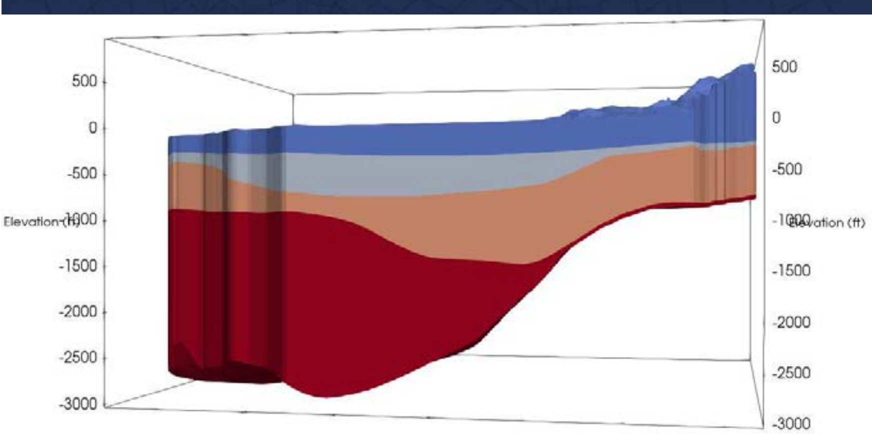
ATTACHMENT 2

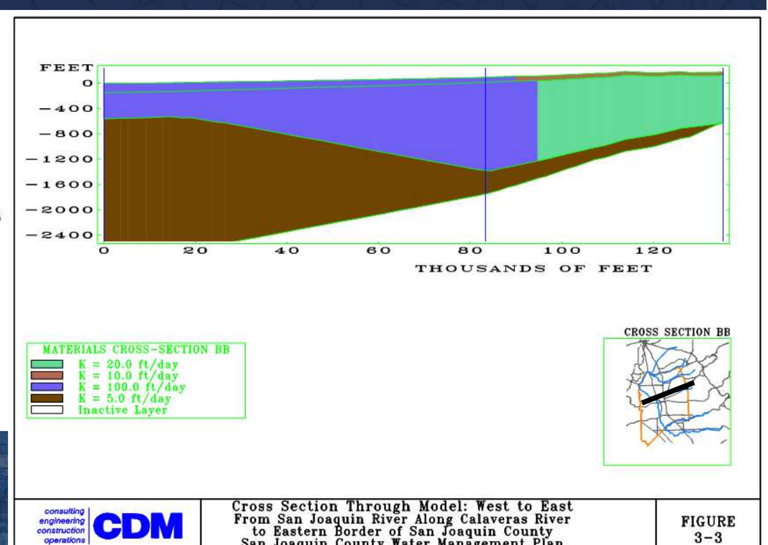
Comparison: ESJ Stratigraphy and DYNFLOW





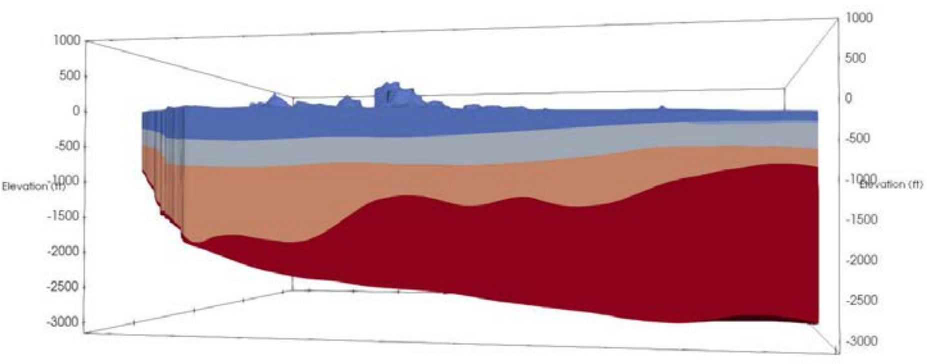
Comparison: ESJ Stratigraphy and DYNFLOW

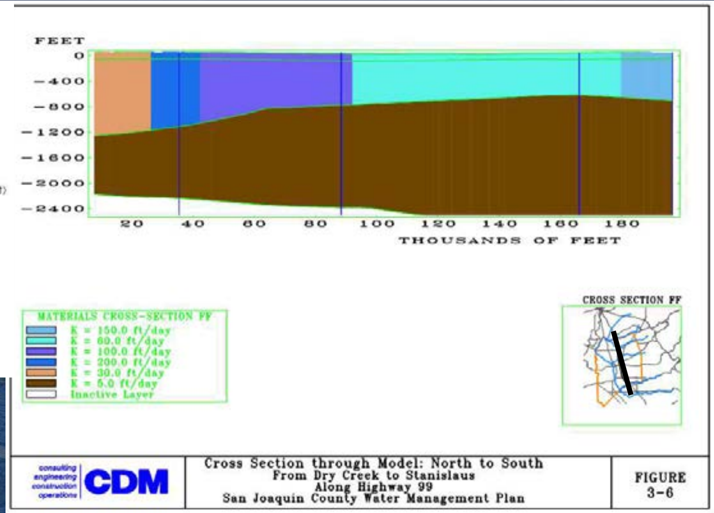




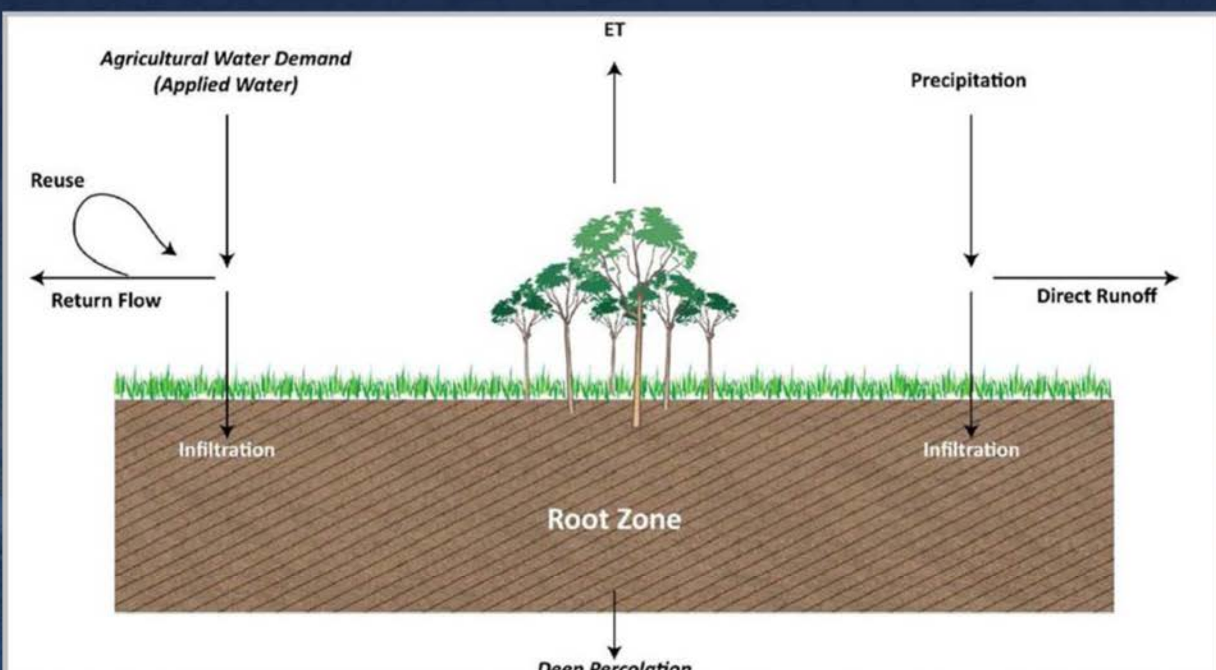
ATTACHMENT 2

Comparison: ESJ Stratigraphy and DYNFLOW



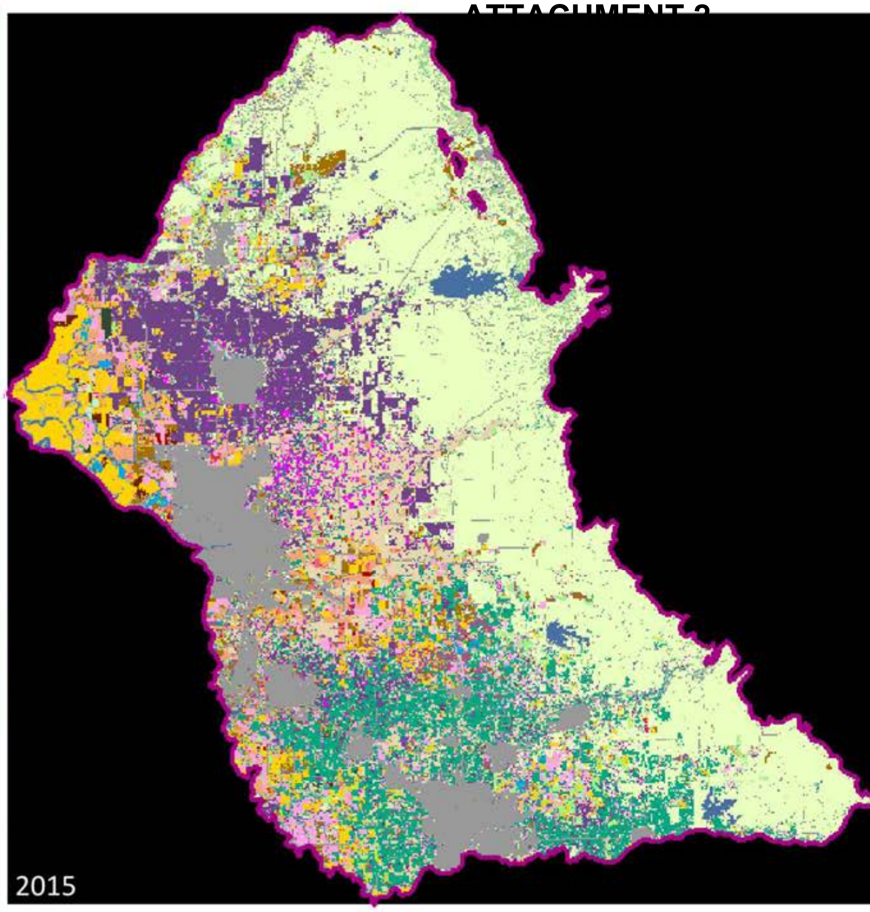


IWFM Demand Calculator: IDC

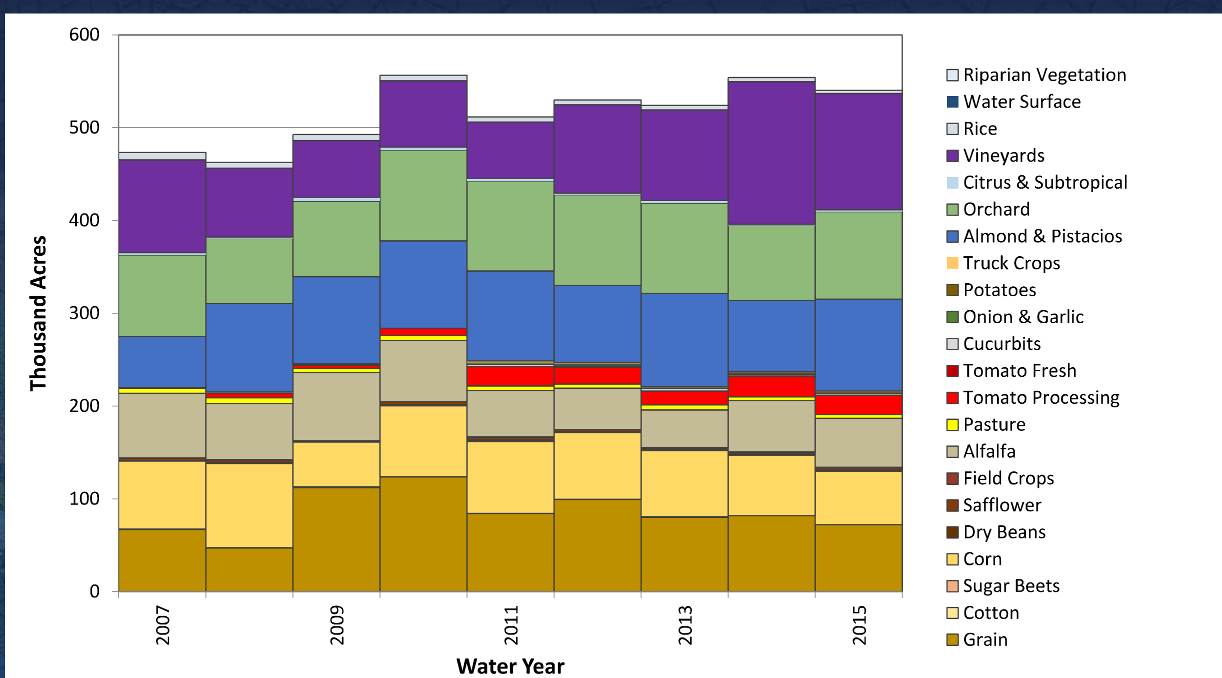


Land Use and Crop Coverage

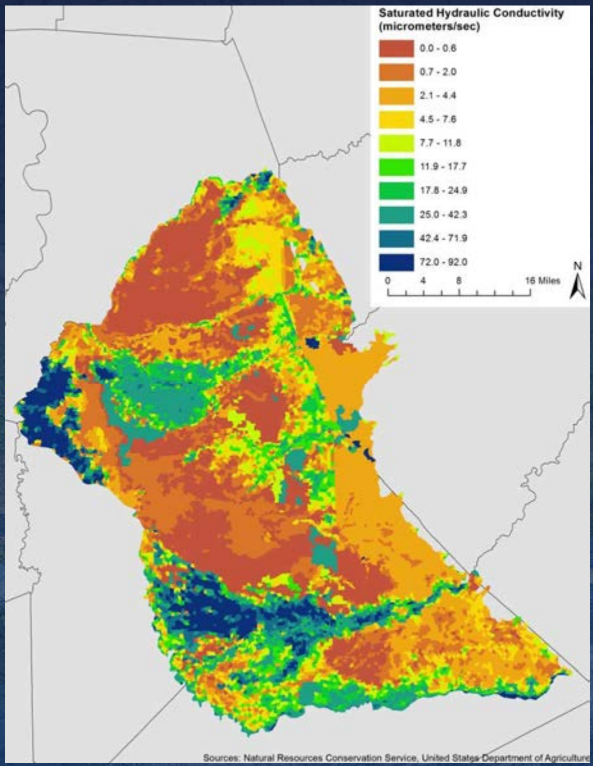
- DWR Land Use Surveys
- USDA's CropScape – Remote Sensing
- DWR's LandIQ Survey; 2014- Remote Sensing
- Local Data Sources

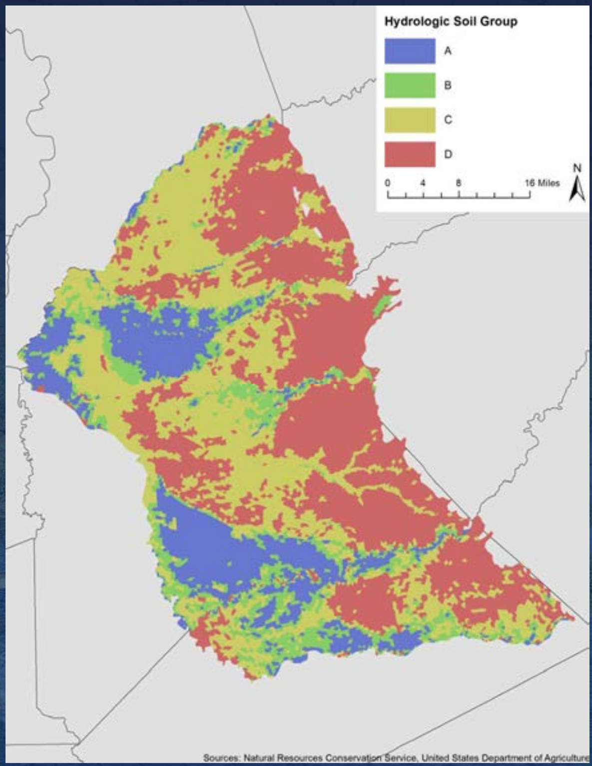


Draft Land Use Acreages



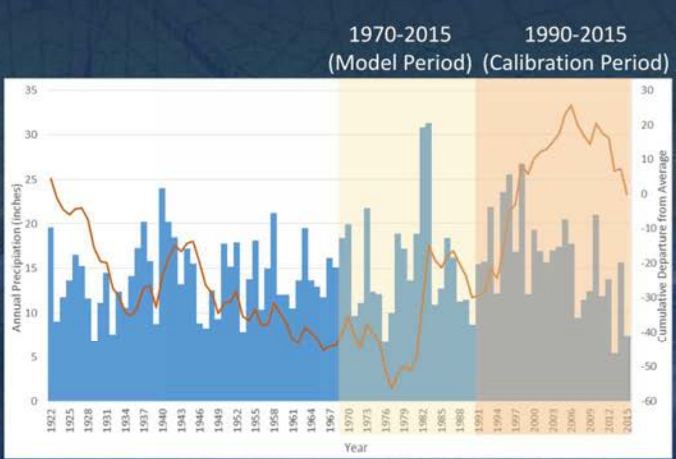
Root Zone Parameters

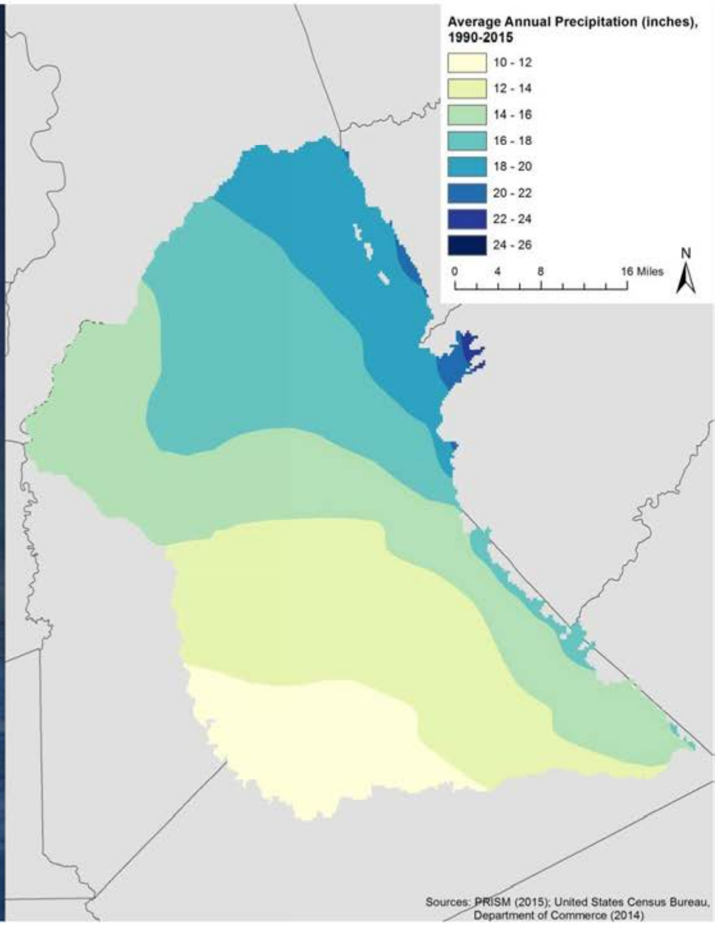




Precipitation

- Completed model input file for precipitation
- Source of Data: PRISM for entire model period (1990-2015)

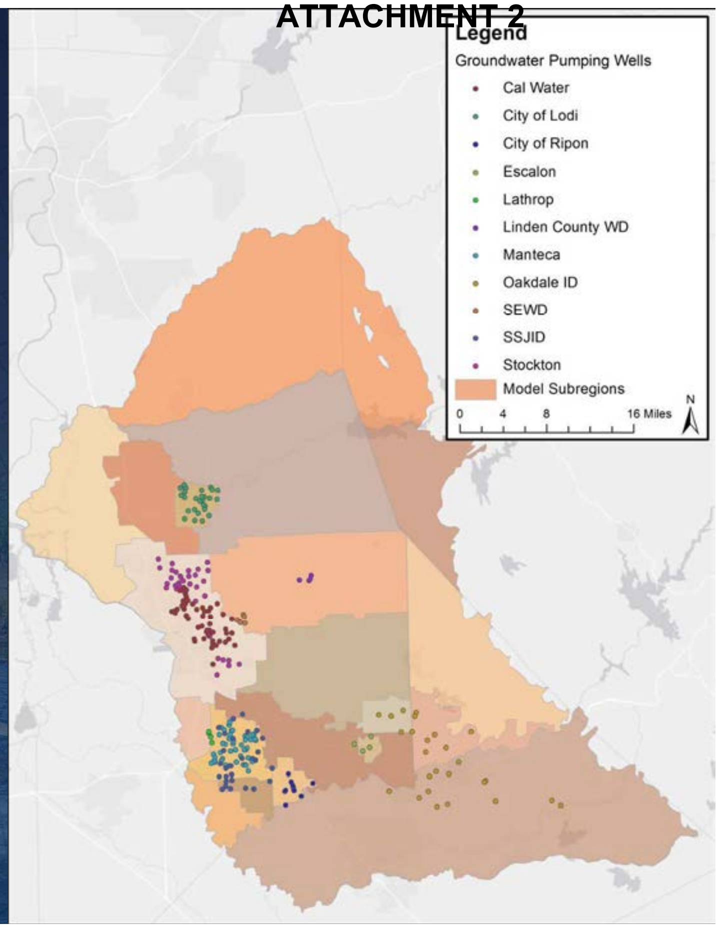




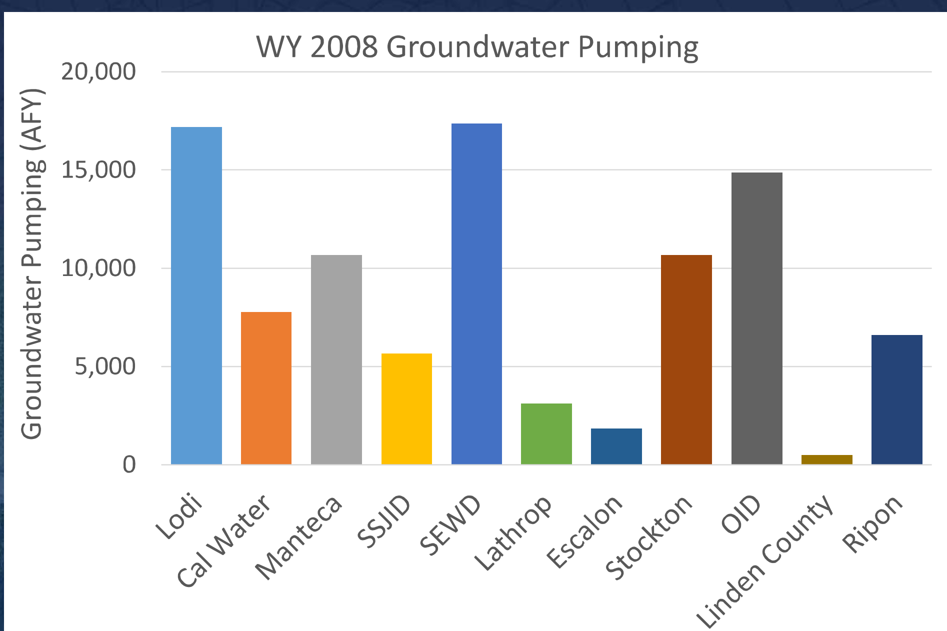
ATTACHMENT 2

Groundwater Pumping

Agency	Number of Wells Contributing to Water Demand
Cal Water	56
City of Escalon	4
City of Lathrop	5
City of Lodi	35
City of Manteca	46
City of Ripon	10
City of Stockton	38
Linden County WD	4
Oakdale ID	26
Stockton East WD	5
South San Joaquin ID	28
TOTAL (as of 4/25/17)	**257**



Groundwater Pumping



- Data issues:
  - Incomplete monthly time series for many agencies
  - Interpolation between years not always feasible

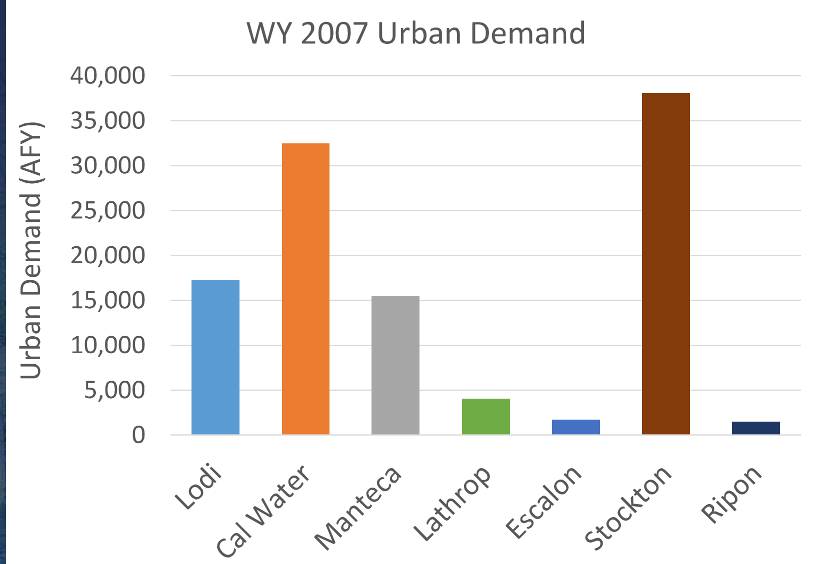
Agency	Data Period of Record
Lodi	1990-2015
Cal Water	1990-2015
Manteca	2002-2015 with gaps depending on well type
SSJID	1990-2015
SEWD	2005-2015
Lathrop	2006-2010 (need breakdown by well)
Escalon	1998-2015
Stockton	2002-2015
OID	2001-2010
Linden County	1995-2015
Ripon	Need breakdown by well

ATTACHMENT 2

Urban Water Demand

- Based on GPCD and population if water demand information unavailable
- Data issues:
  - Incomplete agency data
  - Estimates about demand are tricky to balance with supply

Agency	Data Period of Record
Lodi	1990-2015
Cal Water	1995-2015
Manteca	1996-2007
Lathrop	1990-2011
Escalon	1998-2015
Stockton	1998-2009
Ripon	1995, 2002, 2005, 2007, 2014-2015



* Values for Cal Water and Stockton may represent total demand, not just urban

Project General Schedule

ATTACHMENT 2

Next Steps

- Complete Stream Geometry Data
- Compile and Process pumping well construction information
- Compile and Process GW pumping for urban and agricultural use
- Compile and Process Surface water diversions for urban and agricultural use
- Communicate LU/Cropping patterns with local agencies
- Complete IDC input data files:
  - Annual land use acreages
  - ET maps from DWR
  - Ag water budget from agencies

Sustainable Groundwater Management Act Readiness Project

Meeting No. 6:

Integrated Water Resources Model Development Update

RMC water and environment

Complex Challenges | Innovative Solutions

San Joaquin County California

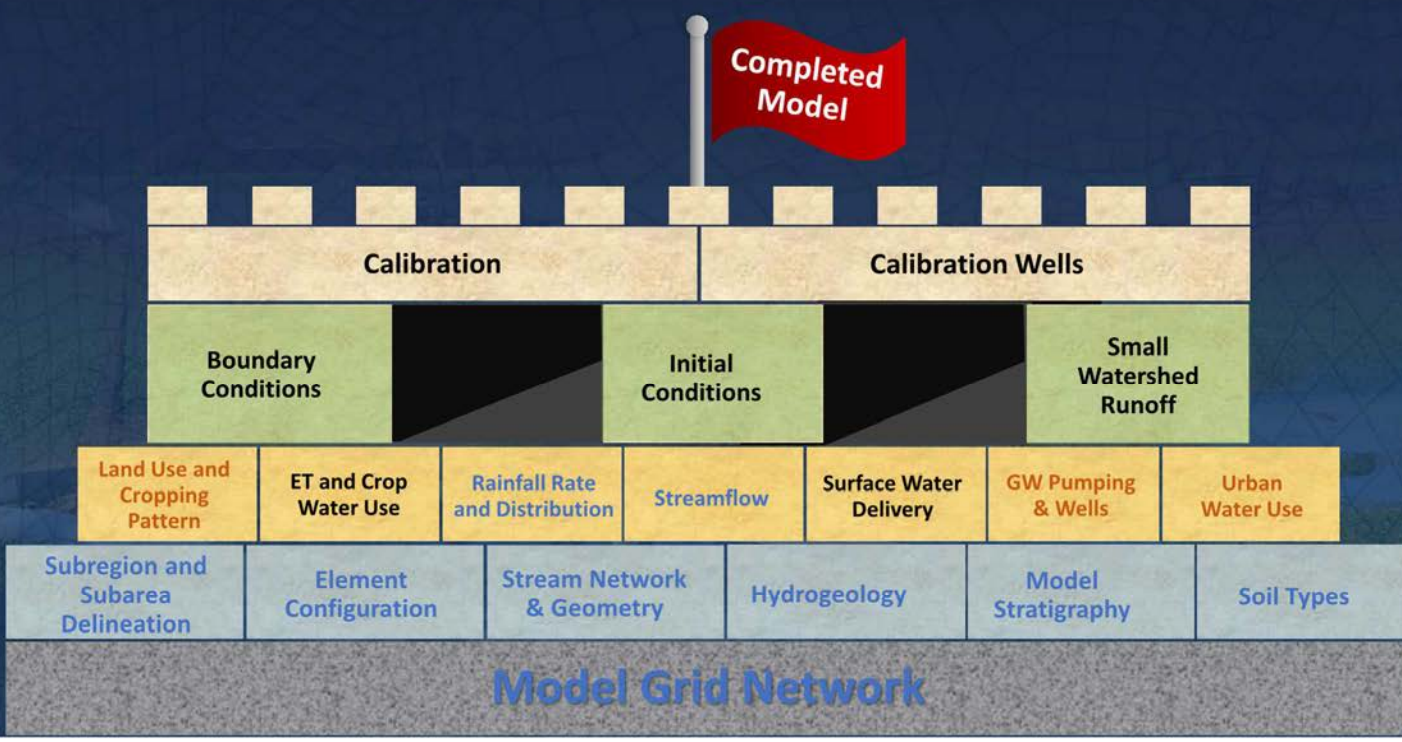
May 24, 2017

ATTACHMENT 2

Agenda

- Introduction
- Model Crop and Other Land Use Acreage
- Model Urban Water Demand and Groundwater Pumping
- Prop 1 SGMA Groundwater Sustainability Plans Grant
- Next Meeting

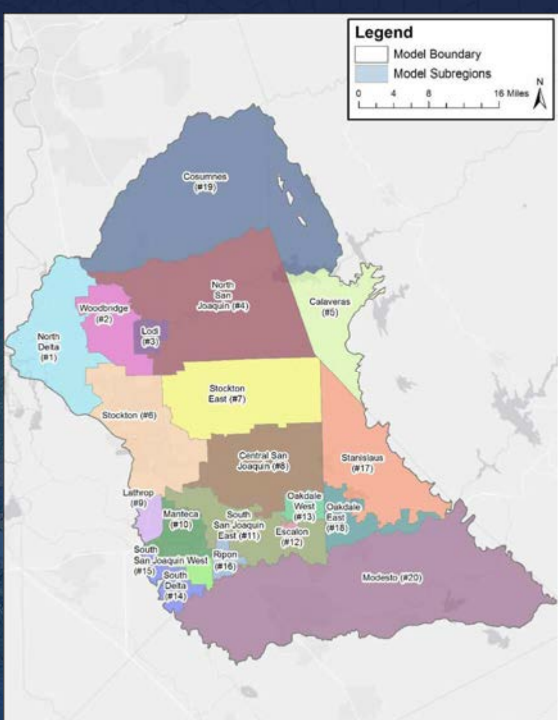
Integrated Model Construction

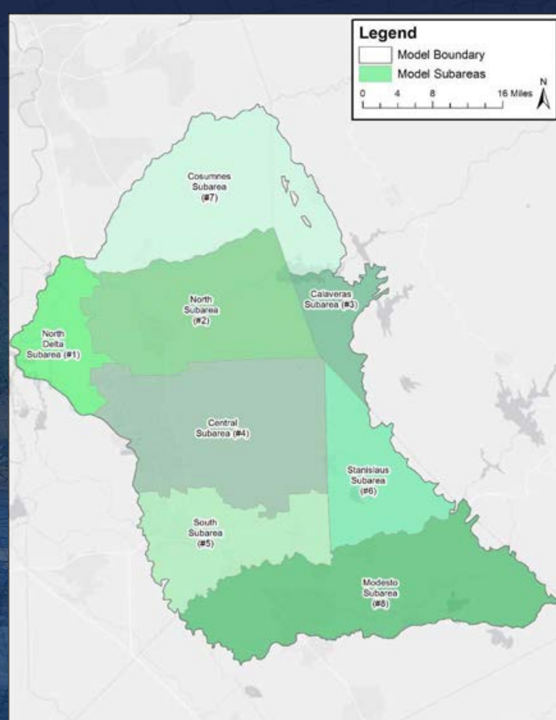


ESJ Model Trivia Part I

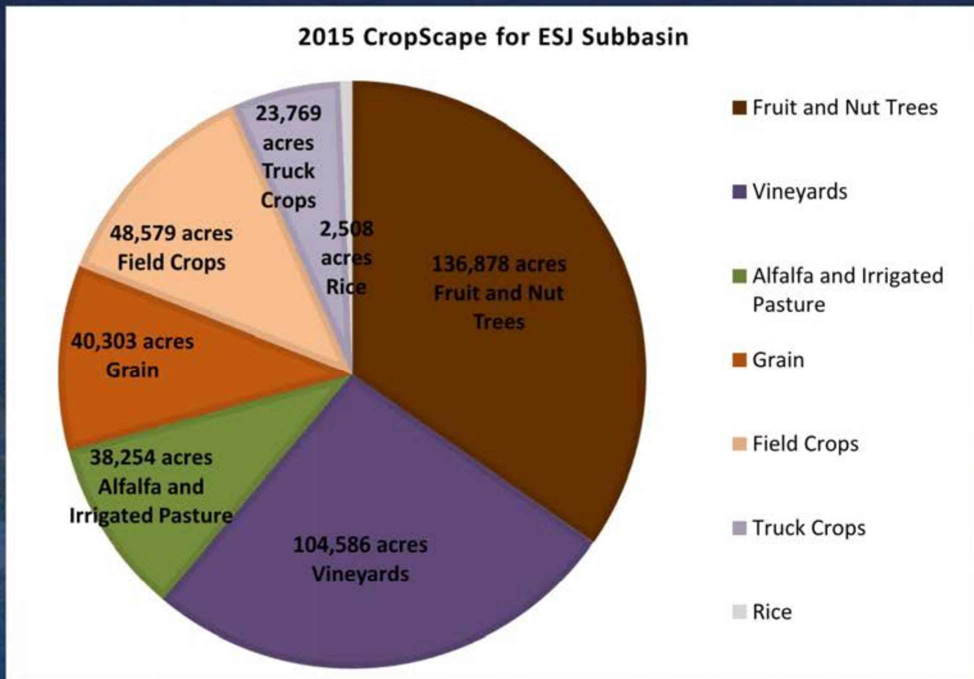
1. What are the neighboring Subbasins of the ESJ GW Subbasin?
   Solano, South American, Cosumnes, Tracy, Delta-Mendota, and Modesto
2. What are the geographic features of ESJ GW Subbasin at the boundaries?
   - Northern boundary: Dry Creek and County Boundary
   - Eastern boundary: Foothills
   - Southern boundary: Stanislaus River
   - Western boundary: San Joaquin River
3. What is the total gross acreage of ESJ GW Subbasin?
   772,377 acres (~1,207 square miles or ~3,126 square kilometers)
4. What is the total irrigated acres in ESJ Subbasin?
   381,907 acres (~597 square miles or ~1,546 square kilometers)

Completed Model Component: Model Boundary and Subregions

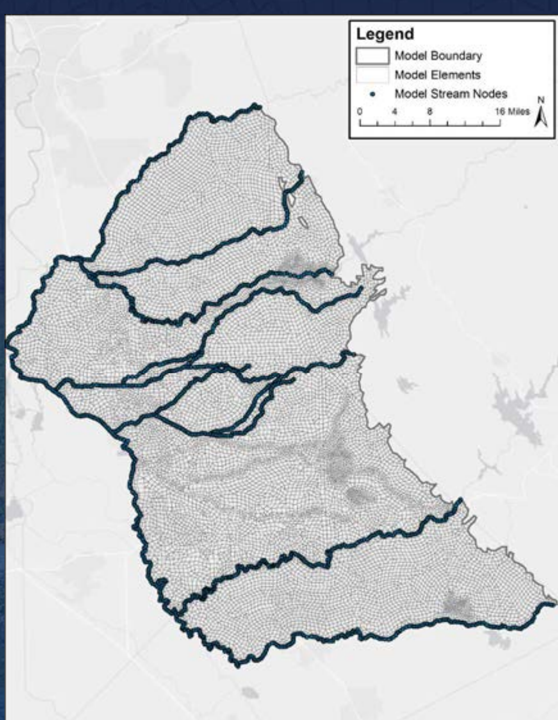




Primary Cropping Pattern in ESJ Subbasin



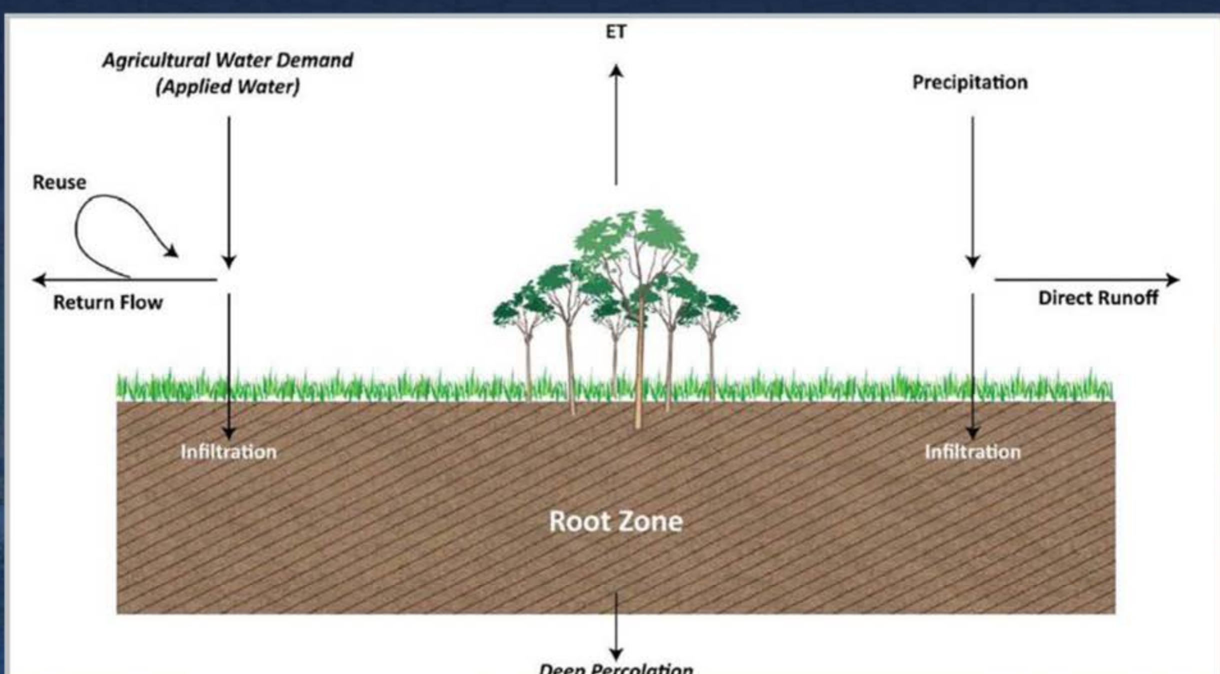
Completed Model Component: Stream Hydrology



ESJ Model Trivia Part II

1. How many elements are in the model?
   16,054 elements
2. What is the average node spacing in the model area?
   - Across Model Area: 0.37 miles
   - Along the Rivers / Water Courses: 0.28 miles
3. Why do we break up the model into elements?
   - Delineate hydrologic and jurisdictional features at local scale
   - Simulate hydrologic processes at local scale

AG Water Demand Estimation

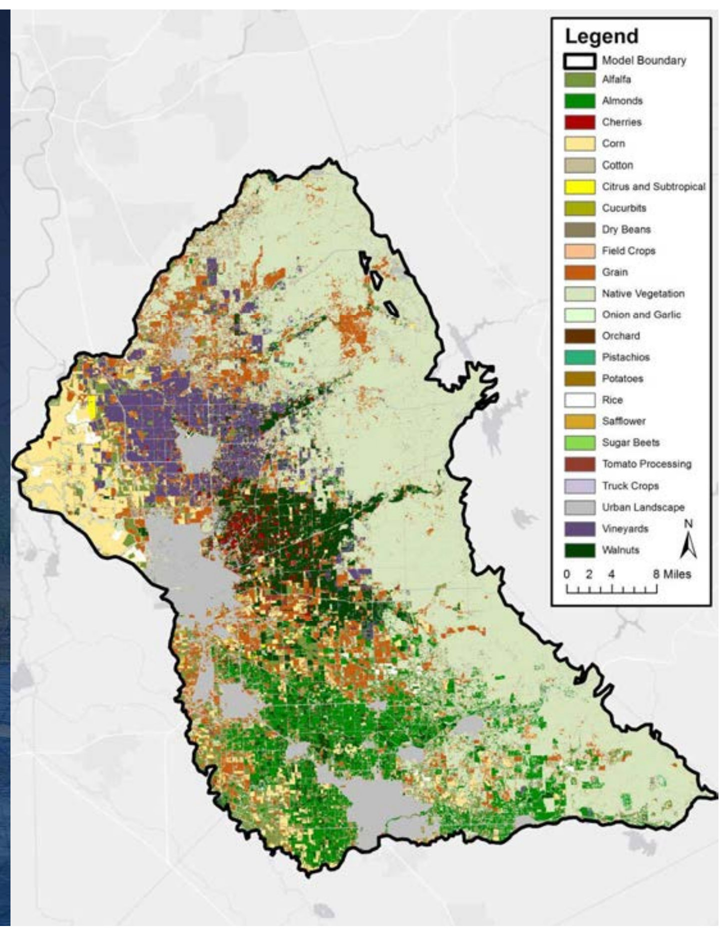


Land Use and Crop Coverage

1. DWR Land Use Surveys (Representing ~1995 Era)
   - San Joaquin County (1996)
   - Sacramento County (1993)
   - Amador County (1997)
   - Calaveras County (2000)
   - Stanislaus County (1996)
2. Remote Sensing Data:
   - USDA's CropScape
   - DWR's LandIQ Survey; 2014
3. Local Data Sources

USDA CropScape

- Satellite imagery collected during growing season
- 30 meter by 30 meter pixels
- Level of accuracy: Generally 85% to 95% for crop-specific land cover categories
- 256 land use categories



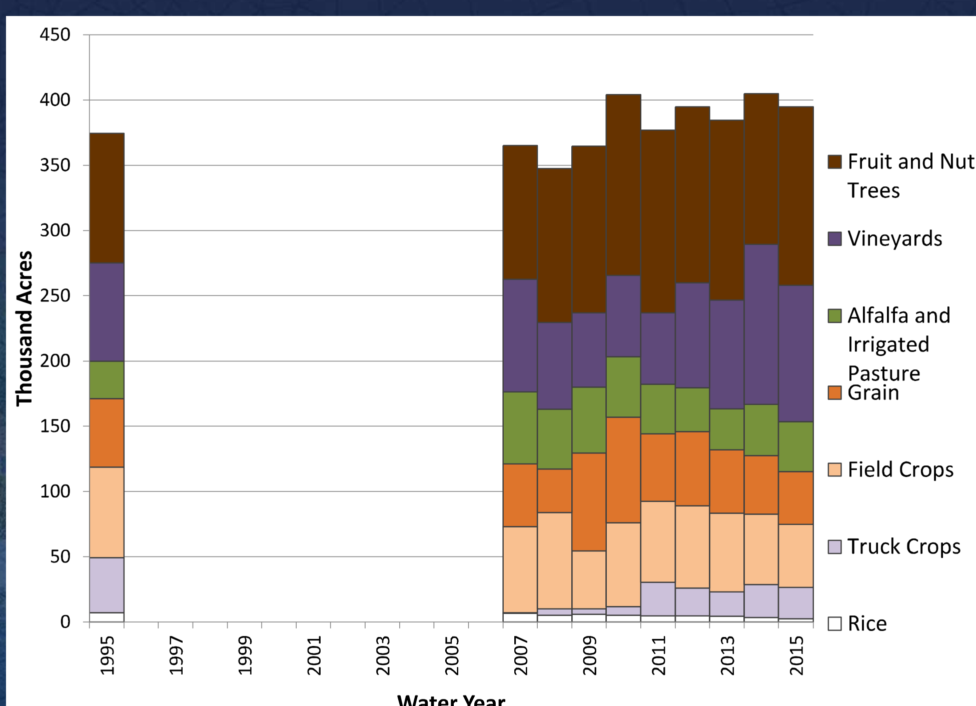
ATTACHMENT 2

Model Land Use Types

- 23 irrigated crop categories
- 4 other land use categories
- 7 high-level categories used for verification purposes

Model Crop Category	Grouped Crop Categories
Almonds Cherries Citrus & Subtropical Other Orchard Pistachios Walnuts	Fruit and Nut Trees
Vineyards	Vineyards
Alfalfa Pasture	Alfalfa and Irrigated Pasture
Grain	Grain
Corn Cotton Dry Beans Field Crops Safflower Sugar Beets	Field Crops
Cucurbits Onion & Garlic Potatoes Tomato Fresh Tomato Processing Truck Crops	Truck Crops
Rice	Rice
Urban Landscape Water Surface Riparian Vegetation Native Vegetation	Other Land Use

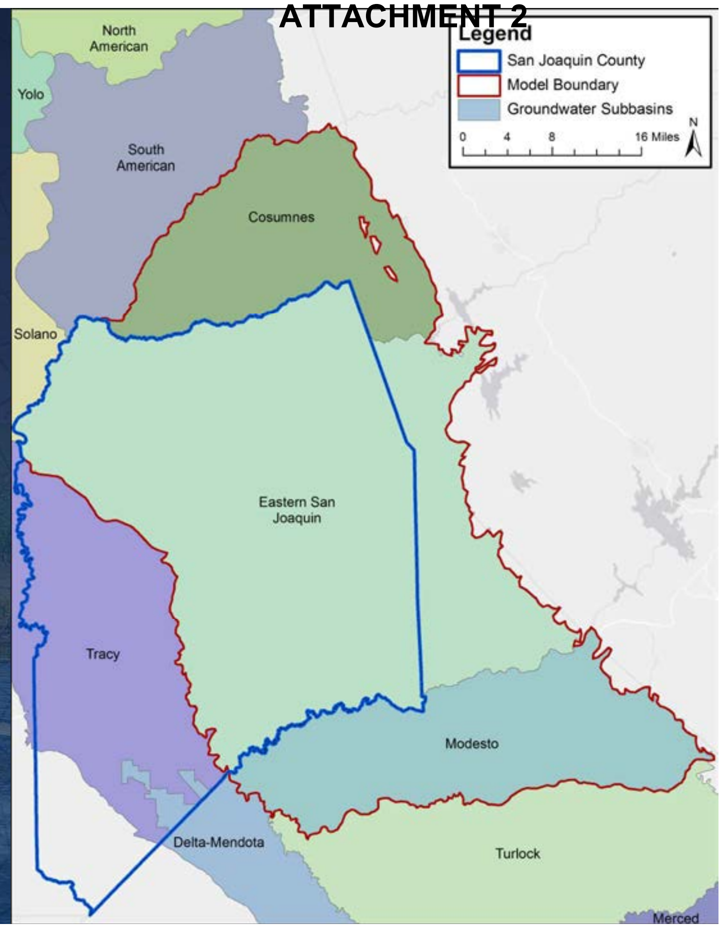
Primary Cropping Pattern in ESJ Subbasin



ATTACHMENT 2

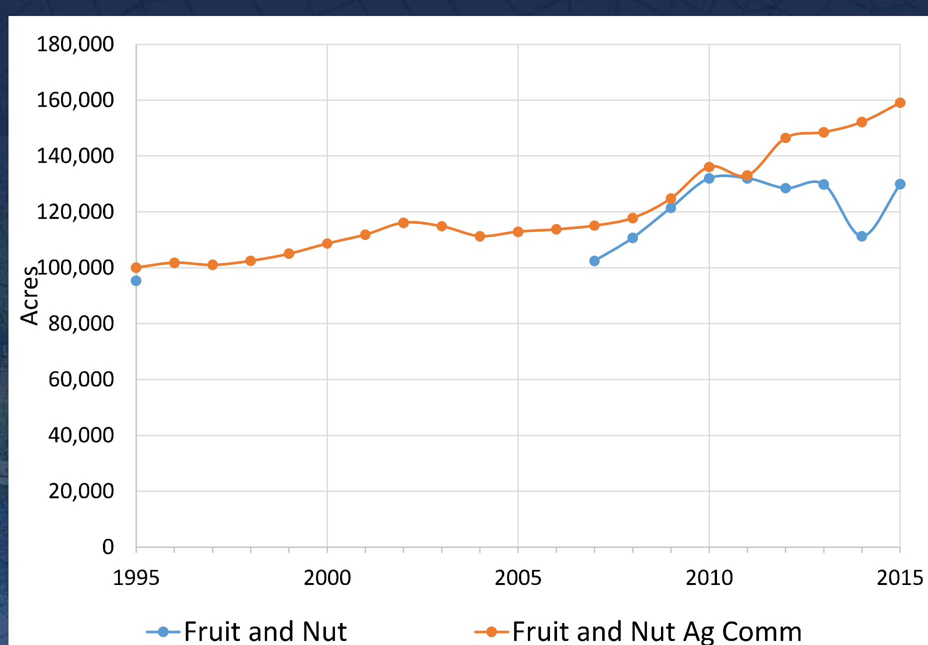
Regional Data: Comparison with Agricultural Commissioner Reports

- Ag Commissioner annual reports cover the entire county
- Model covers only the portion of the Eastern San Joaquin groundwater subbasin within the county
- Numbers not directly comparable, but can be used to glean trends



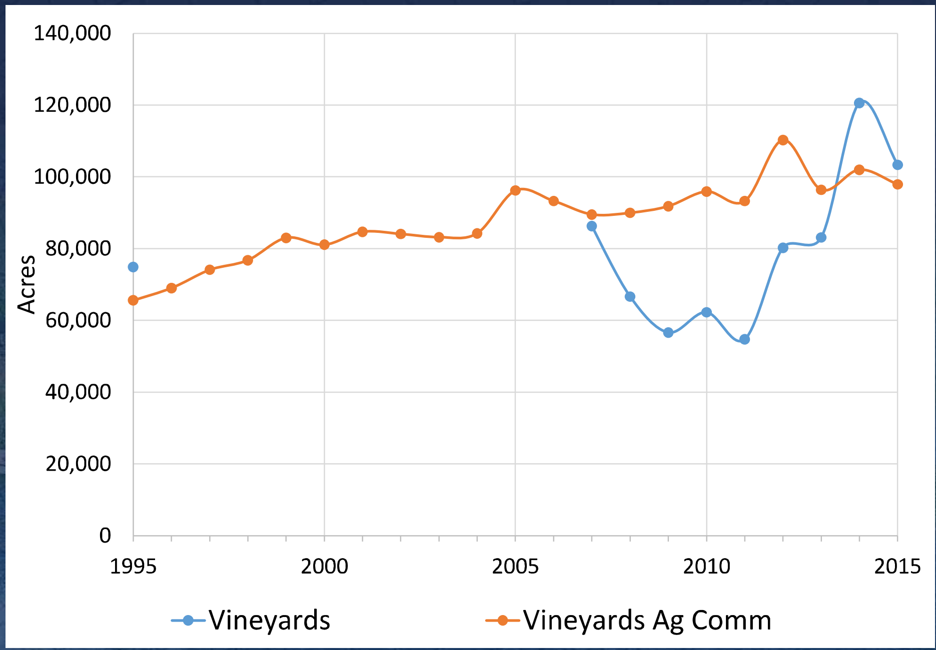
Fruit and Nut Crops

- Categories:
  - Almonds
  - Cherries
  - Citrus & Subtropical
  - Other Orchard
  - Pistachios
  - Walnuts



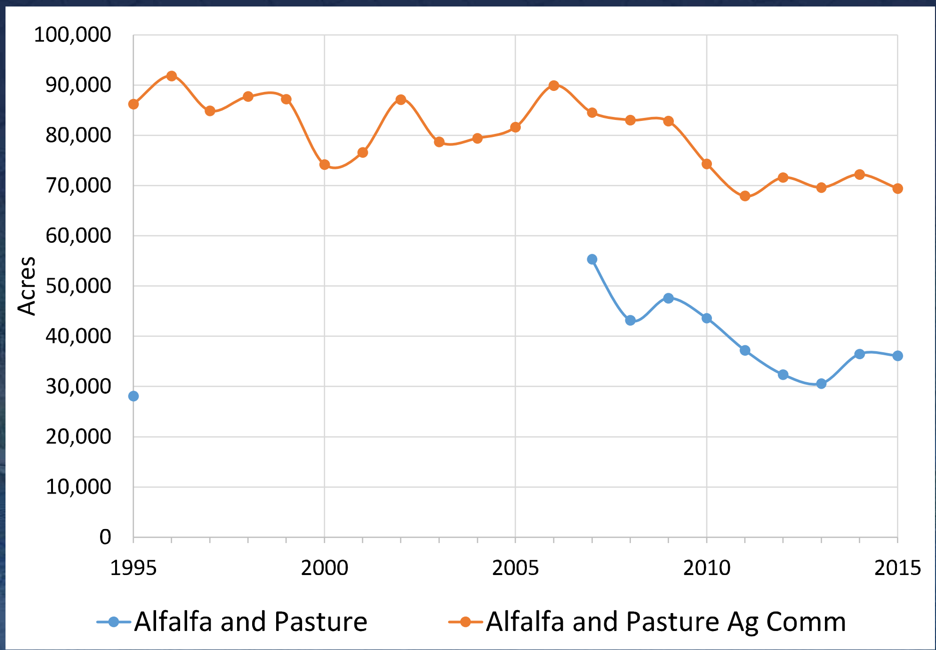
Vineyards

- Categories:
  - Vineyards



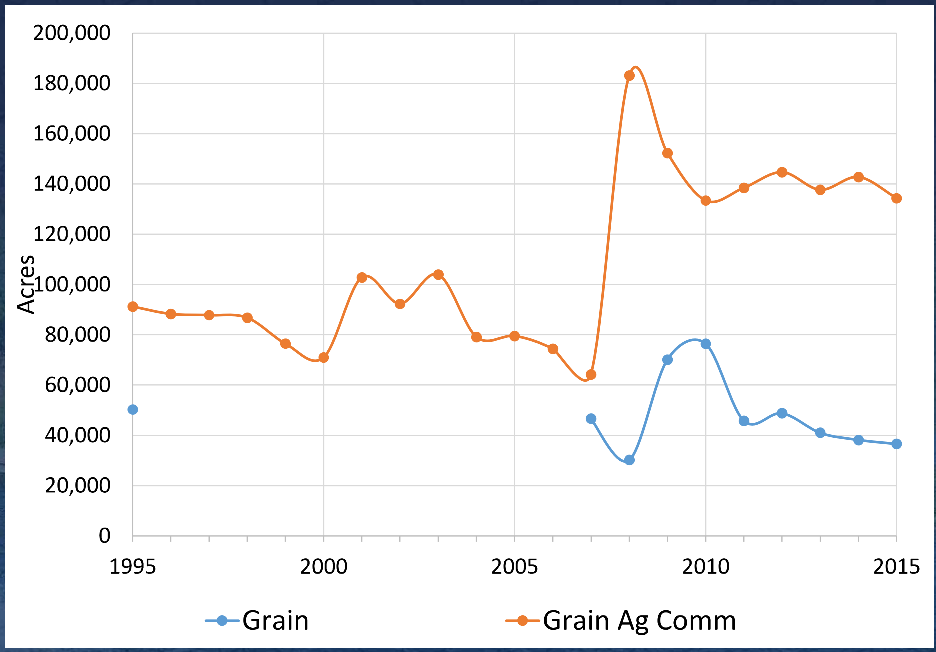
Alfalfa and Irrigated Pasture

- Categories:
  - Alfalfa
  - Pasture



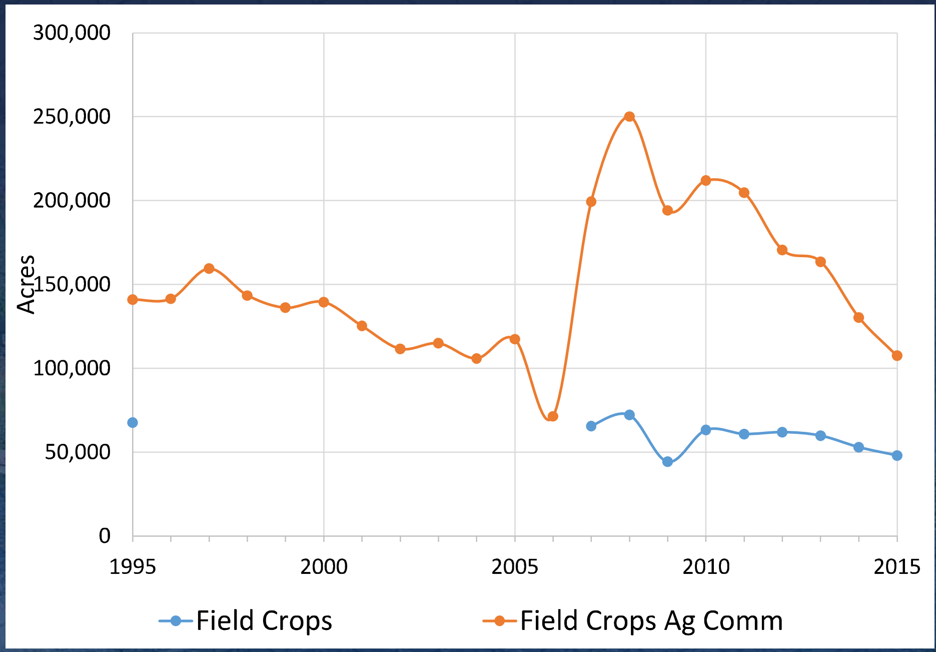
Grain

- Categories:
  - Grain
  - Silage



Field Crops

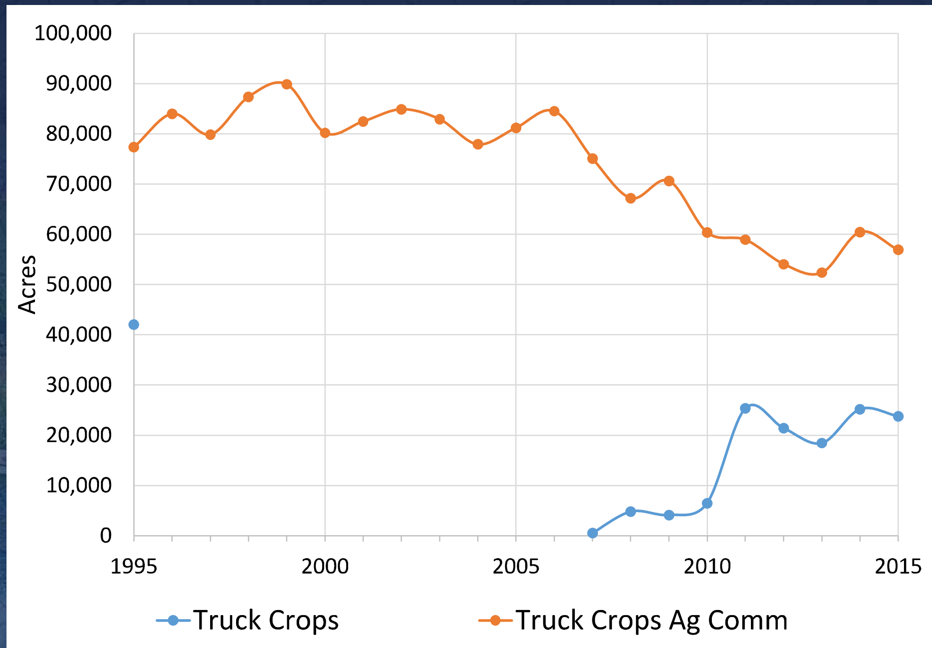
- Categories:
  - Corn
  - Cotton
  - Dry Beans
  - Field Crops
  - Safflower
  - Sugar Beets



ATTACHMENT 2

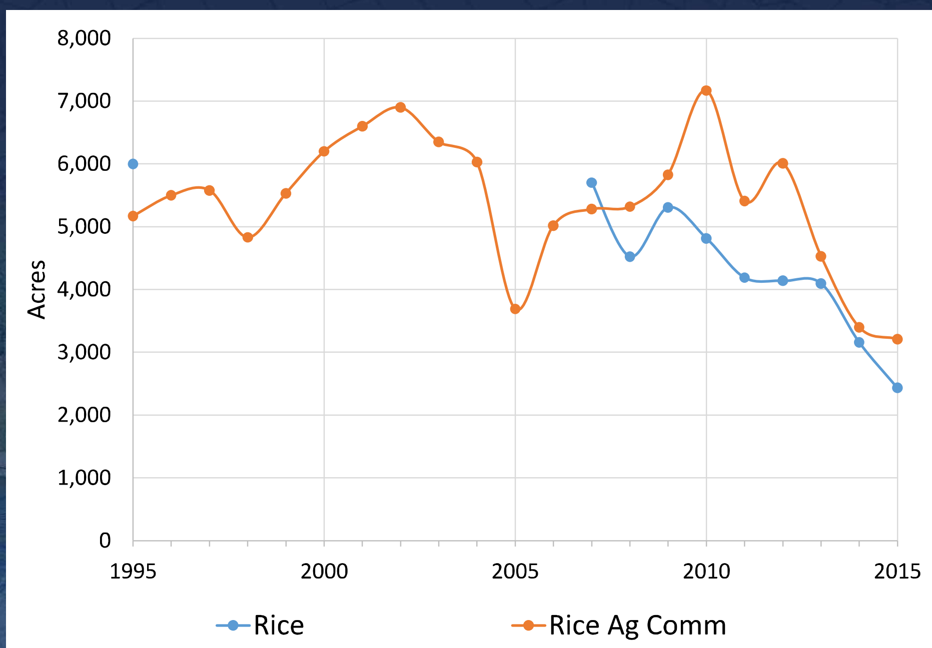
Truck Crops

- Categories:
  - Cucurbits (e.g., squash, melons, cucumbers, etc.)
  - Onion & Garlic
  - Potatoes
  - Tomato Fresh
  - Tomato Processing
  - Truck Crops



Rice

- Categories:
  - Rice

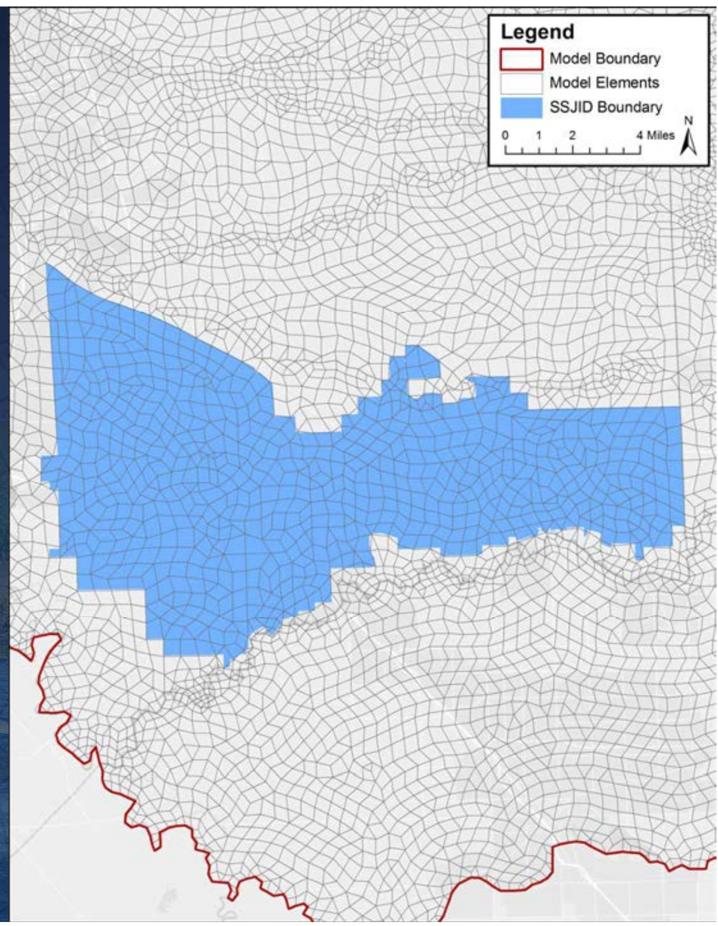


Summary

- Ag Commissioner data provides reasonable trends in the cropping pattern by major cropping categories, which can be used to modify CropScape trends
- Additional information for CropScape adjustment:
  - San Joaquin & Delta Water Quality Coalition
  - DWR's LandIQ survey
  - Local data from irrigation districts

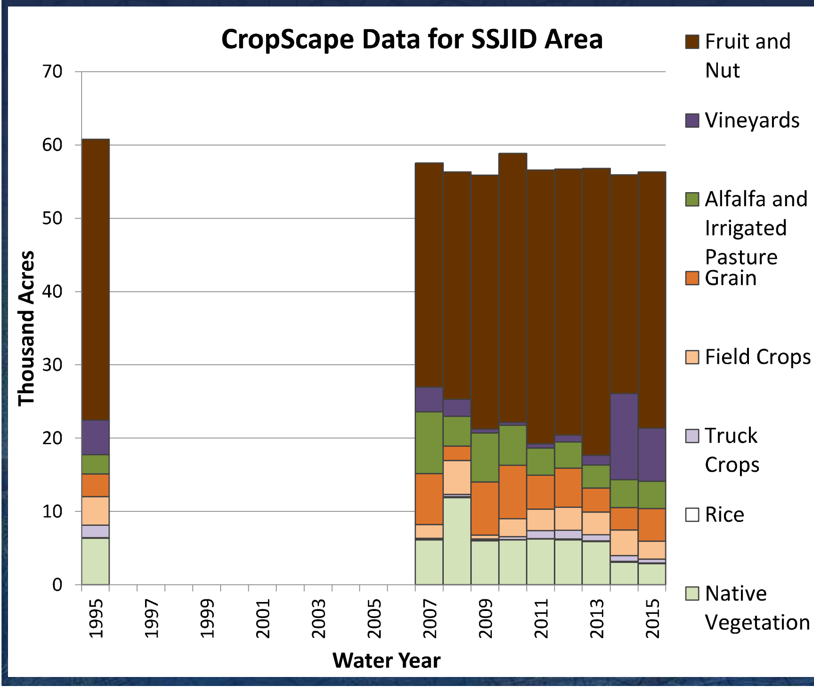
Local Data: Comparison with SSJID Acreages

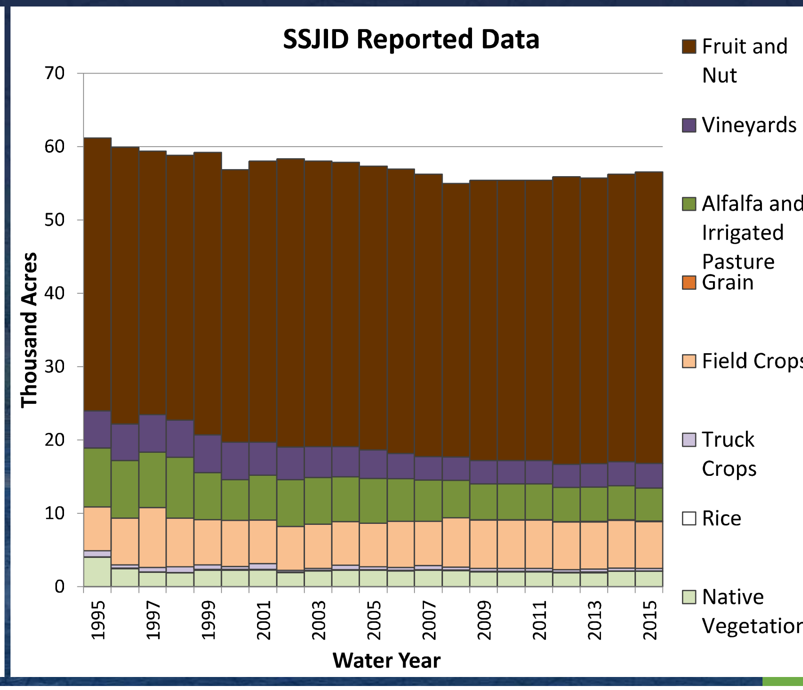
- SSJID provided annual acreages by crop
- SSJID crop categories were mapped to model categories
- For CropScape years, overall agricultural area is larger for SSJID-provided acreages by average of ~3,000 acres, which may most likely be attributed to immature orchards or immature croplands



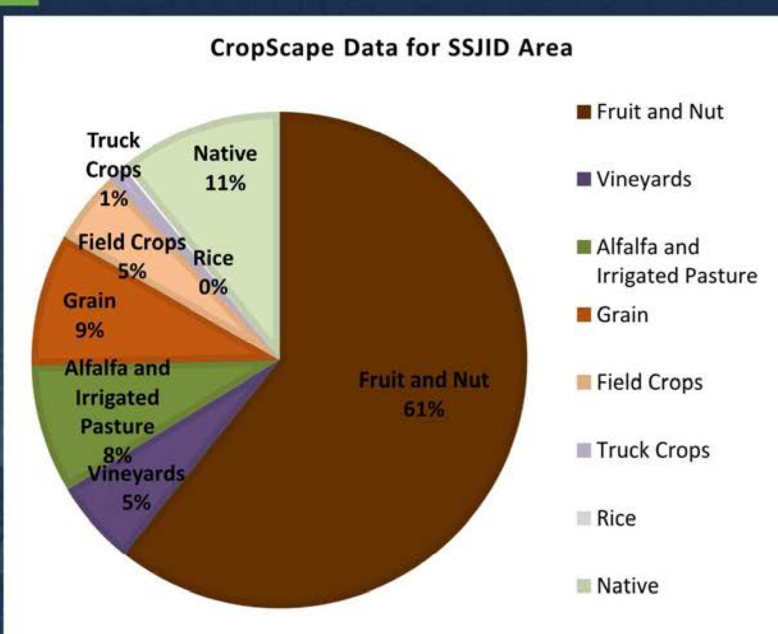
ATTACHMENT 2

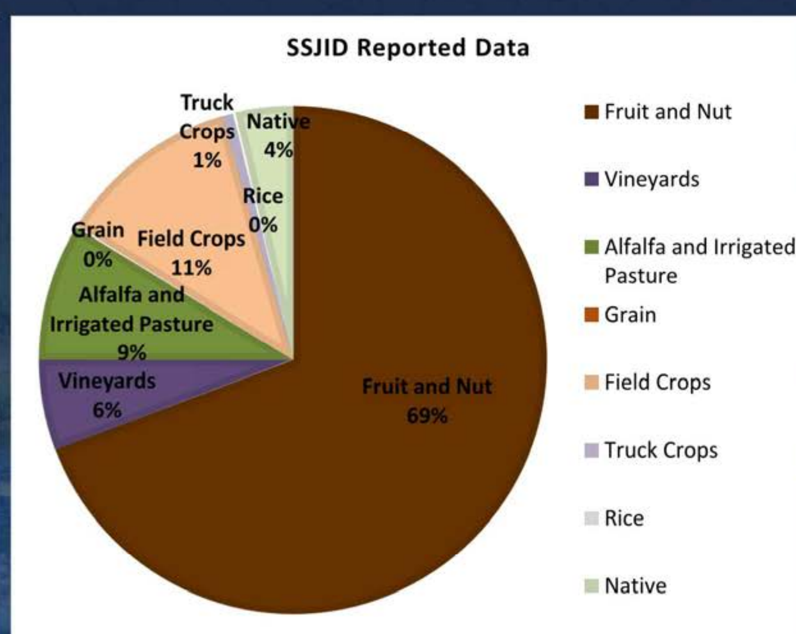
Bar Chart of Grouped Crop Categories





Comparison Pie Charts: Grouped Crop Categories





Note: Data is averaged across CropScape years (2007-2015)

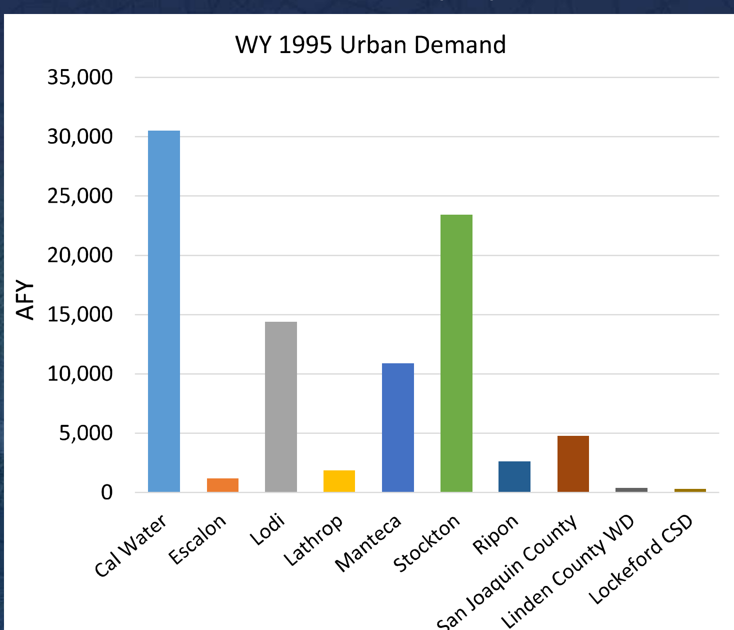
ATTACHMENT 2

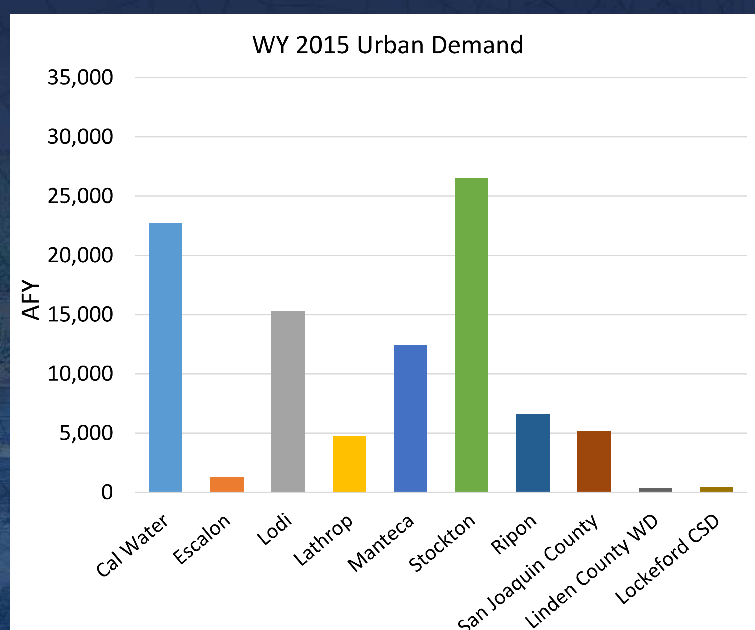
Ag Cropping Pattern: What We Need From You

- Any local crop acreages and spatial information
- Local knowledge of crop trends/types to help correct problems in CropScape data
- Any direction needed by Friday May 26, 2017; COB

Urban Water Demand

- Based on GPCD and population if water demand information unavailable





ATTACHMENT 2

Urban Water Demand: What We Need From You

- Review of population, GPCD, and urban water use data
- Breakdown between indoor and outdoor water use
- Any direction needed by Friday May 26, 2017; COB

Next Steps

1. Complete LU/Cropping acreages
2. Complete IDC input data files
3. Complete GW pumping for urban
4. Compile and Process Surface water deliveries for urban
5. Compile and Process Surface water deliveries for agricultural use
6. Complete GW pumping for agricultural use
7. Complete pumping well construction information

ATTACHMENT 2

Sustainable Groundwater Management Act Readiness Project

Meeting No. 7:

Integrated Water Resources Model Development Update

RMC water and environment

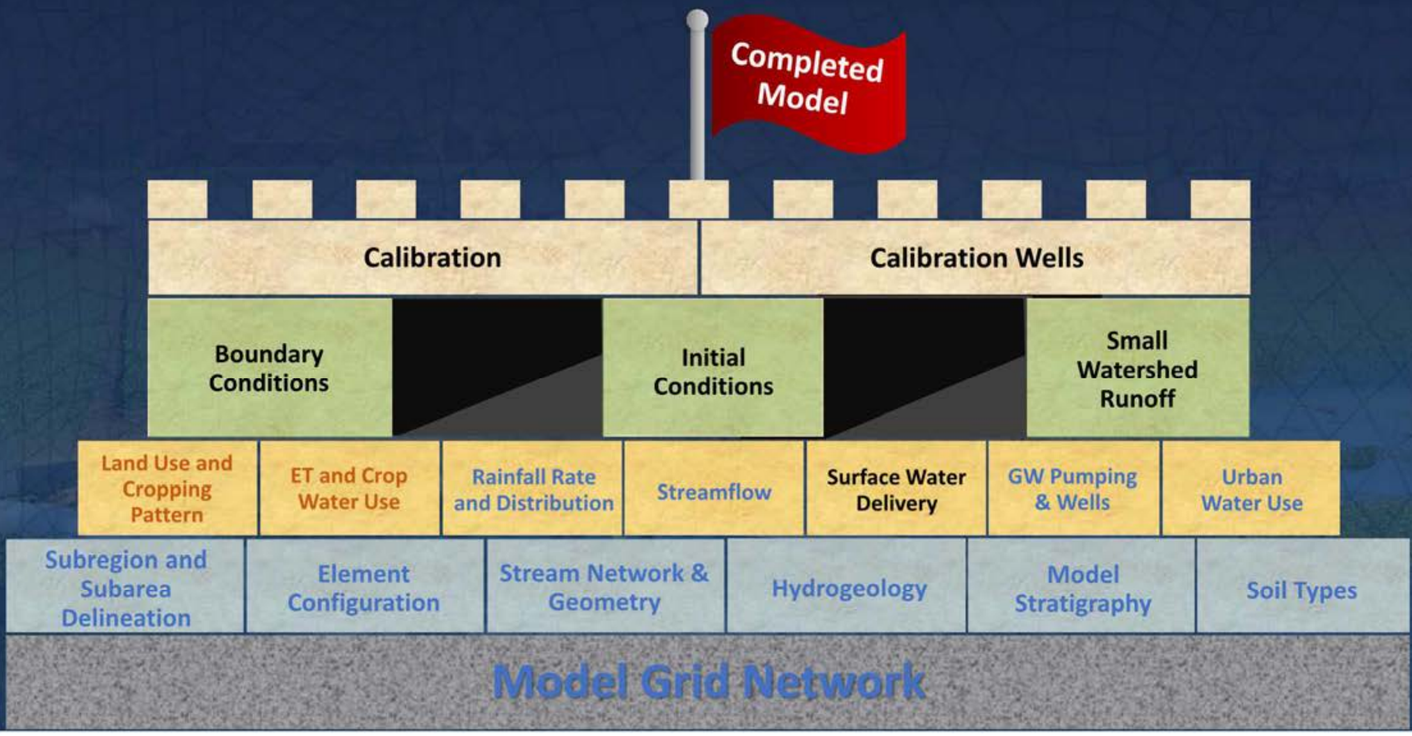
Complex Challenges | Innovative Solutions

June 28, 2017

Agenda

- Introduction
- Recap of Land Use and Cropping Patterns
- Ag Demand Estimation Methodology (IDC)
- Preliminary Ag Demand Estimates
- SJ County – GSP Work Plan
- Next Meeting

Integrated Model Construction



Model Name Examples

- Other IWFM Models:
  - MercedWRM (Merced Water Resources Model)
  - YGM (Yuba Groundwater Model)
  - BBGM (Butte Basin Groundwater Model)
  - YCIWFM (Yolo County IWFM)
- Other Models:
  - SacIGSM (Sacramento County IGSM)
  - NARIGSM (North American River Basin IGSM)
  - Stony Creek Fan (SCF) IGSM
  - KingsIGSM (Kings Basin IGSM)
  - C2VSim (California Central Valley Groundwater-Surface Water Simulation Model

IWFM
Integrated Water Flow Model

IGSM
Integrated Groundwater and Surface Water Model

ATTACHMENT 2

Our Model Name

For your consideration…

ESJ Integrated Water Flow Model

Or

ESJ Integrated Water Resources Model

Thoughts?

ESJ Model Trivia Part I

1. How many data input subregions are in ESJ-IWFM? ESJ Subbasin?
   20 data input subregions (ESJ-IWFM) / 18 data input subregions (ESJ Subbasin)
2. How many model output subareas make up ESJ-IWFM? ESJ Subbasin?
   8 model output subareas (ESJ-IWFM) / 6 model output subareas (ESJ Subbasin)
3. How many land use categories are in ESJ-IWFM?
   27 (23 crop categories and 4 other land use types)
4. What is the gross irrigated acreage in the ESJ Subbasin in 2015?
   394,877 acres
5. What are the biggest 3 crops by acreage in the ESJ Subbasin in 2015?
   Vineyards (104,586 acres), Walnuts (71,365 acres), and Almonds (52,614 acres)

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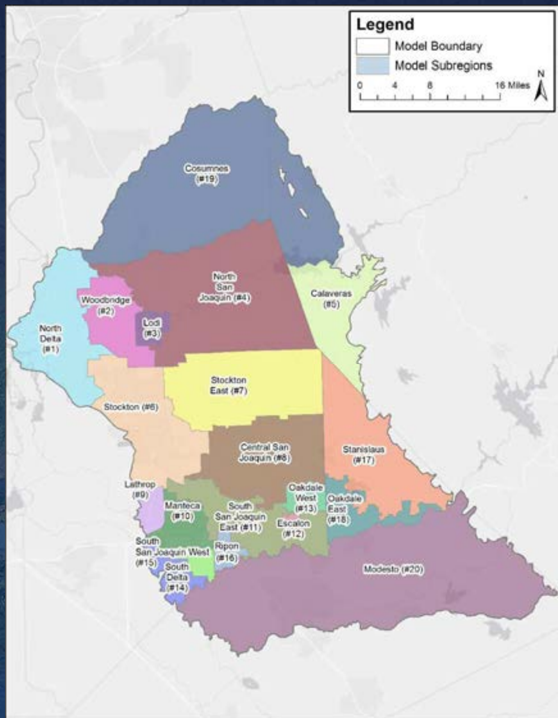
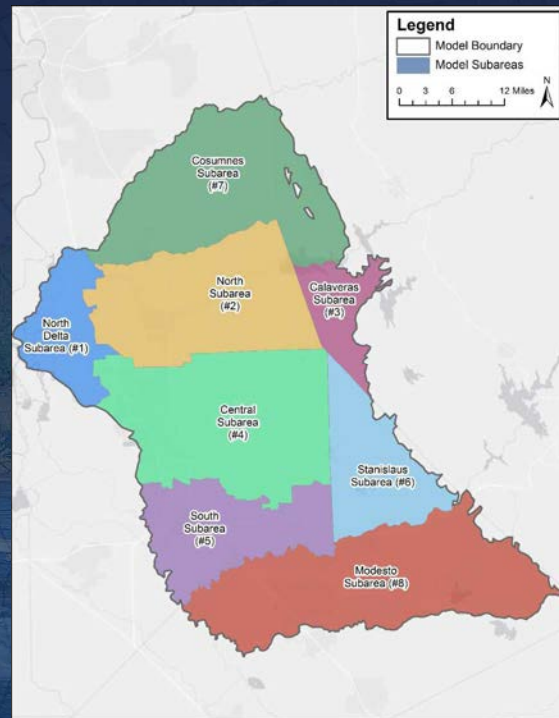
Completed Model Component: Model Subregions and Subareas





Model Land Use Types

- 23 irrigated crop categories
- 4 other land use categories
- 7 high-level categories used for verification purposes

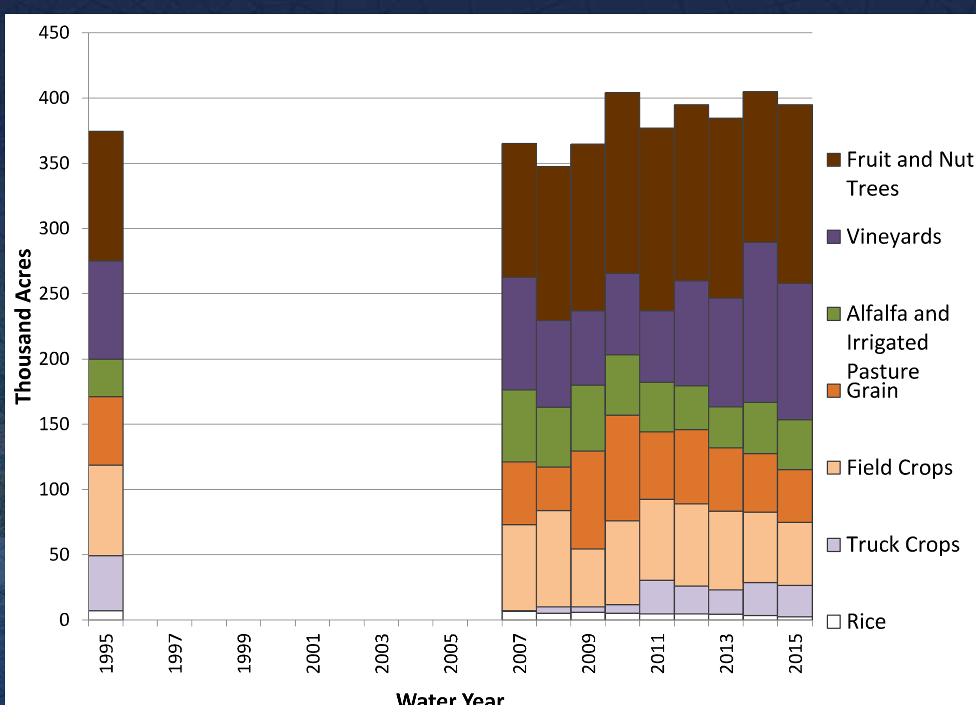
Model Crop Category	Grouped Crop Categories
Almonds Cherries Citrus & Subtropical Other Orchard Pistachios Walnuts	Fruit and Nut Trees
Vineyards	Vineyards
Alfalfa Pasture	Alfalfa and Irrigated Pasture
Grain	Grain
Corn Cotton Dry Beans Field Crops Safflower Sugar Beets	Field Crops
Cucurbits Onion & Garlic Potatoes Tomato Fresh Tomato Processing Truck Crops	Truck Crops
Rice	Rice
Urban Landscape Water Surface Riparian Vegetation Native Vegetation	Other Land Use

ATTACHMENT 2

Recap of Land Use and Cropping Patterns

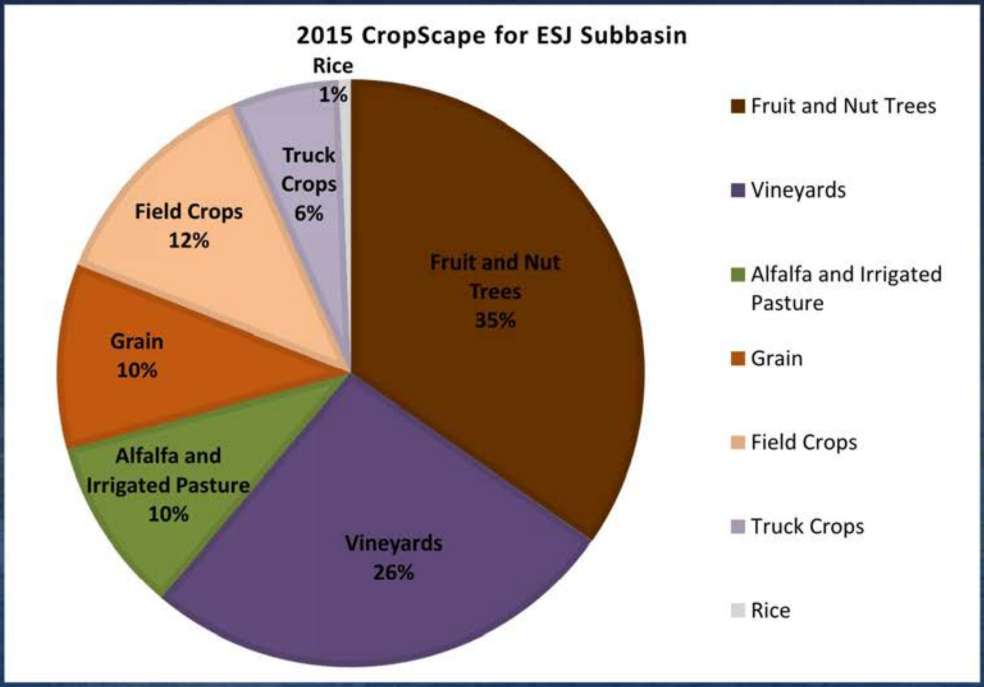
1. DWR Land Use Surveys (Representing ~1995 Era)
   - San Joaquin County (1996)
   - Sacramento County (1993)
   - Amador County (1997)
   - Calaveras County (2000)
   - Stanislaus County (1996)
2. Remote Sensing Data:
   - USDA's CropScape
   - DWR's LandIQ Survey; 2014
3. Local Data Sources

Primary Cropping Pattern in ESJ Subbasin

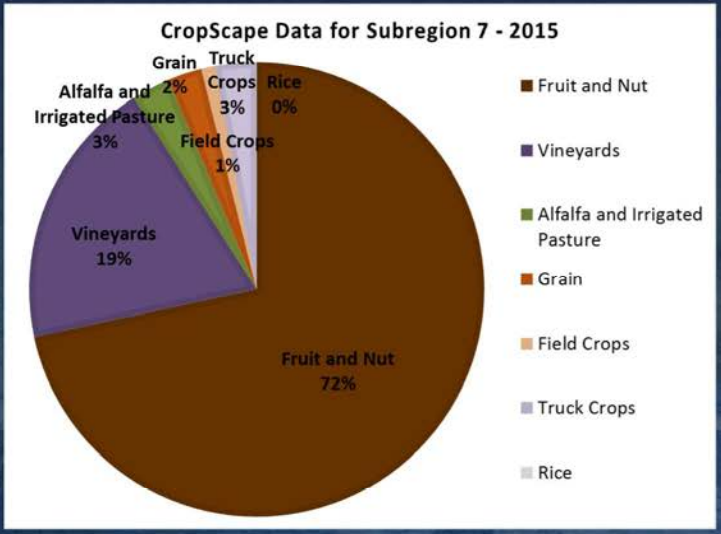


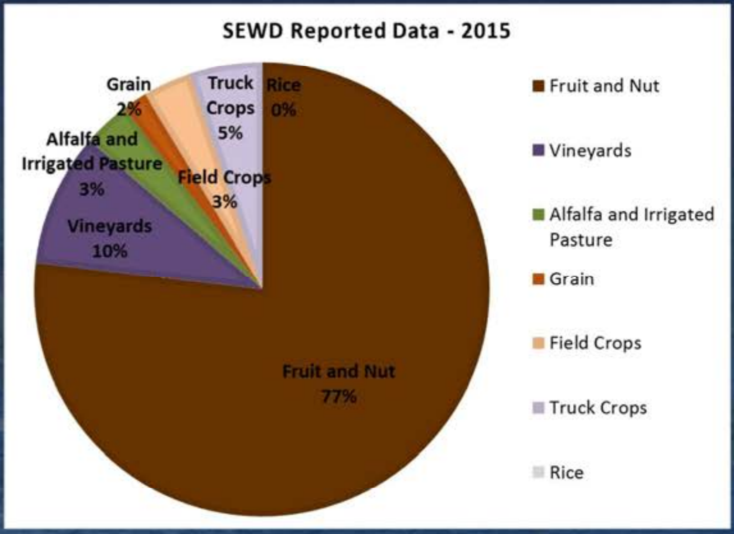
ATTACHMENT 2

Primary Cropping Pattern in ESJ Subbasin



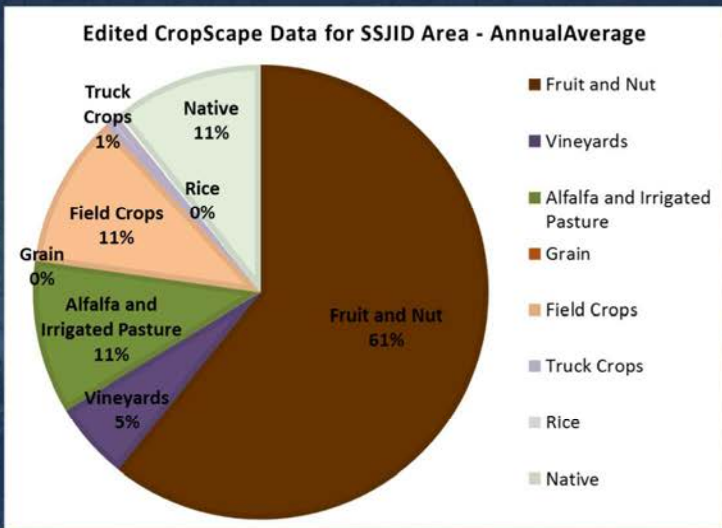
SEWD Crop Acreage Comparison

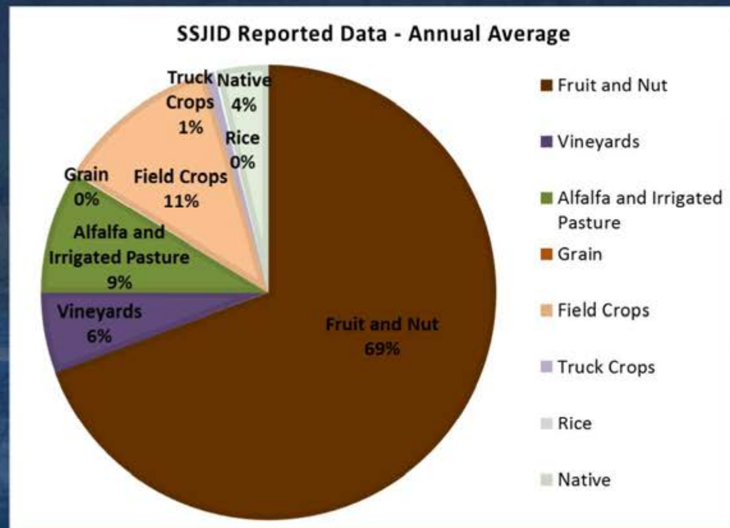




SSJID Acreage Edits

- Based on information provided by SSJID, transferred what CropScape was picking up as grain to either corn or alfalfa





Future Land Use Edits

- Coordination with Stanisalus County model effort:
  - Jacobson James & Associates estimating end of July for updating land use data based on Ag Commissioner reports
  - Will consider edits to Stanislaus triangle and Modesto Subbasin at that time
- Incorporation of LandIQ spatial data for WY 2014
- Additional input from others

ATTACHMENT 2

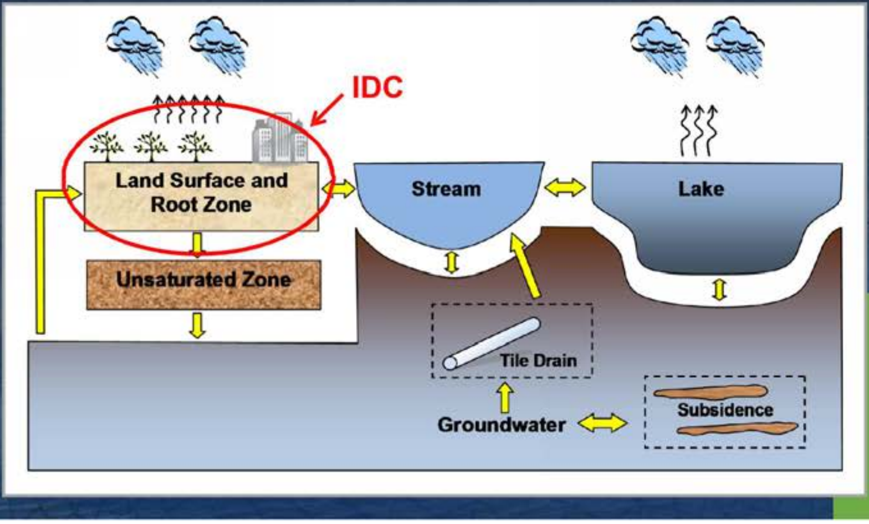
ESJ Model Trivia Part II

1. What does IDC stand for? What does it do?
   IWFM Demand Calculator
   IDC estimates agricultural demand
2. What is the County's average daily temperature in the past 60 years?
   Daily average temperature is 54.4°F[1]
3. What is the County's average annual precipitation in the past 60 years?
   Annual average observed precipitation is 14.7 inches[1]
4. What is the County's average monthly reference evapotranspiration in the past 30 years?
   Monthly average reference evapotranspiration is 4.2 inches[2]

1. Stockton Fire Station #4 – NCDC Weather Station
2. Manteca CIMIS Station

Ag Demand Estimation using IDC

- IWFM Demand Calculator (IDC) is a software that calculates land use based water demands and routes water through the land surface and root zone using physically-based simulation methods
- Uses methods from irrigation-scheduling-type models and applies them at regional scales
- Stand-alone executable or root zone module of Integrated Water Flow Model (IWFM) v2015



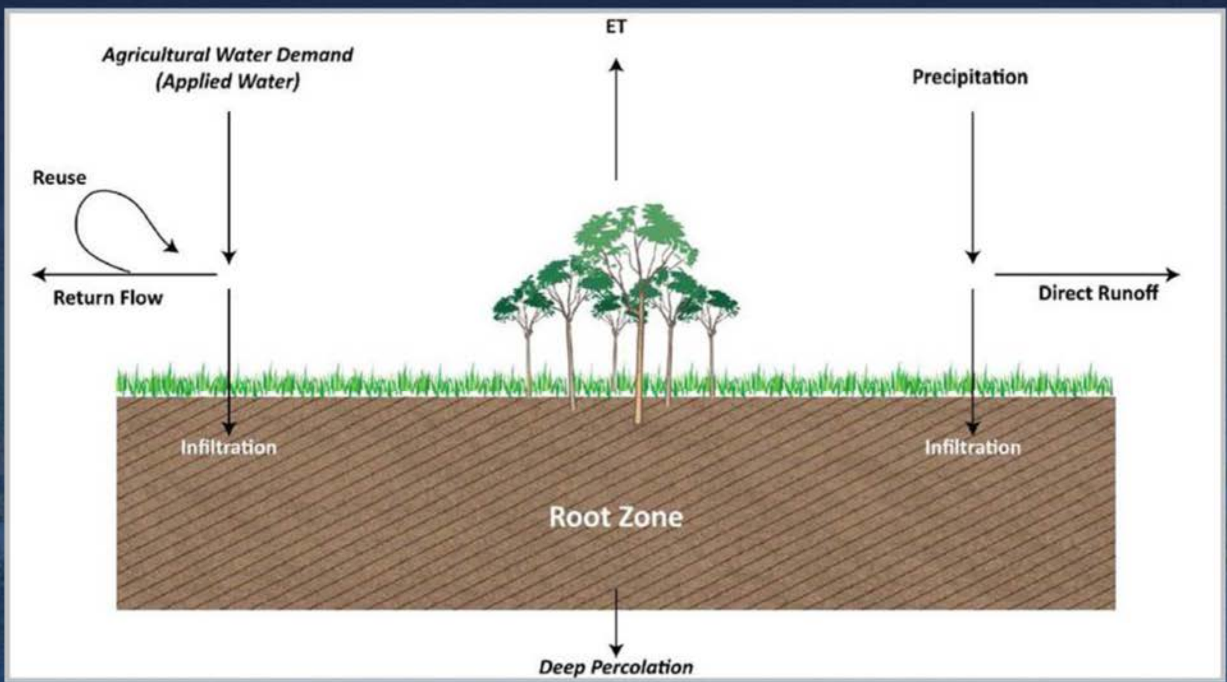
Source: IDC training workshop (Emin Can Dogrul, DWR)

IDC Background

- IDC was initially developed to…
  - Maintain consistency between C2VSim and CalSim
  - Calculate downstream water demands for CalSim under current conditions and future scenarios
- First version of IDC did not have rice and refuge simulations, had incompatible calculations for daily runs
- IDC v4.0 was developed to improve upon the initial version of IDC
- With alternative root zone routing schemes developed (v4.0, v4.1 and v3.02) IDC-2015 became a container for different root zone routing methods

Source: IDC training workshop (Emin Can Dogrul, DWR)

IDC Data



Source: IDC training workshop (Emin Can Dogrul, DWR)

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Features of IDC-2015

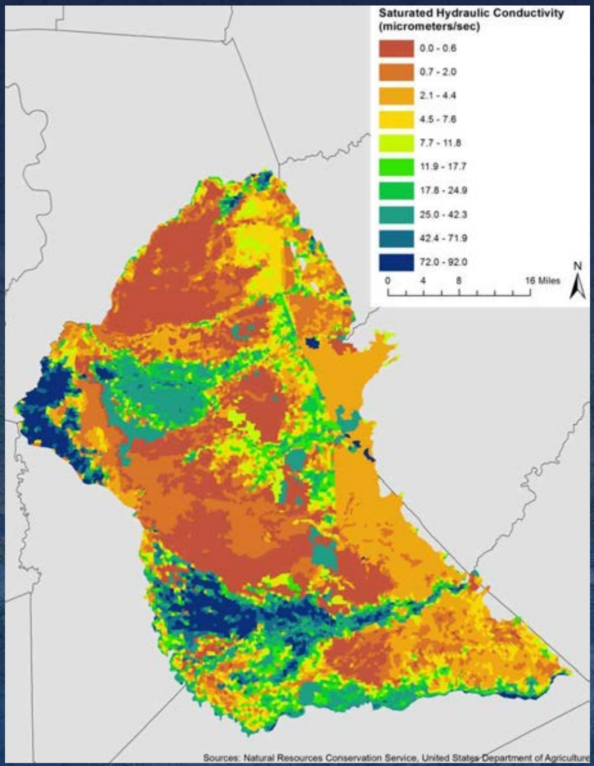
- Use of a computational grid, finite-element or finite-difference, to represent spatial distribution of land-use, climatic, soil and farm management properties; each cell can have multiple land-use types specified as time-series data
- Simulation of land surface and root zone flow processes as well as water demand computations are done at each grid cell for each land-use type
- Irrigation-scheduling-type approach at each grid cell for each agricultural crop
- Direct representation of rice fields (including simulation of flooded decomposition, non-flooded decomposition and no decomposition) and refuges (seasonal and permanent)
- Riparian vegetation access to stream flows and simulation of evapotranspiration from groundwater
- Urban water demand computation based on population and per capita water usage
- Simulation of ETAW and effective precipitation
- Simulation of re-use of irrigation return flow that takes place at a grid cell, between grid cells or between subregions
- Budget output includes soil moisture, and land and water use budgets for individual crops at each subregion

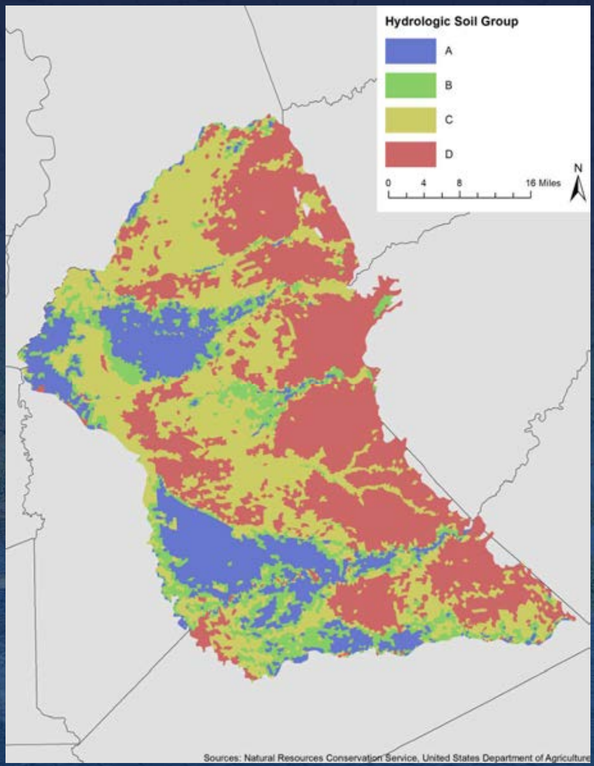
Source: IDC training workshop (Emin Can Dogrul, DWR)

Key Parameters and Data in IDC

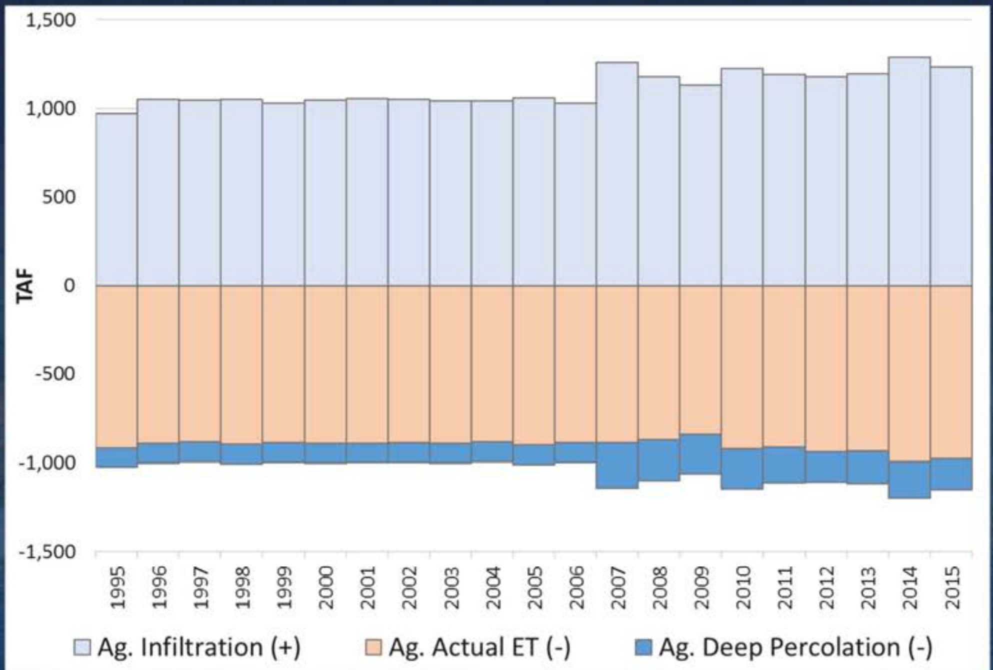
- Monthly Rainfall
- Crop Evapotranspiration, Et_c
- Return and reuse fractions
- Irrigation period
- Land use and crop acreages
- Urban population and per capita water use
- Soil Properties:
  - Hydraulic Conductivity
  - Pore Size Distribution Index
  - Others: Wilting Point, Field Capacity, Total Porosity

Root Zone Parameters

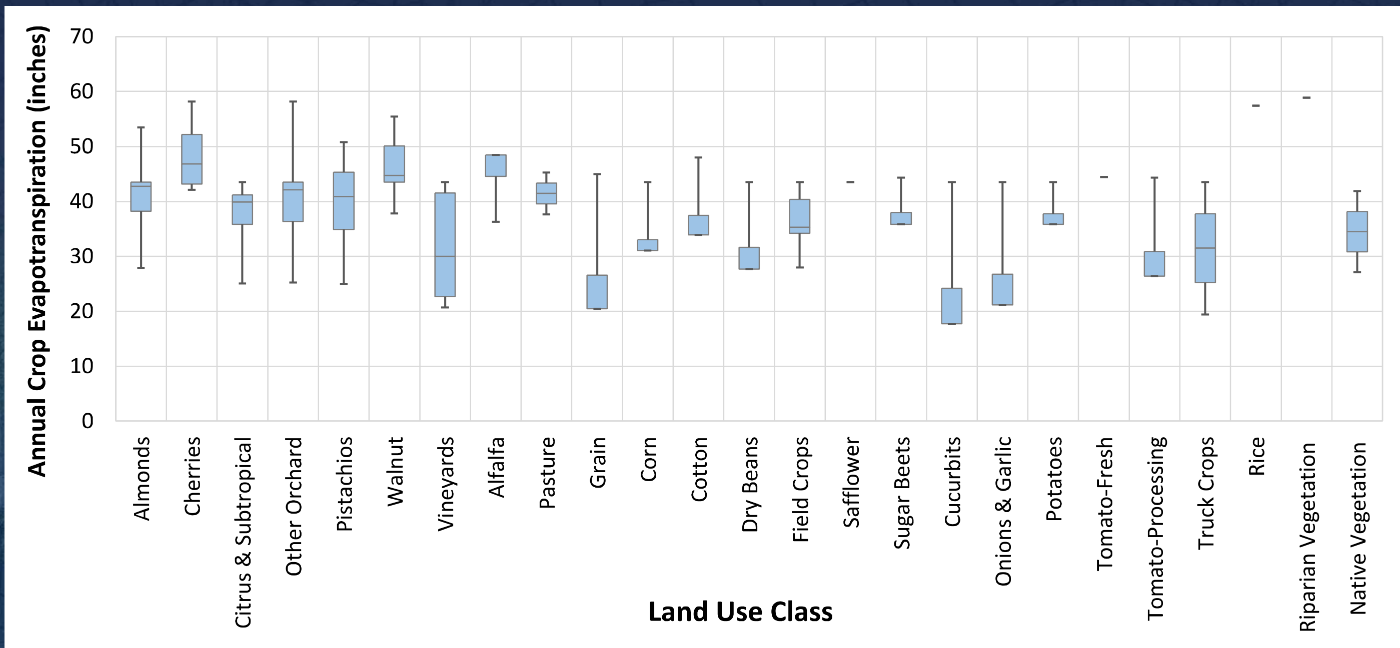




Preliminary IDC Results for ESJ Subbasin: Agricultural Root Zone Budget

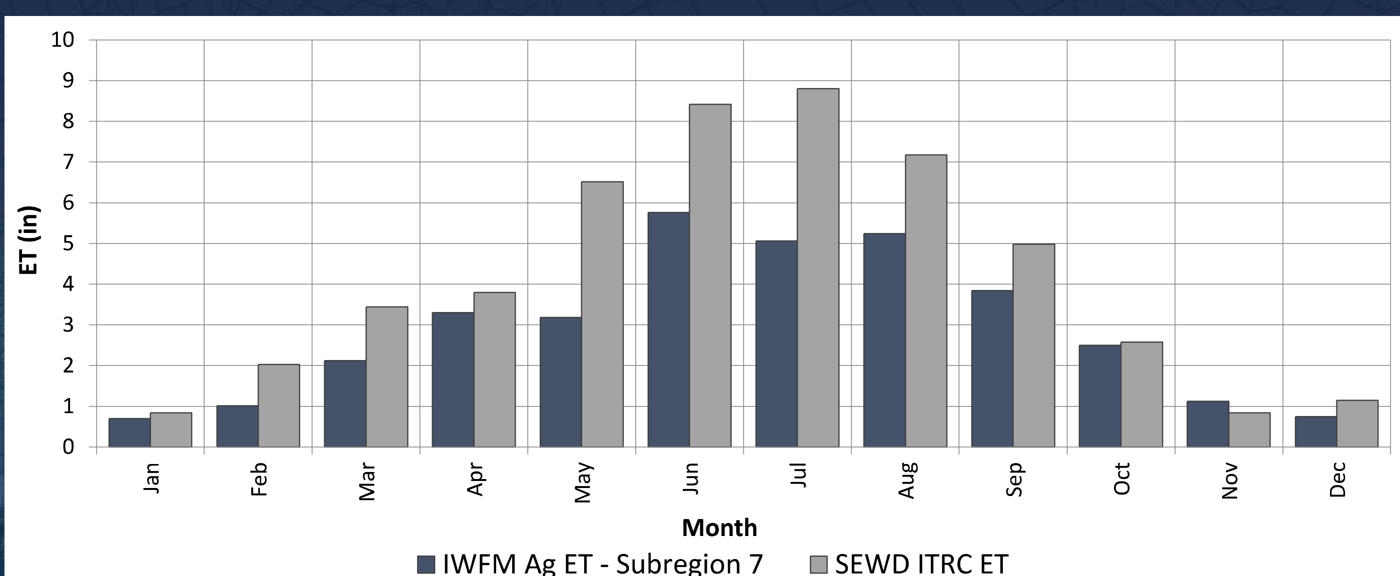


Range of Crop Evapotranspiration in Model Area



Sources: C2VSim Subregion 8 ETc, SEWD ITRC Typical Year ETc, and SSJID ITRC Average ETc

Ag Evapotranspiration Comparison



Note: ITRC includes cover crops with all tree crops (annual ET of trees with cover crops is ~10 inches higher than trees alone)

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Preliminary IDC Results: Estimated Irrigation Efficiency

- Irrigation efficiency estimated as agricultural evapotranspiration (i.e., use of applied water by plants) divided by total water applied to irrigated lands

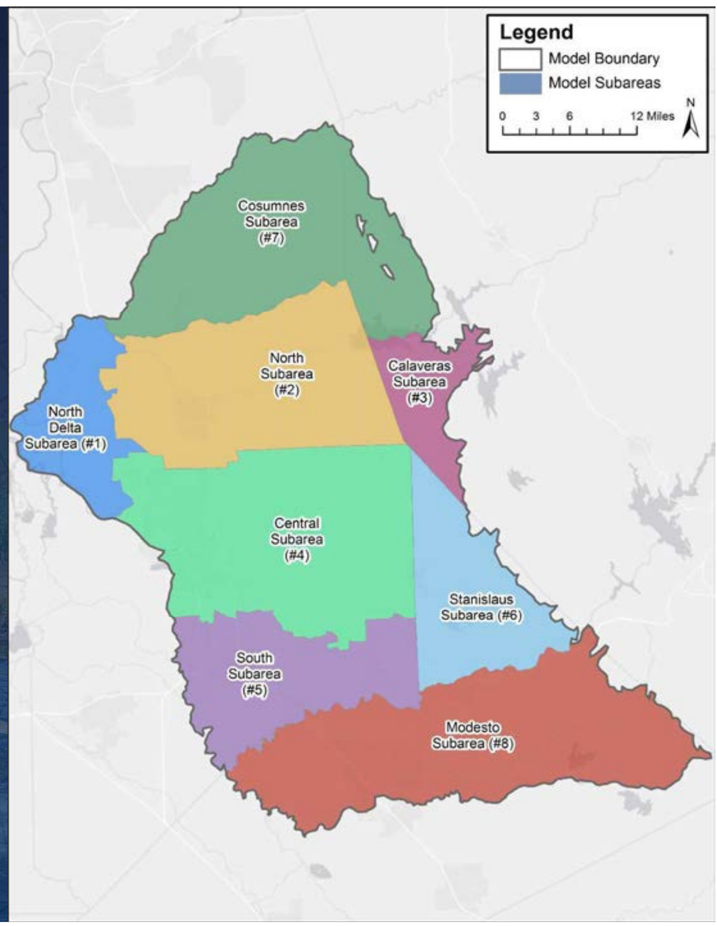
$$IE = \frac{Ag\ ET}{Applied\ Water}$$

Subarea	Name	Estimated Irrigation Efficiency
1	North Delta Subarea	73%
2	North Subarea	77%
3	Calaveras Subarea	74%
4	Central Subarea	74%
5	South Subarea	76%
6	Stanislaus Subarea	71%
TOTAL	Eastern San Joaquin Subbasin	75%

Note: Using averages from irrigation period (March-October)

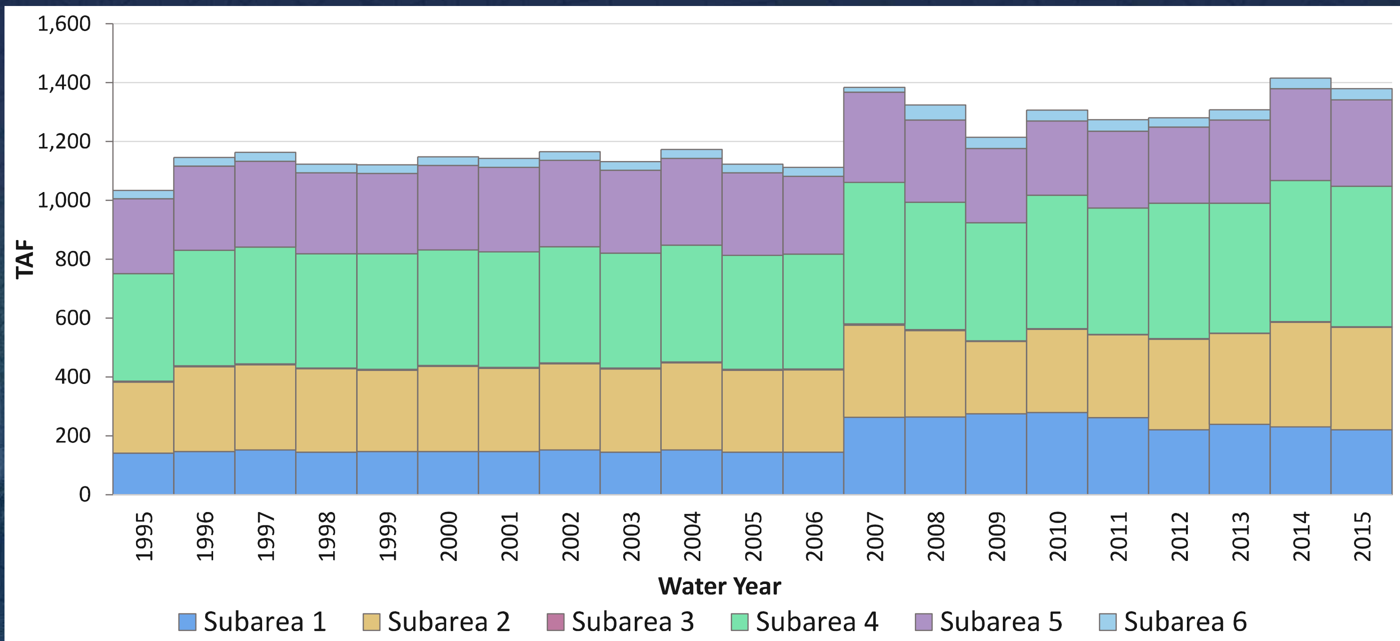
Model Subareas

- Eastern San Joaquin Subbasin
  - Subarea 1 – North Delta
  - Subarea 2 – North
  - Subarea 3 – Calaveras
  - Subarea 4 – Central
  - Subarea 5 – South
  - Subarea 6 – Stanislaus
- Subarea 7 – Cosumnes
- Subarea 8 - Modesto

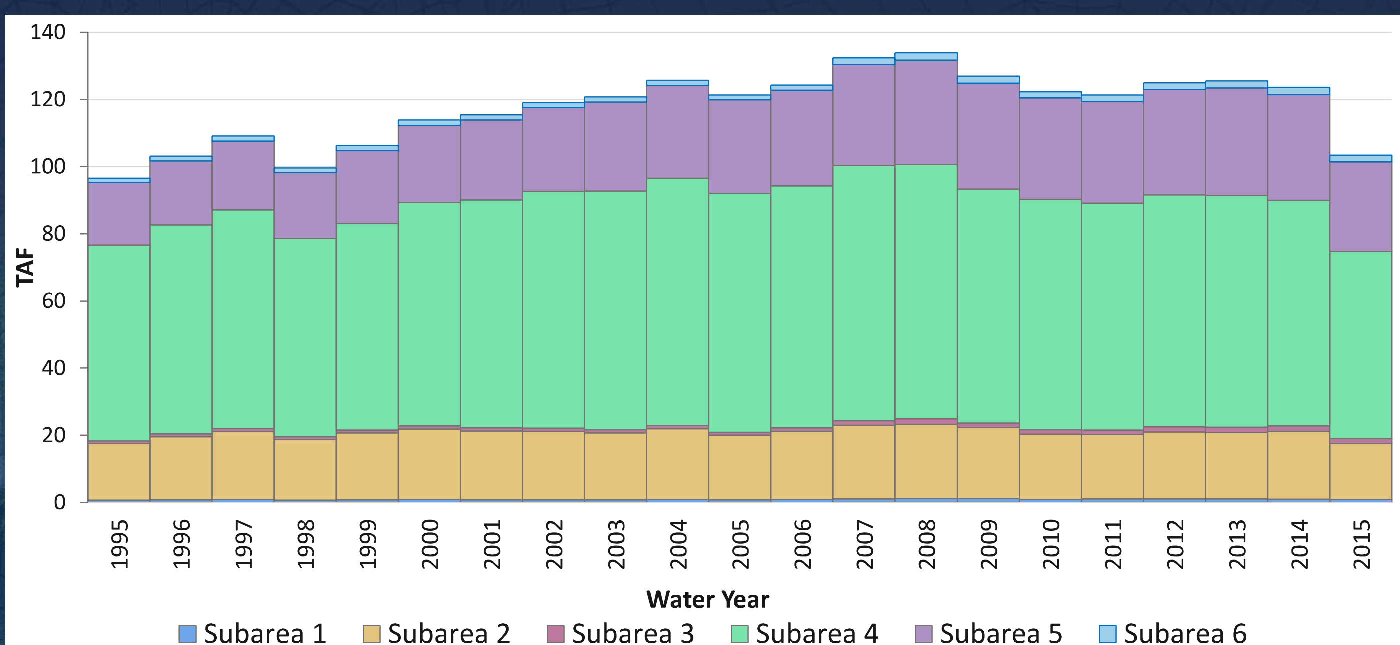


ATTACHMENT 2

Preliminary IDC Results for ESJ Subbasin: Agricultural Water Demand Estimate



Preliminary IDC Results for ESJ Subbasin: Urban Water Demand Estimate



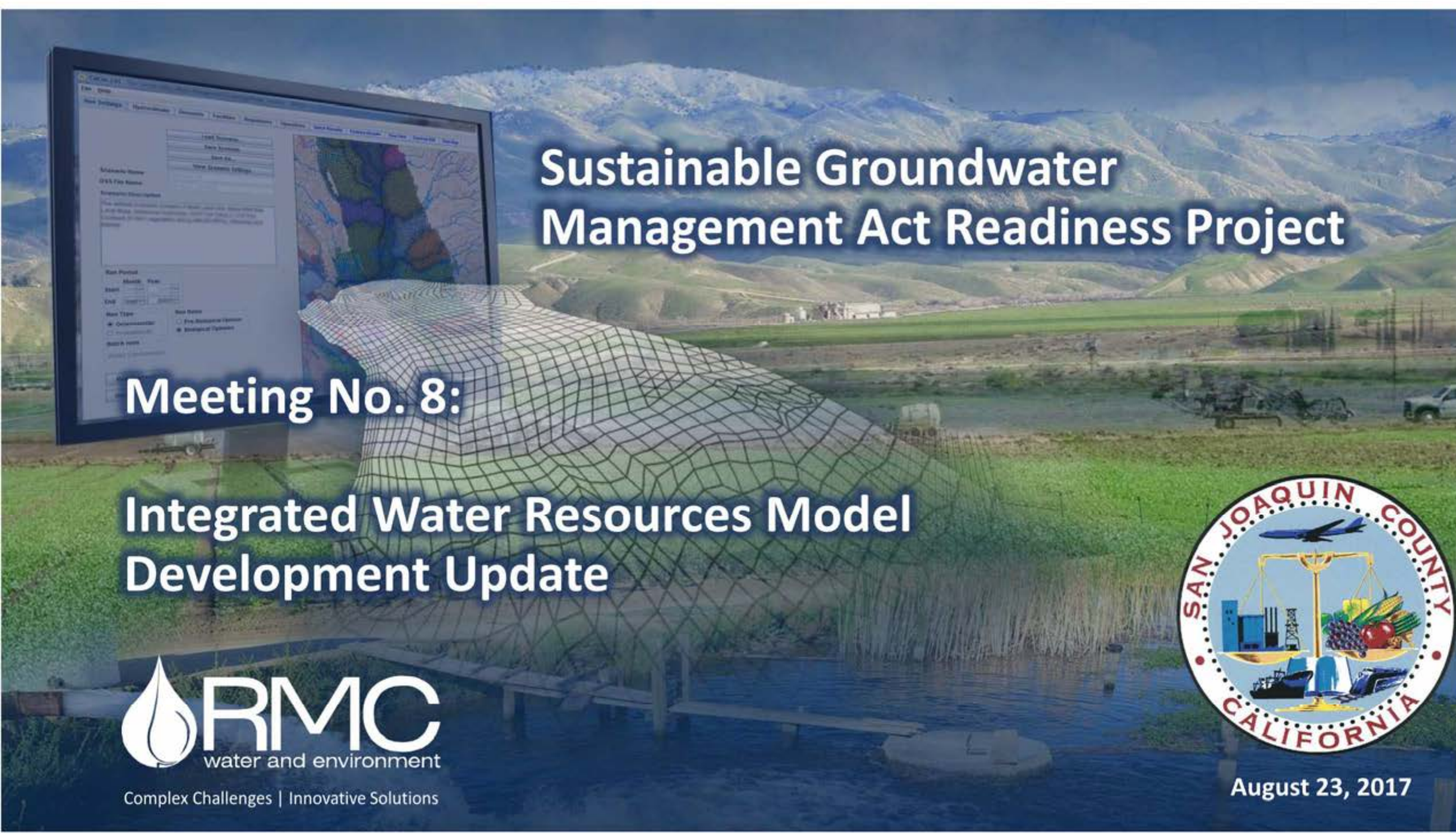
Data Request

- IDC Calibration:
  - METRIC rasters and applied water estimates
- IWFM Model:
  - SW diversions and deliveries
    - Information Provided: CCWD, Manteca, Stockton, OID, SEWD (including info on Stockton, Cal Water, CSJWCD, OID, and SSJID), SSJID, and WID (including info on Lodi and Stockton)
    - Additional Information: Breakdown of diversions by delivery for SSJID
  - Recharge
    - No Projects: Cal Water, Escalon, Lathrop, Linden County WD, Lockeford CSD, and SSJID
    - Information Provided: Lodi, OID, SEWD, and Stockton/WID
    - Need Response on Recharge Practices (if any): Manteca and Ripon

Next Steps

1. Finalize IDC and document results in a TM
2. Compile and Process Surface water deliveries for urban and agricultural use
3. Transfer completed information to IWFM input files
   - Stream flows and stream geometry
   - Well location and pumping information
   - Surface water diversion and deliveries
   - Small watersheds

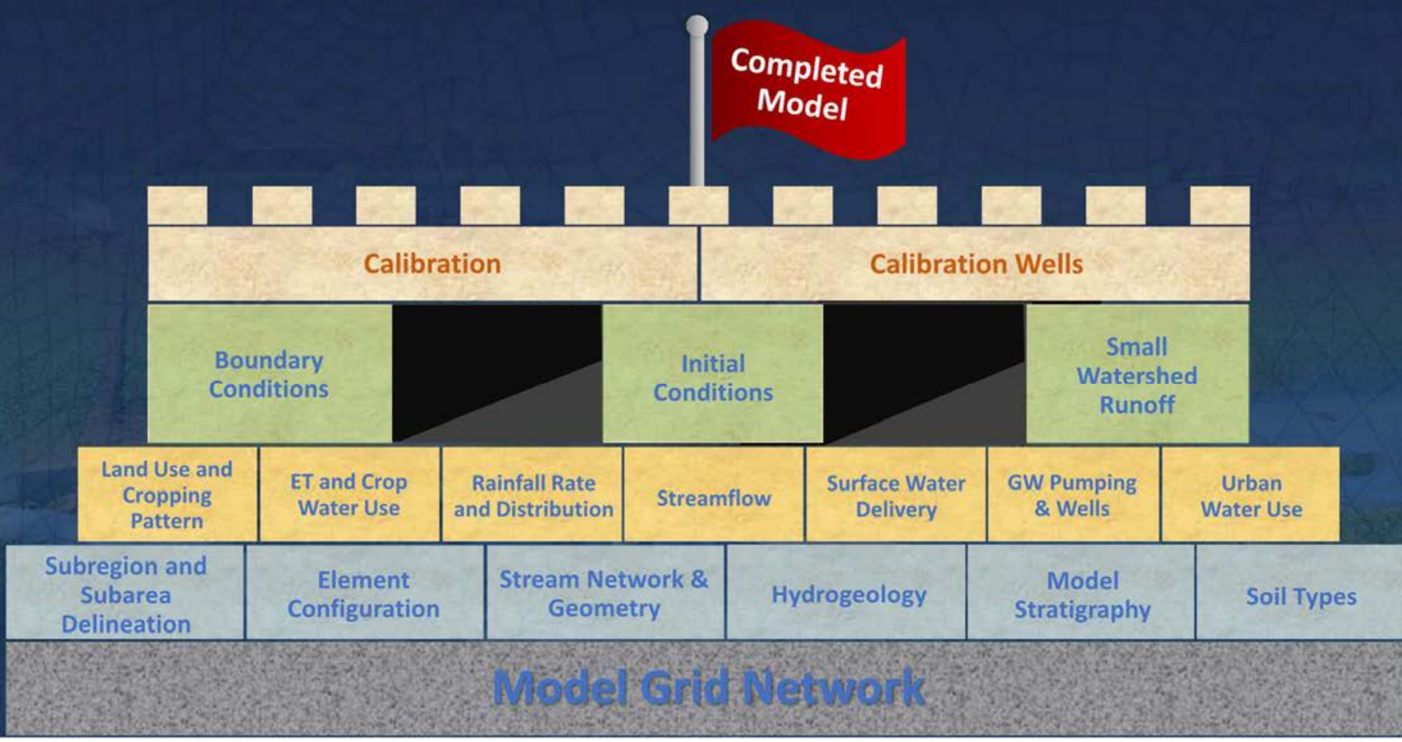
ATTACHMENT 2



Agenda

- Introduction
- Updated Land Use and Cropping Patterns
- Preliminary Land and Water Use Budgets
- IWFM Calibration Process and Sample Hydrographs
- Next Steps

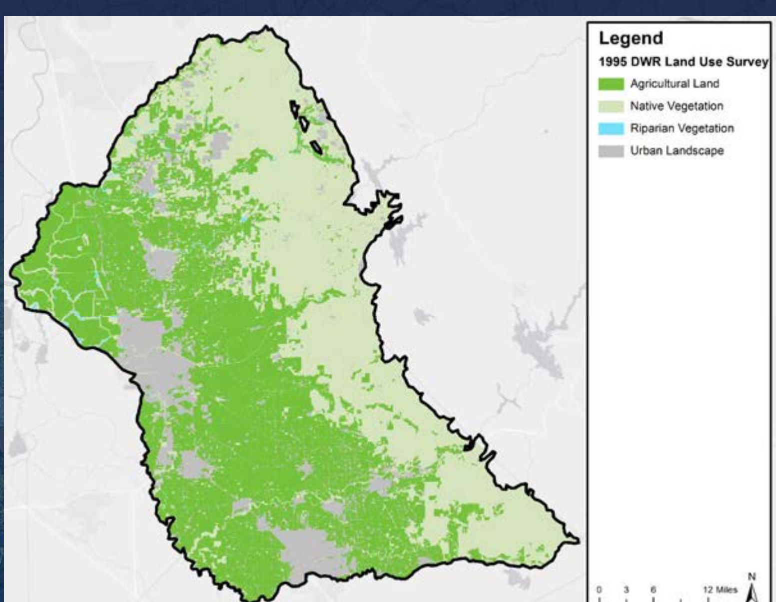
Integrated Model Construction

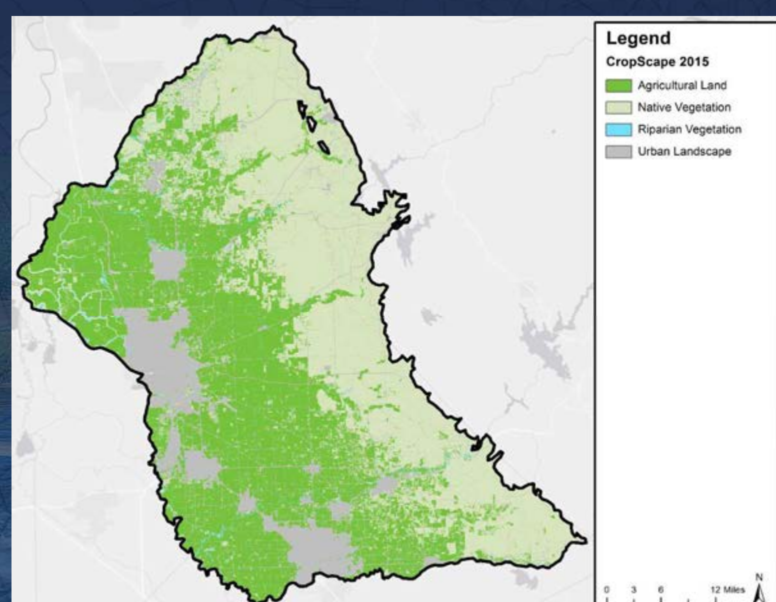


Recap of Land Use and Cropping Patterns

1. DWR Land Use Surveys (Representing ~1995 Era)
   - San Joaquin County (1996)
   - Sacramento County (1993)
   - Amador County (1997)
   - Calaveras County (2000)
   - Stanislaus County (1996)
2. Remote Sensing Data:
   - USDA's CropScape
   - DWR's LandIQ Survey; 2014
3. Local Data Sources

ESJ Model Area Land Use (1995 & 2015)





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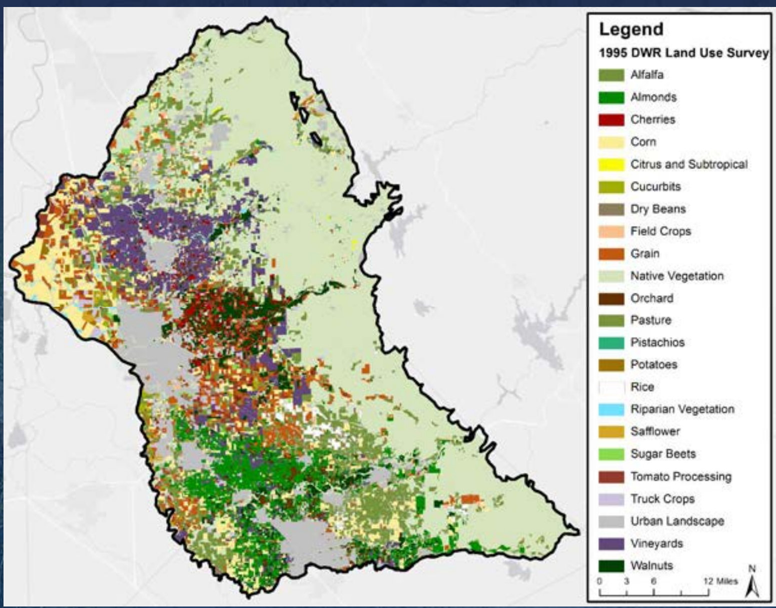
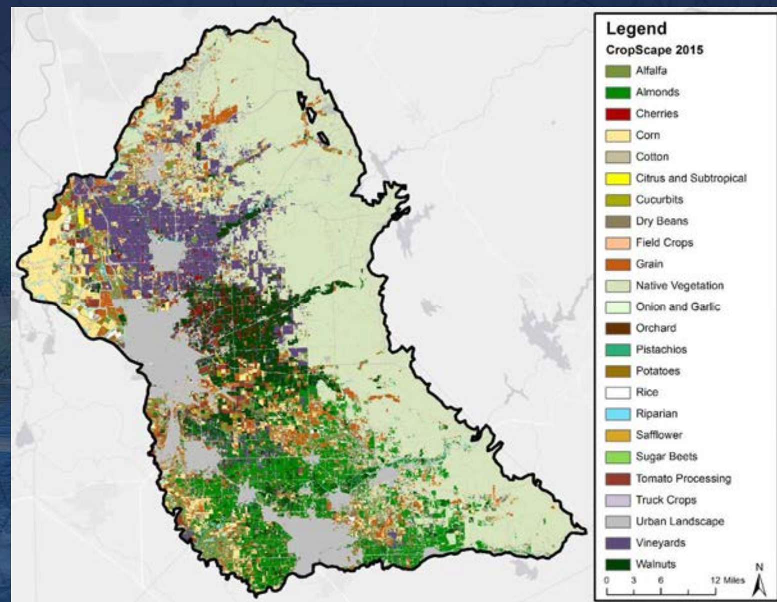
ESJ Model Area Cropping Pattern (1995 & 2015)





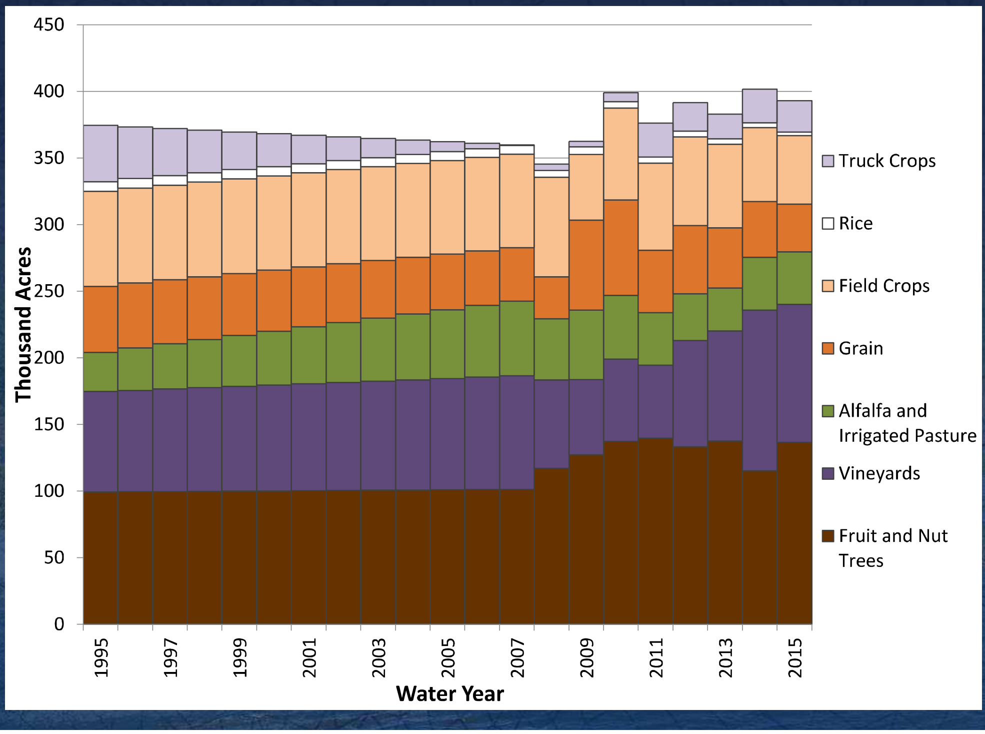
Model Land Use Types

- 23 irrigated crop categories
- 4 other land use categories
- 7 high-level categories used for verification purposes

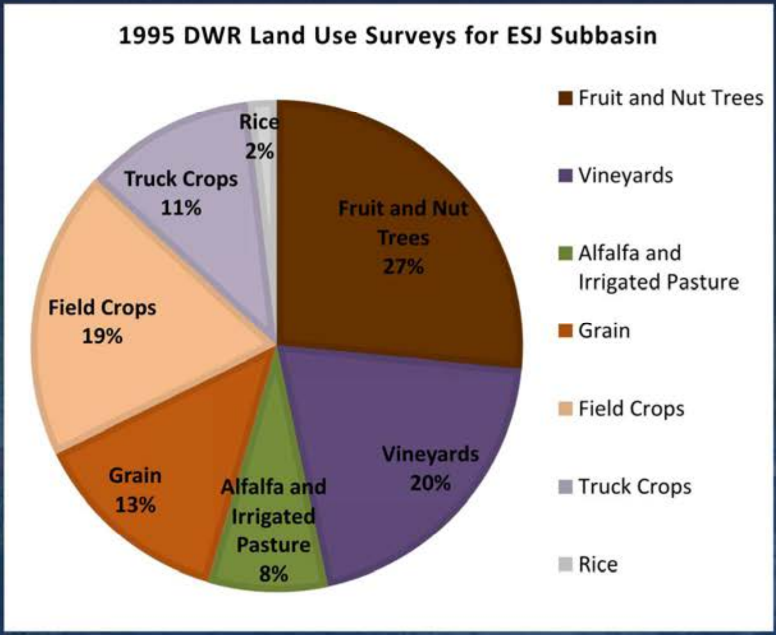
Model Crop Category	Grouped Crop Categories
Almonds Cherries Citrus & Subtropical Other Orchard Pistachios Walnuts	Fruit and Nut Trees
Vineyards	Vineyards
Alfalfa Pasture	Alfalfa and Irrigated Pasture
Grain	Grain
Corn Cotton Dry Beans Field Crops Safflower Sugar Beets	Field Crops
Cucurbits Onion & Garlic Potatoes Tomato Fresh Tomato Processing Truck Crops	Truck Crops
Rice	Rice
Urban Landscape Water Surface Riparian Vegetation Native Vegetation	Other Land Use

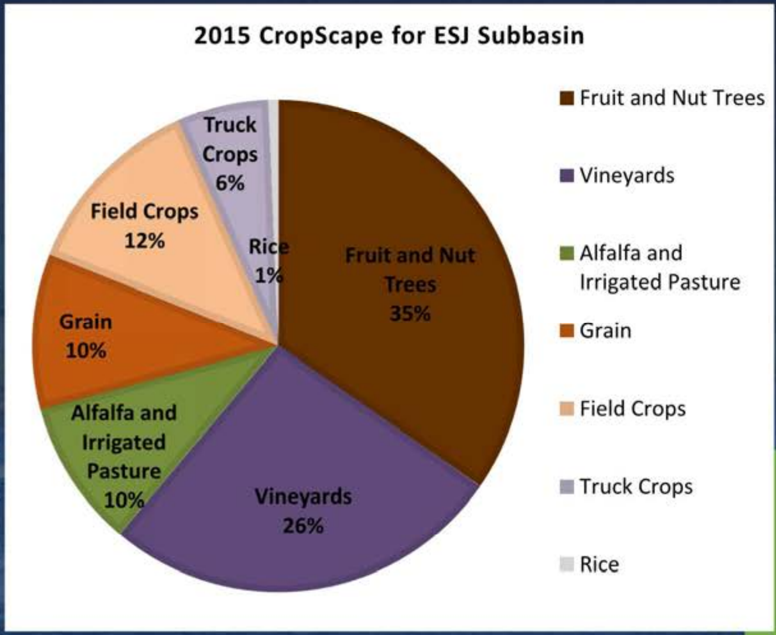
ATTACHMENT 2

Primary Cropping Pattern in ESJ Subbasin



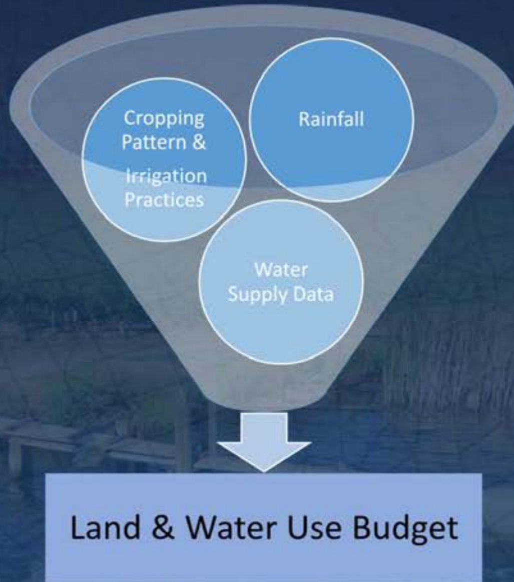
Primary Cropping Pattern in ESJ Subbasin





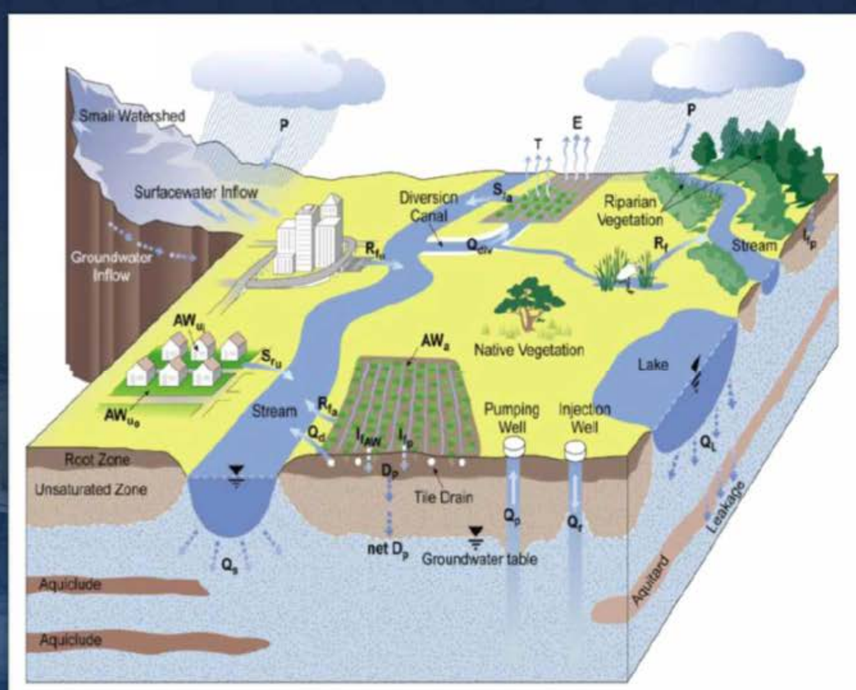
ATTACHMENT 2

Land & Water Use Budget Components

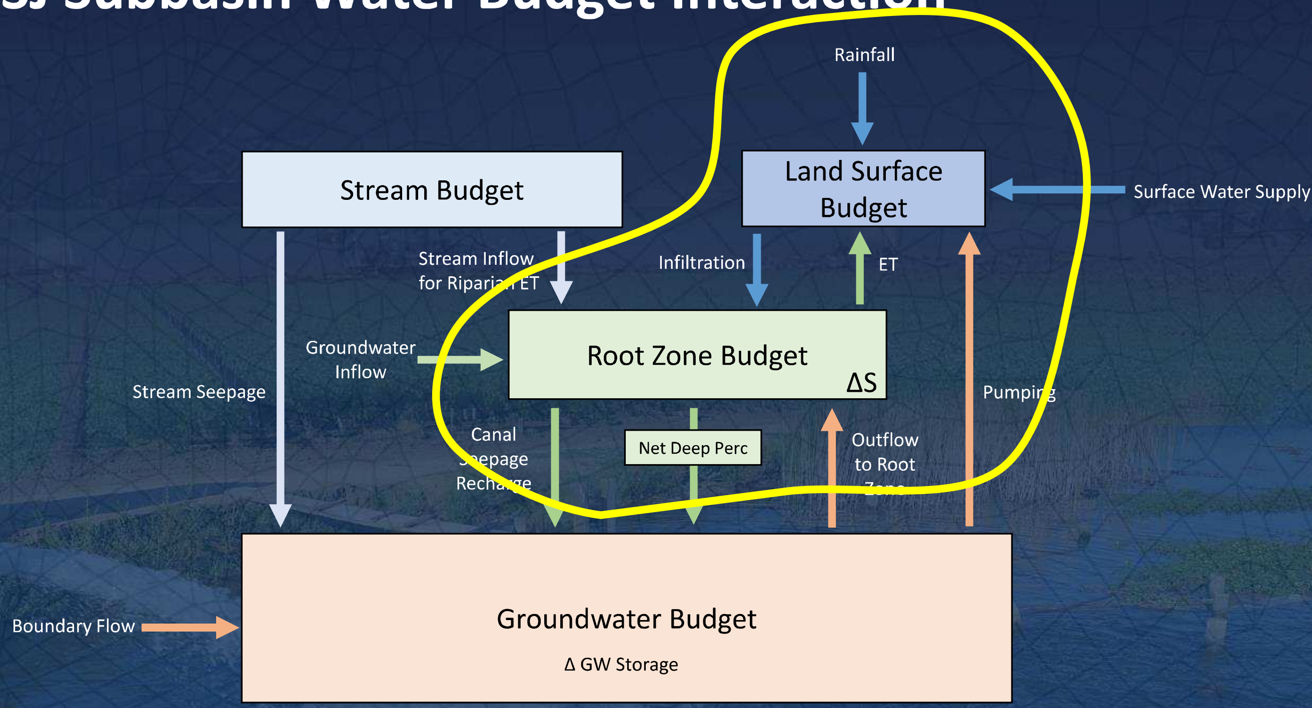


Integrated Hydrologic Processes

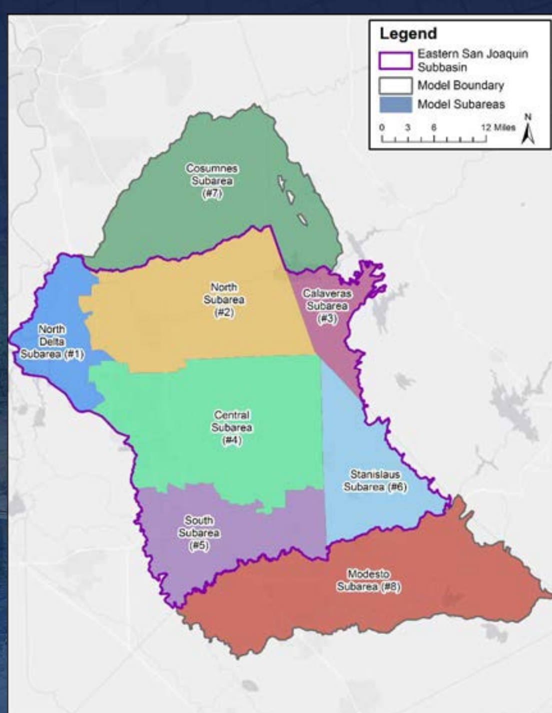
- Land Surface Processes
- Groundwater Flow
- Streamflow
- Physical Systems Integration
- Water Budgets



ESJ Subbasin Water Budget Interaction

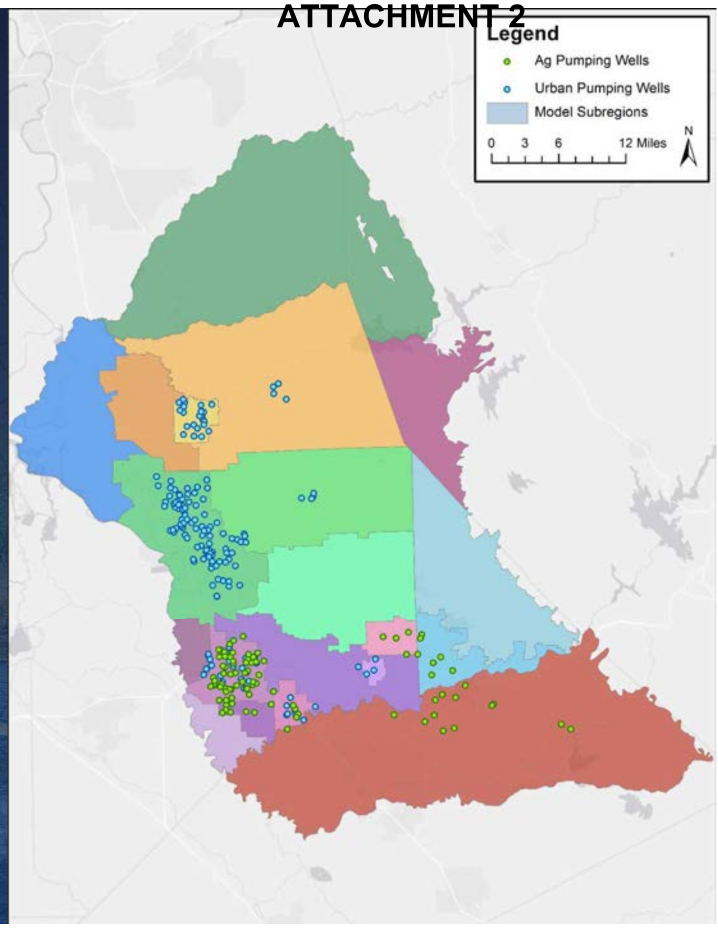


Model Area and ESJ Subbasin



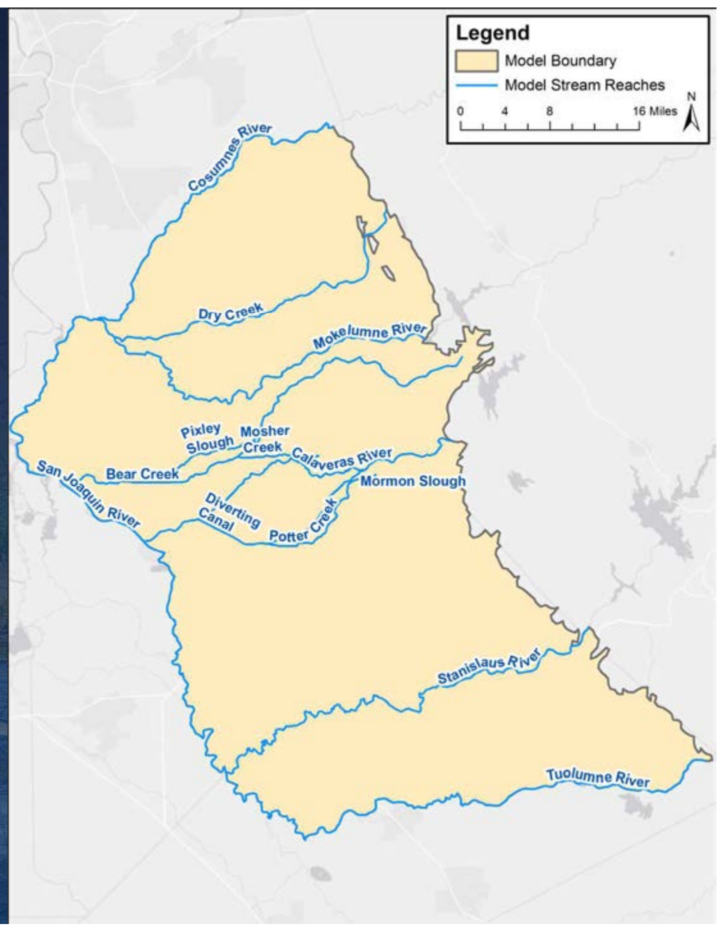
Water Supply Data Sources

- Groundwater pumping for ag or urban purposes:
  - Cal Water
  - Escalon
  - Lathrop
  - Linden County
  - Lockeford
  - Lodi
  - Manteca
  - Ripon
  - SEWD
  - Stockton
  - Oakdale
  - SSJID



Water Supply Data Sources

- Surface water deliveries for ag or urban purposes:
  - WID
  - Lodi
  - CCWD
  - Stockton
  - SEWD
  - CSJWCD
  - Lathrop
  - Manteca
  - SSJID
  - Oakdale ID
  - Modesto ID



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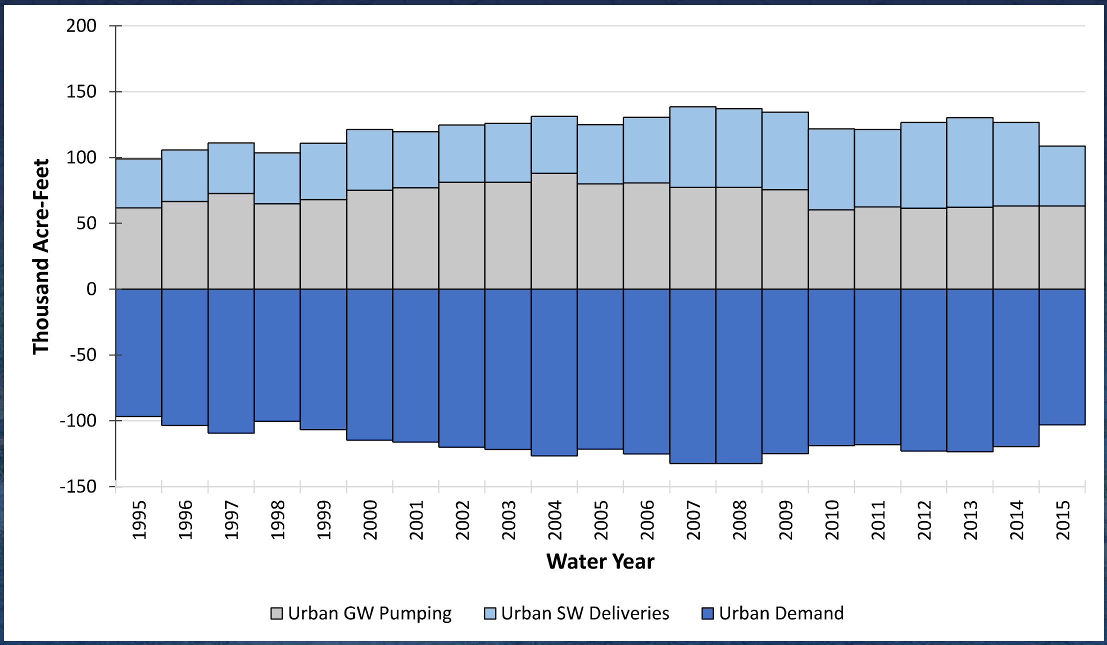
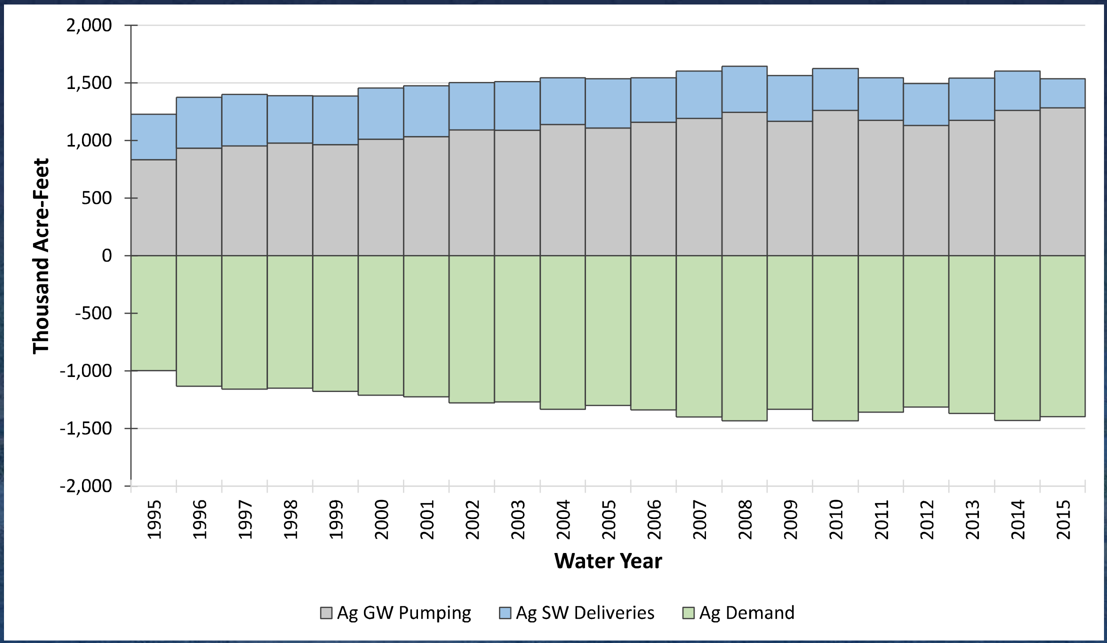
Land and Water Use Budget: ESJ Subbasin



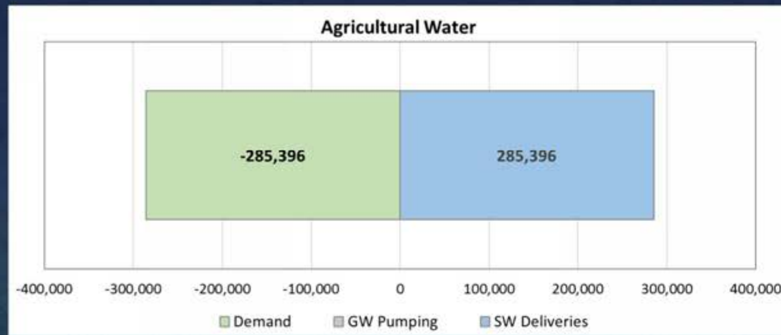
Land and Water Use Budget: ESJ Subbasin

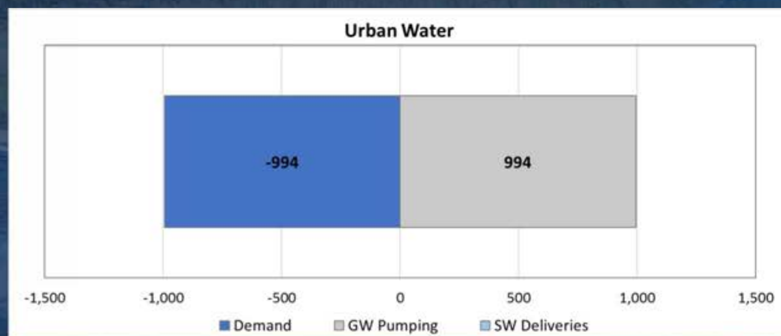


ATTACHMENT 2

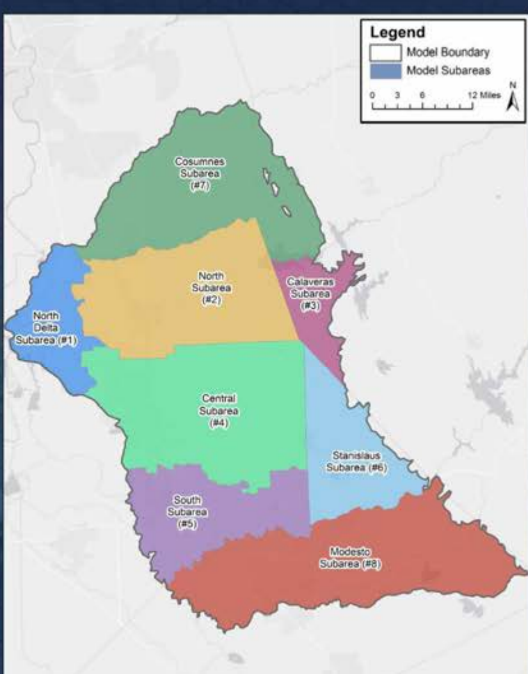
Average Annual Water Budget: Subarea 1

Average Annual for WY 1995-2015, Acre-Feet Per Year

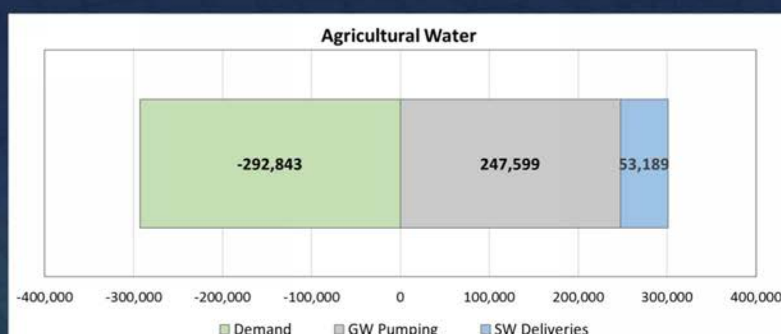


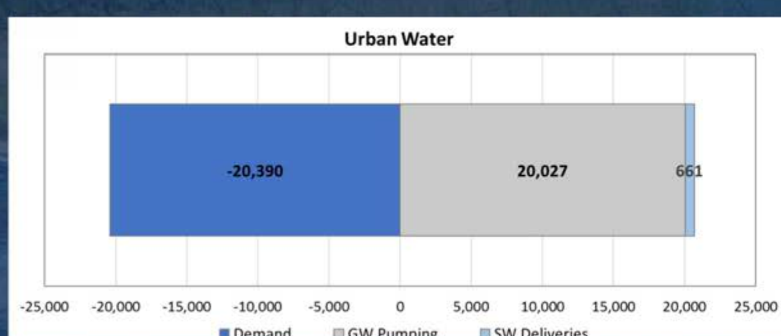


Average Annual Water Budget: Subarea 2



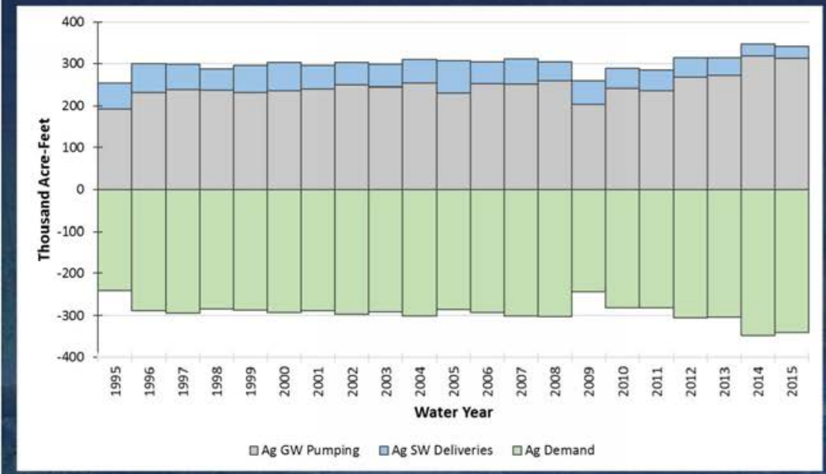
Average Annual for WY 1995-2015, Acre-Feet Per Year

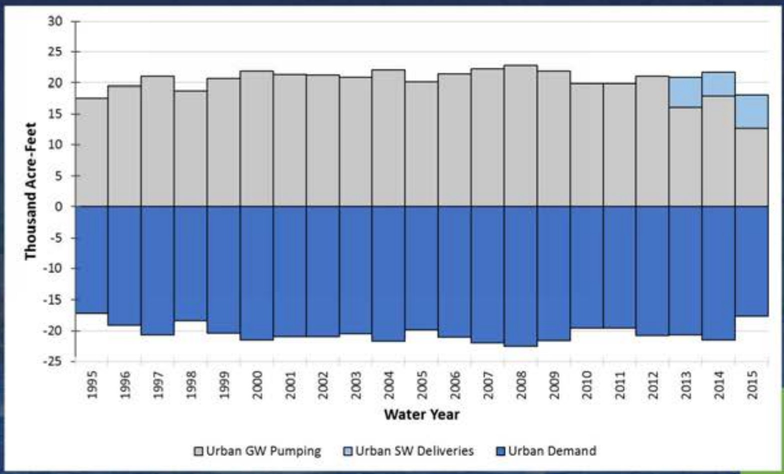




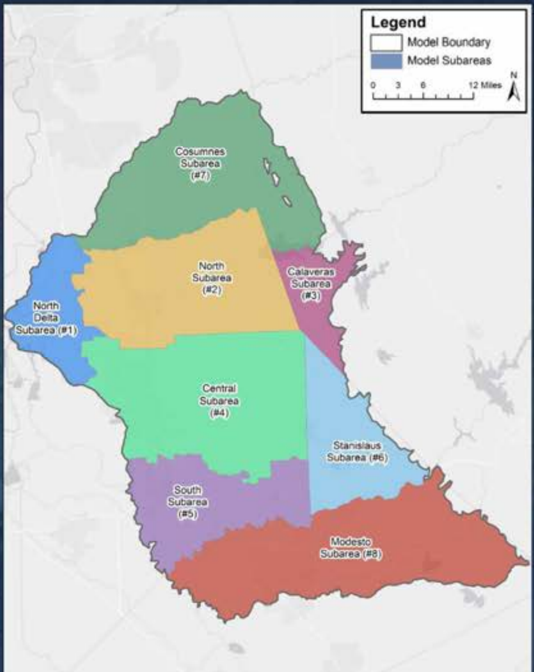
ATTACHMENT 2

Annual Water Budget: Subarea 2

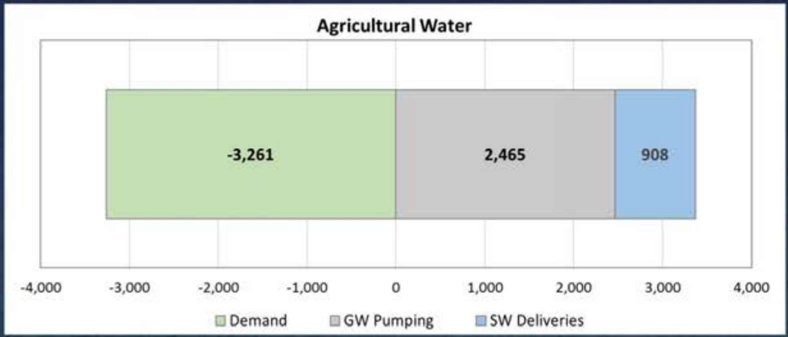


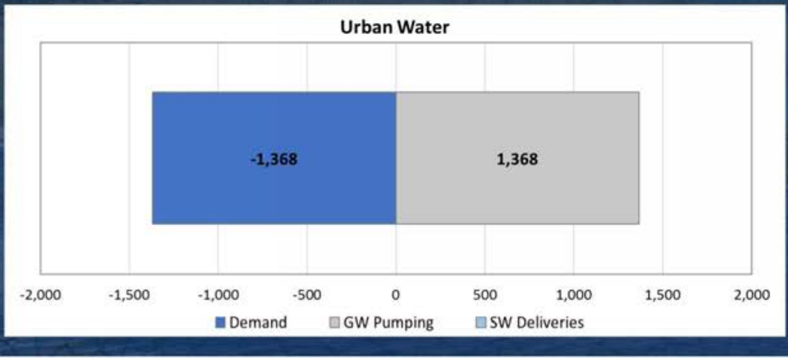


Average Annual Water Budget: Subarea 3



Average Annual for WY 1995-2015, Acre-Feet Per Year





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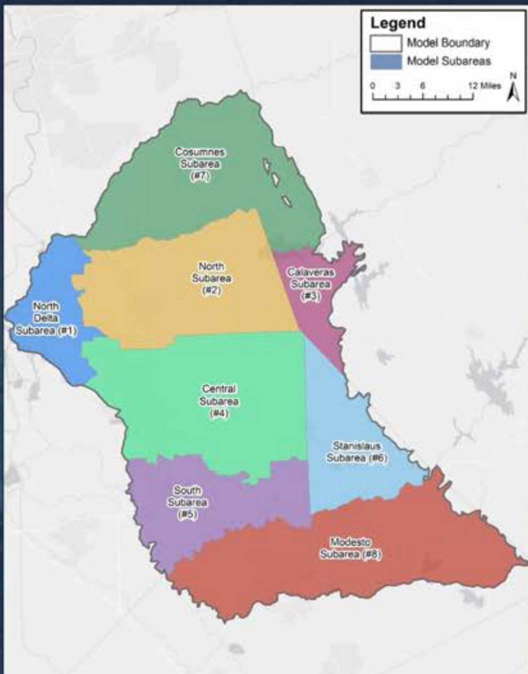
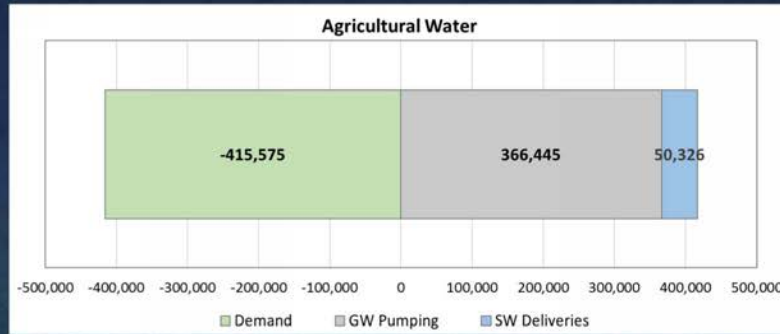
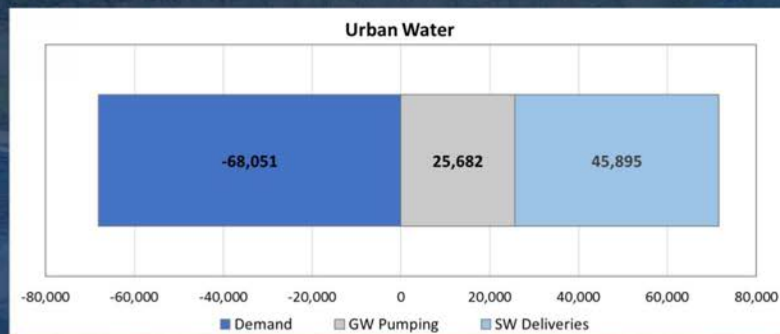
Average Annual Water Budget: Subarea 4

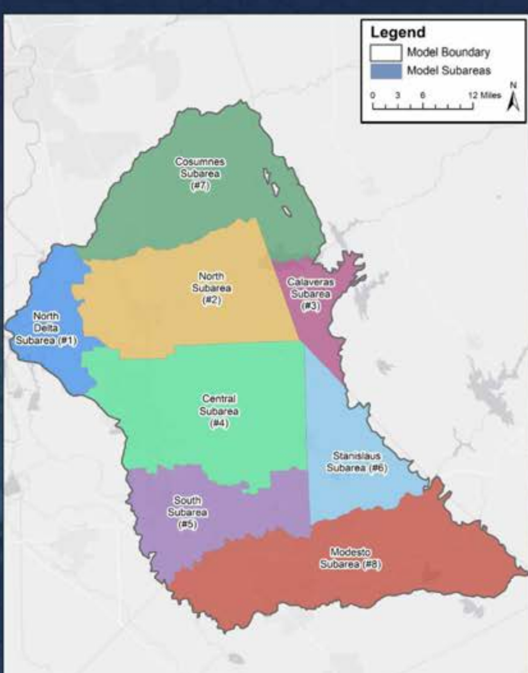


Average Annual for WY 1995-2015, Acre-Feet Per Year

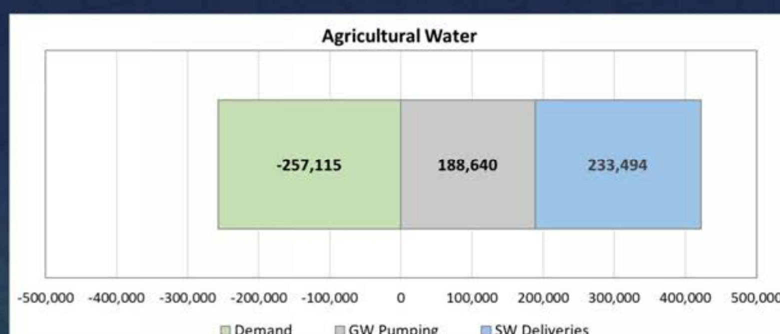




Average Annual Water Budget: Subarea 5



Average Annual for WY 1995-2015, Acre-Feet Per Year



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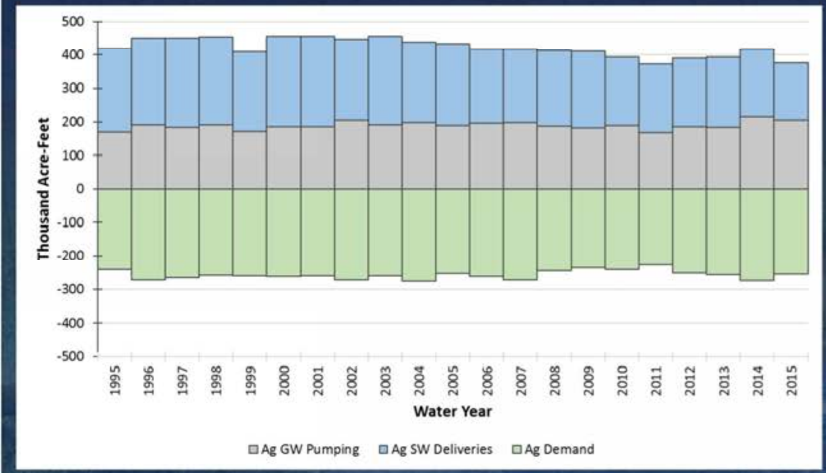
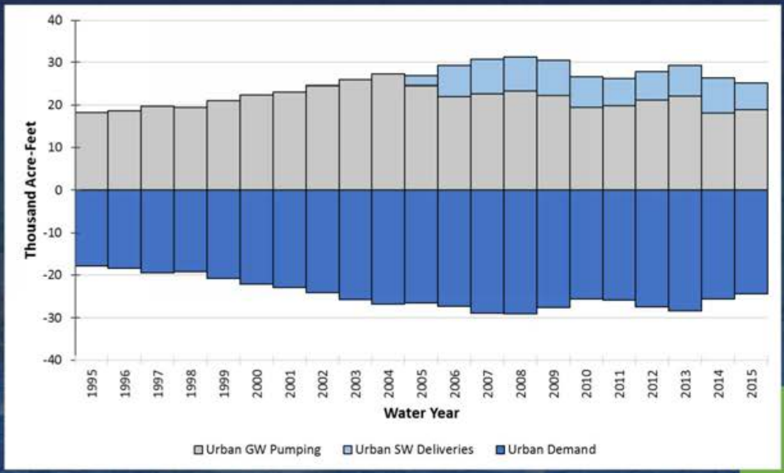
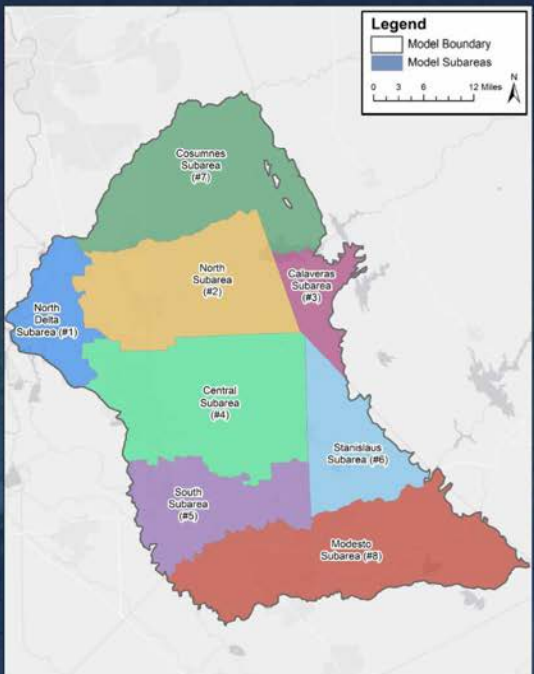
Annual Water Budget: Subarea 5

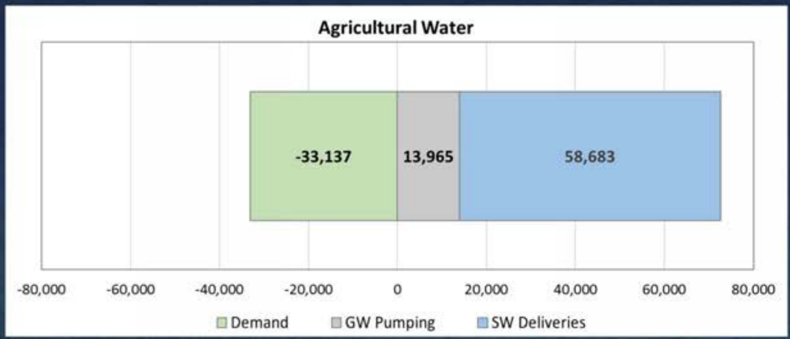


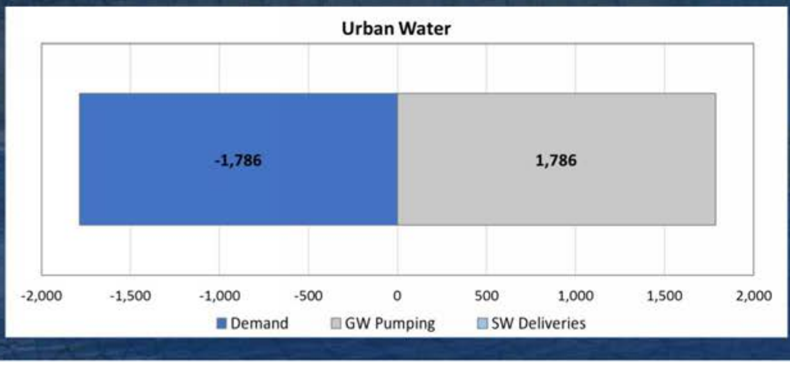


Average Annual Water Budget: Subarea 6



Average Annual for WY 1995-2015, Acre-Feet Per Year





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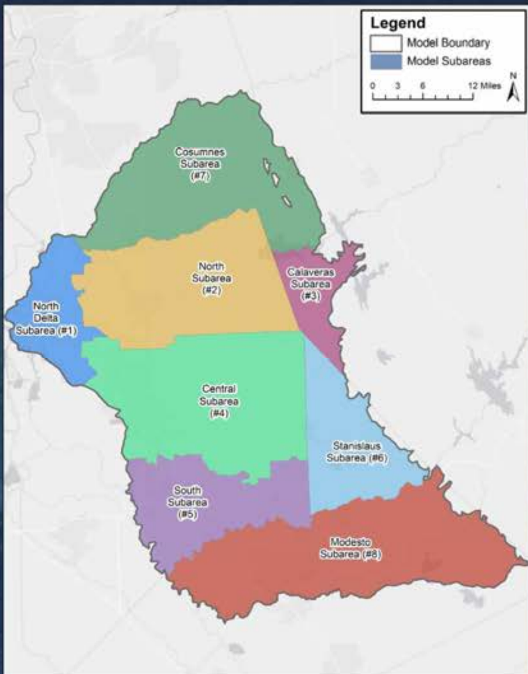
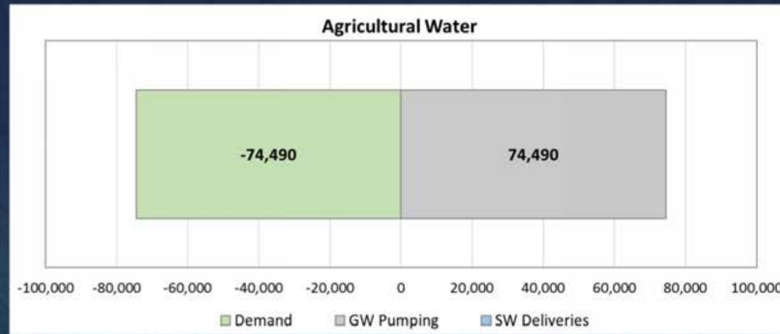
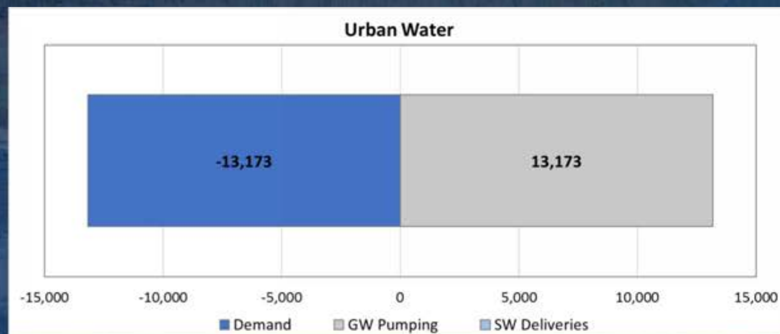
Average Annual Water Budget: Subarea 7

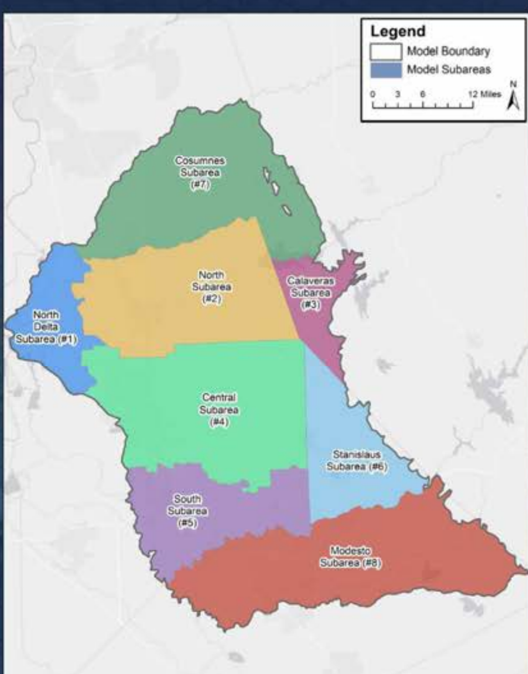


Average Annual for WY 1995-2015, Acre-Feet Per Year

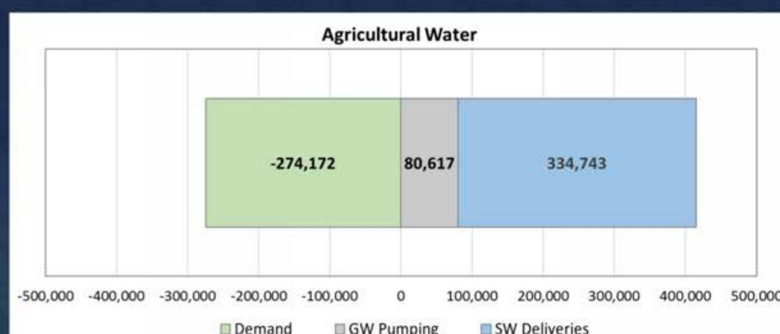


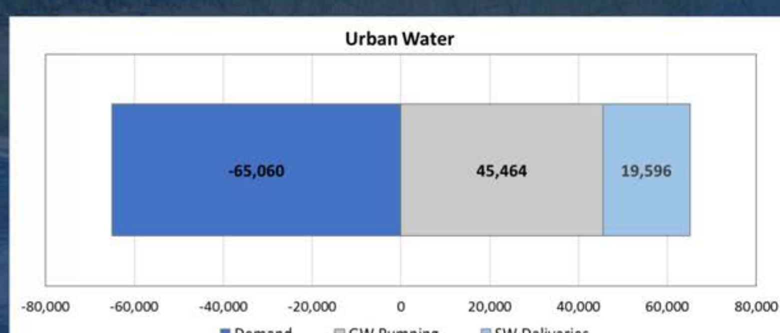


Average Annual Water Budget: Subarea 8



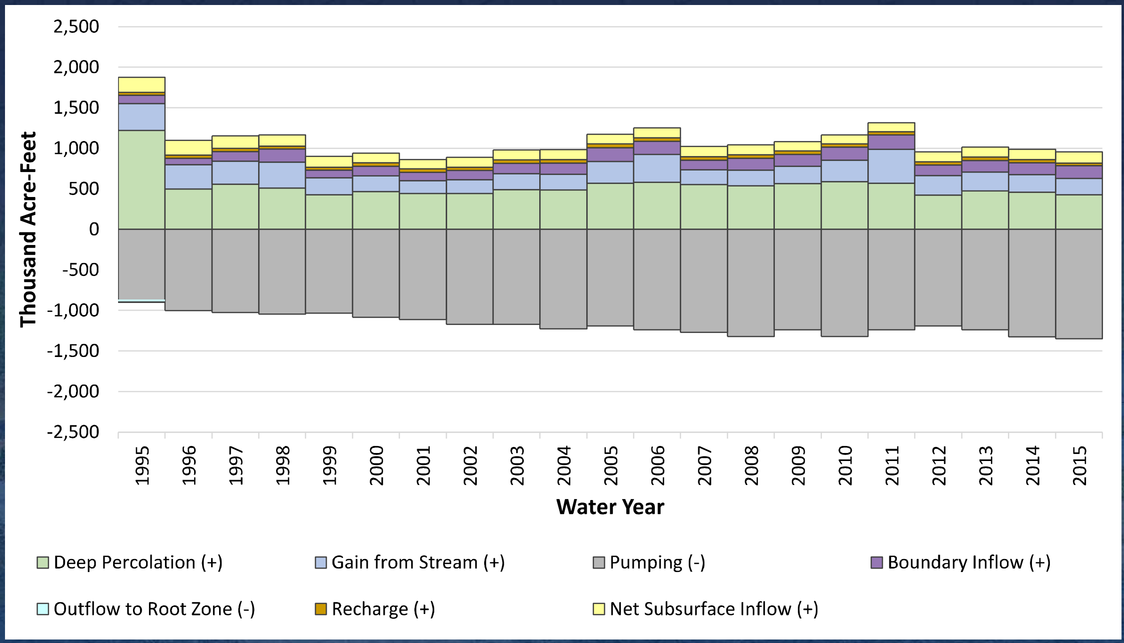
Average Annual for WY 1995-2015, Acre-Feet Per Year





ATTACHMENT 2

Groundwater Budget: ESJ Subbasin



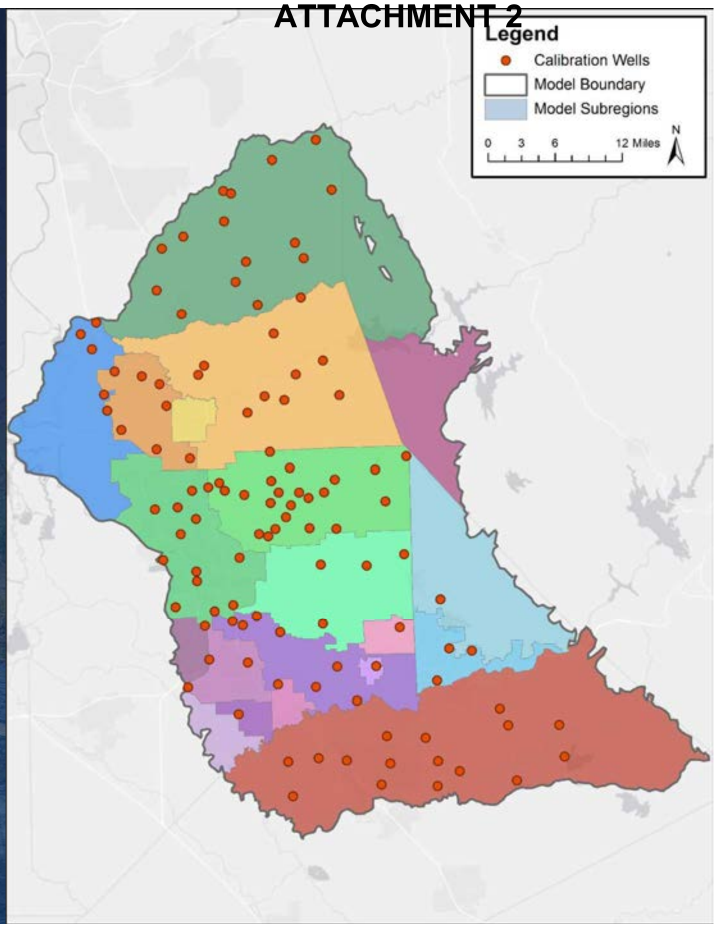
Calibration Process

- Identify:
  - Target calibration wells
  - Target streamflow gaging stations
- Review observed data and set calibration targets
- Calibrate model by adjusting model parameters to attain reasonable match between modeled and opbserved data for:
  - Water budgets for each component of the hydrologic cycle modeled
  - GW levels at select wells
  - Streamflows at select gaging stations
- Compare calibration performance with calibration targets
- Conduct additional refinements as necessary

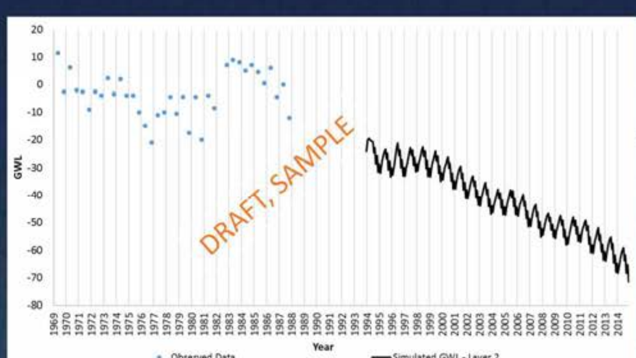
ATTACHMENT 2

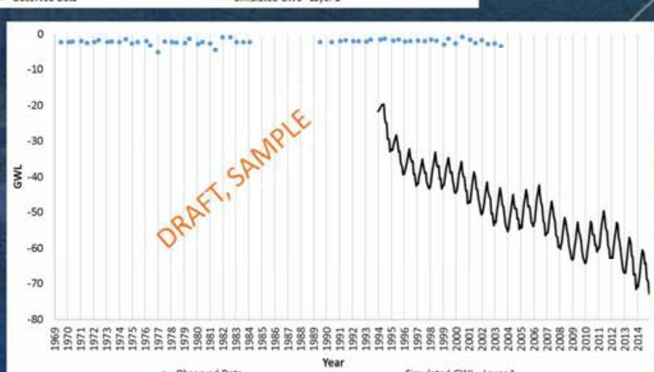
Preliminary Calibration Wells

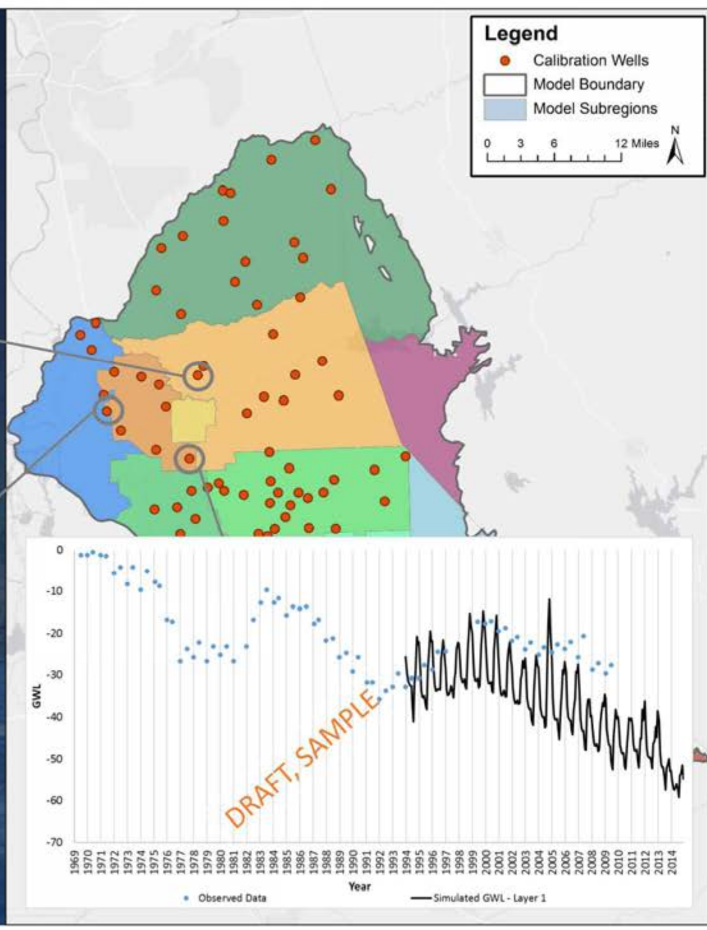
- Correspond to calibration wells in other models:
  - C2VSim-FG
  - San Joaquin-Stanislaus IGSM & DynFlow



Sample Hydrographs







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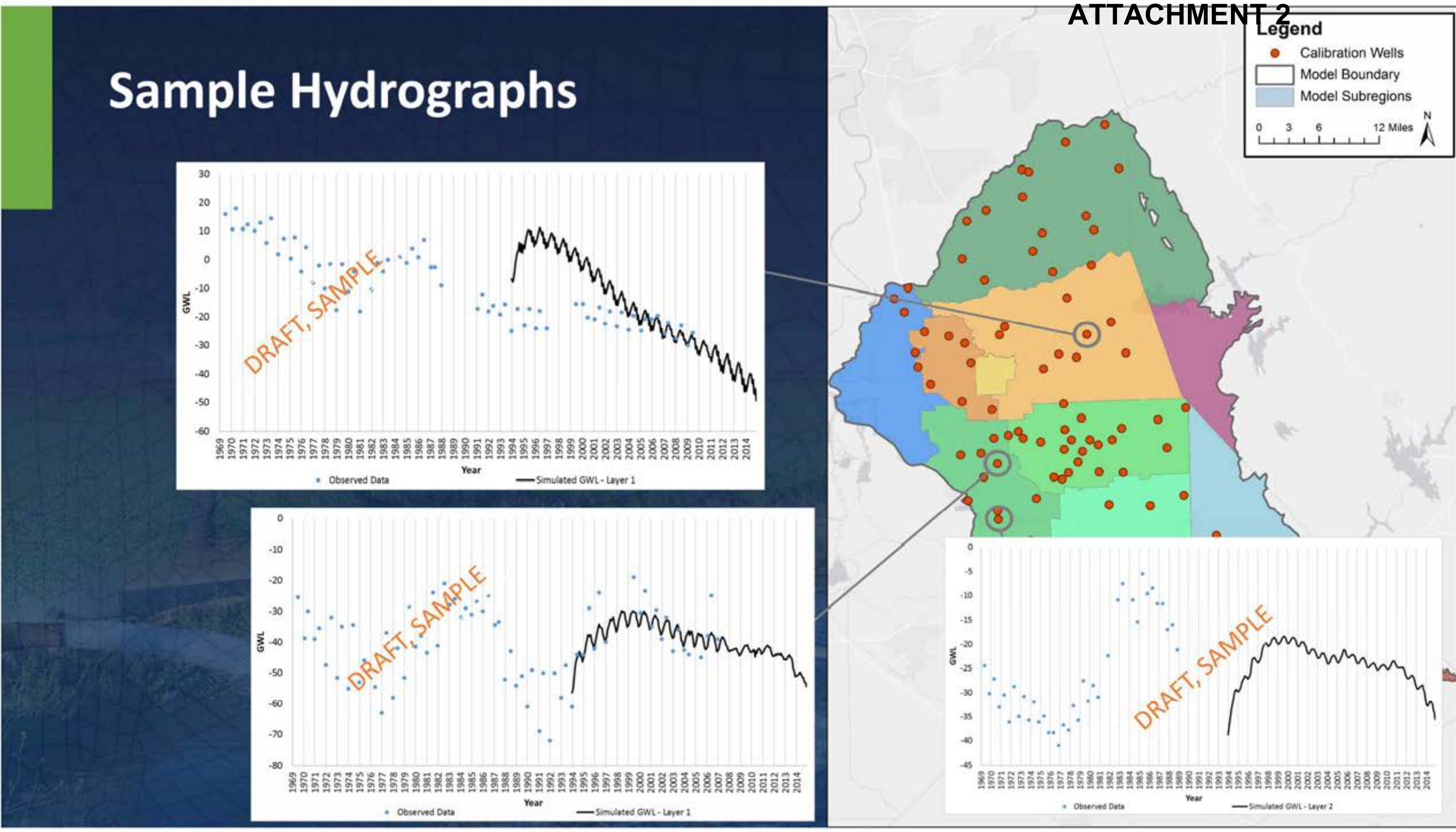
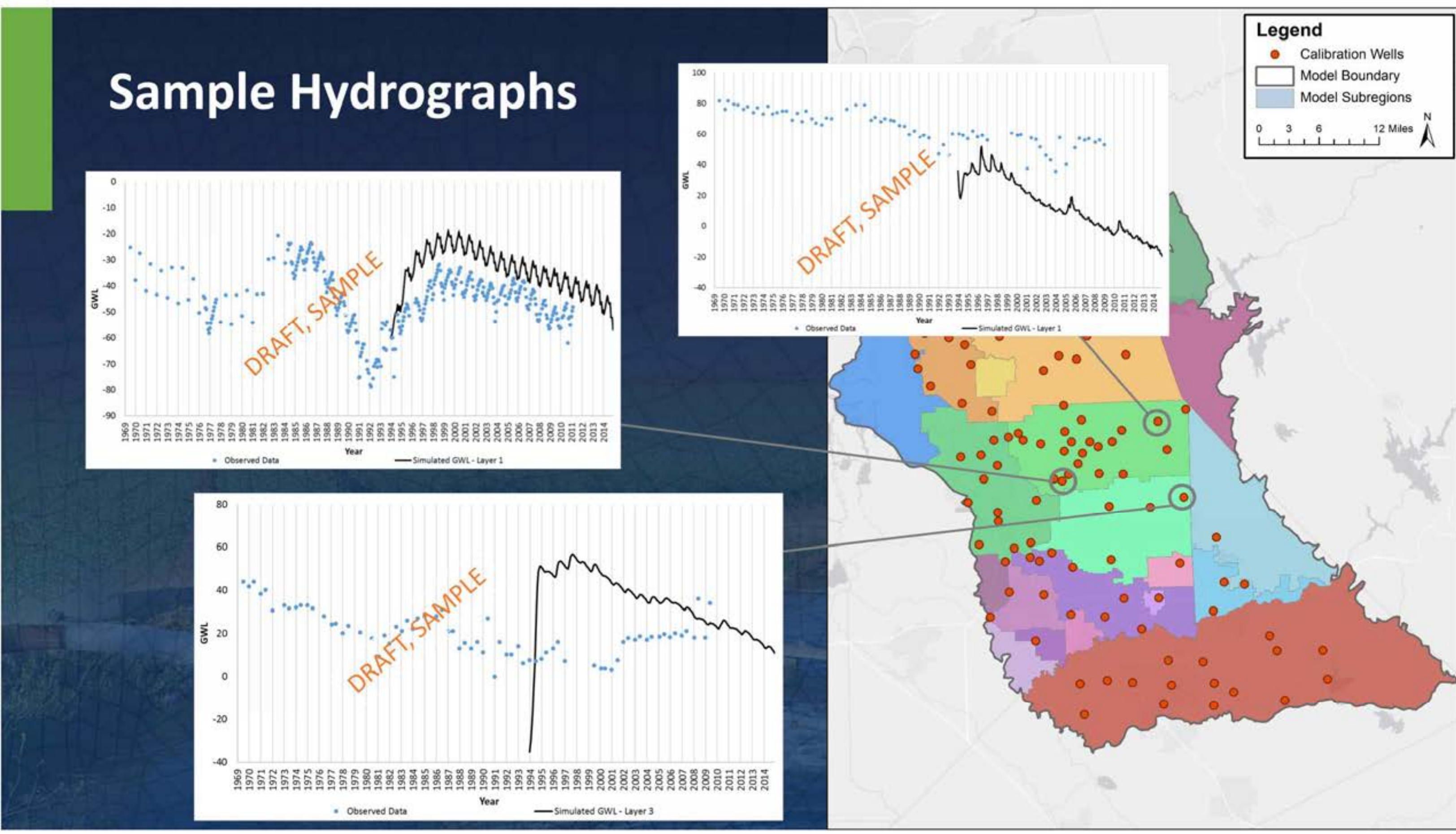
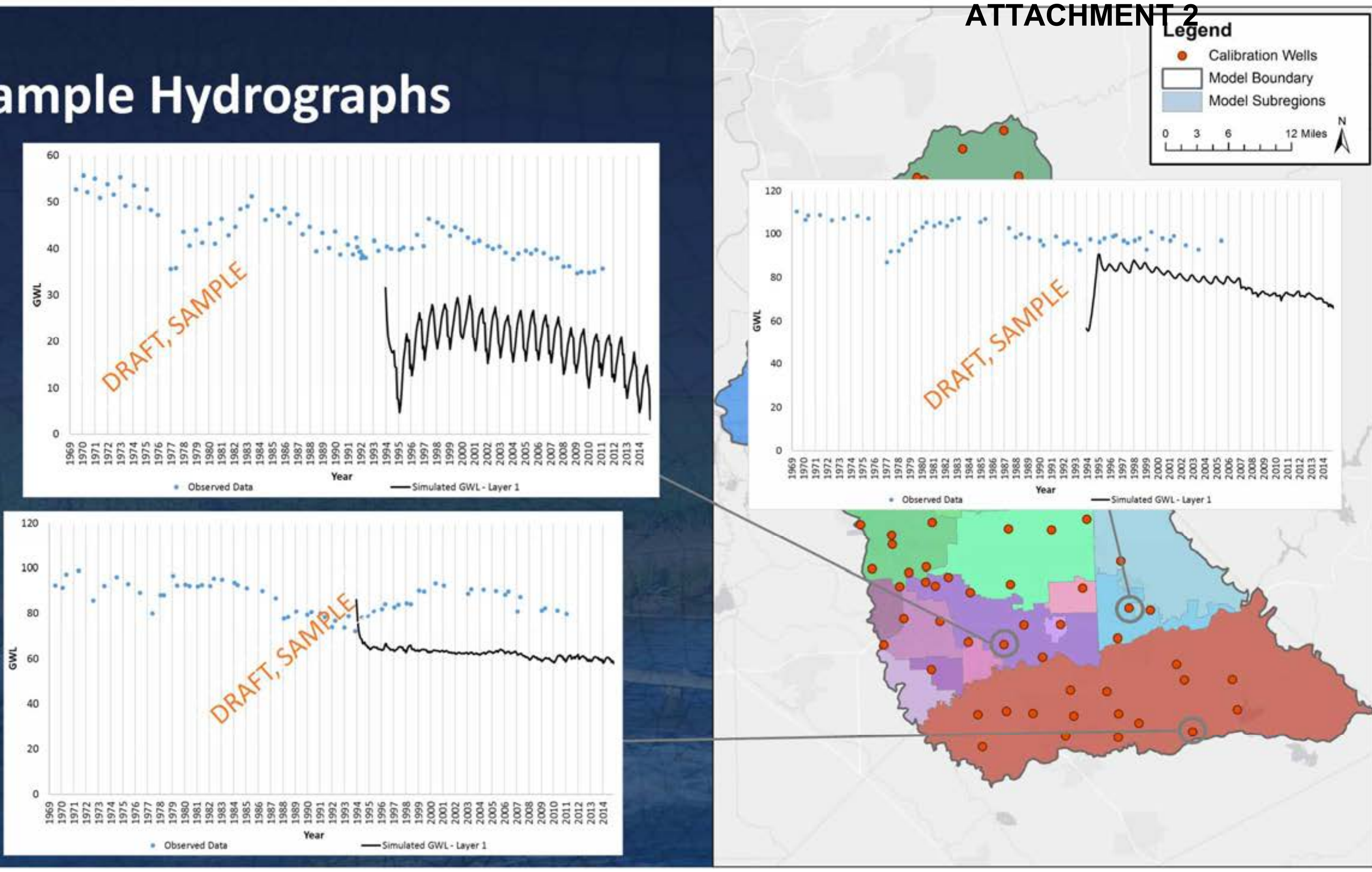




ATTACHMENT 2

Sample Hydrographs



Model Applications Next Steps ...

ATTACHMENT 2

Model Objectives: Historical Conditions

Basin Characteristics

Historical, Current and Projected Levels of Development

GW & SW Conditions

Stream-Aquifer Interaction

Model Objectives: Projected Conditions

Projected Conditions

IRWM, GWMP
SGMA

Storm water and Recycled Water Opportunities

Groundwater Banking

Groundwater Sustainability

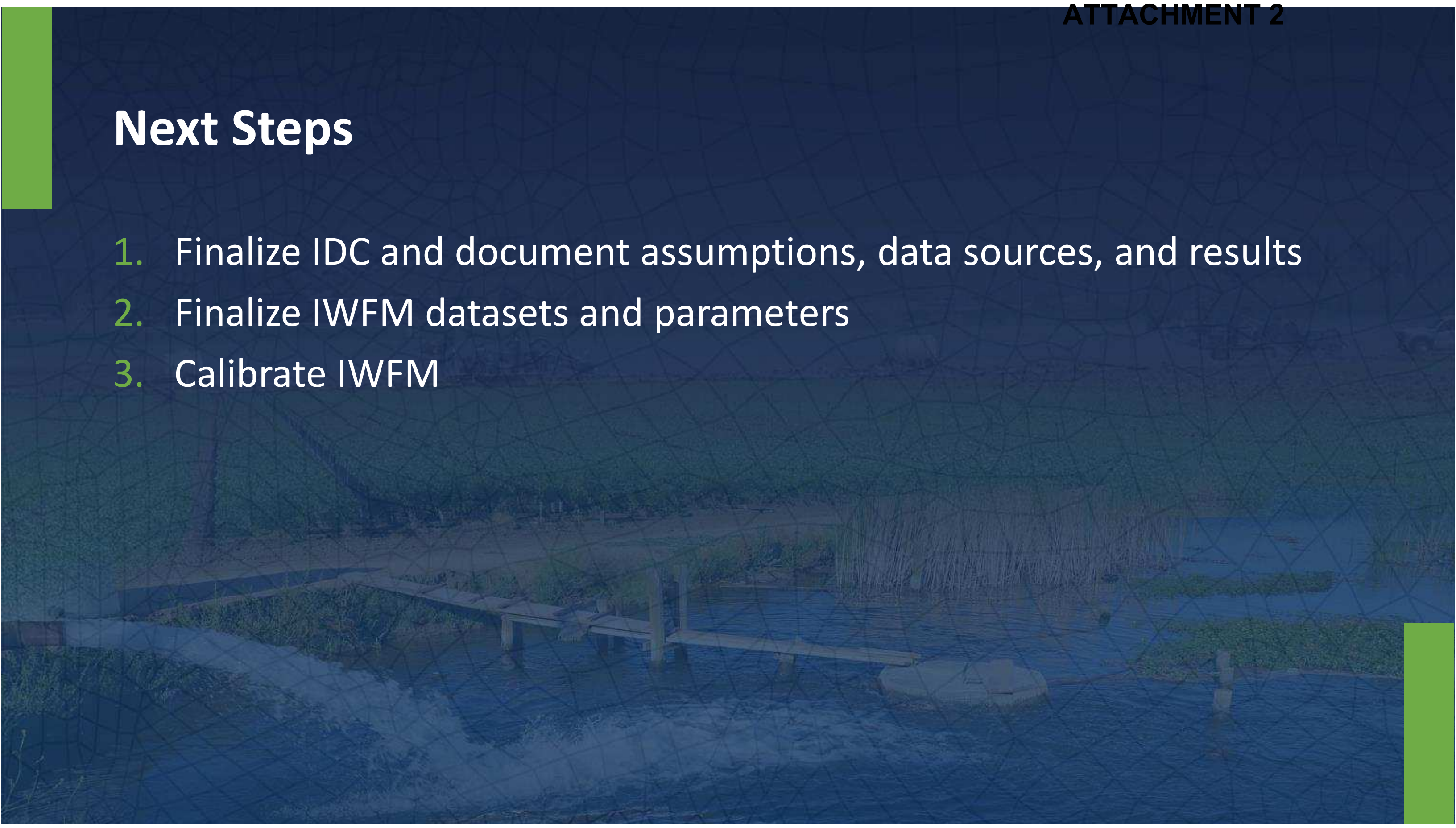
Hydro-Economic Evaluations

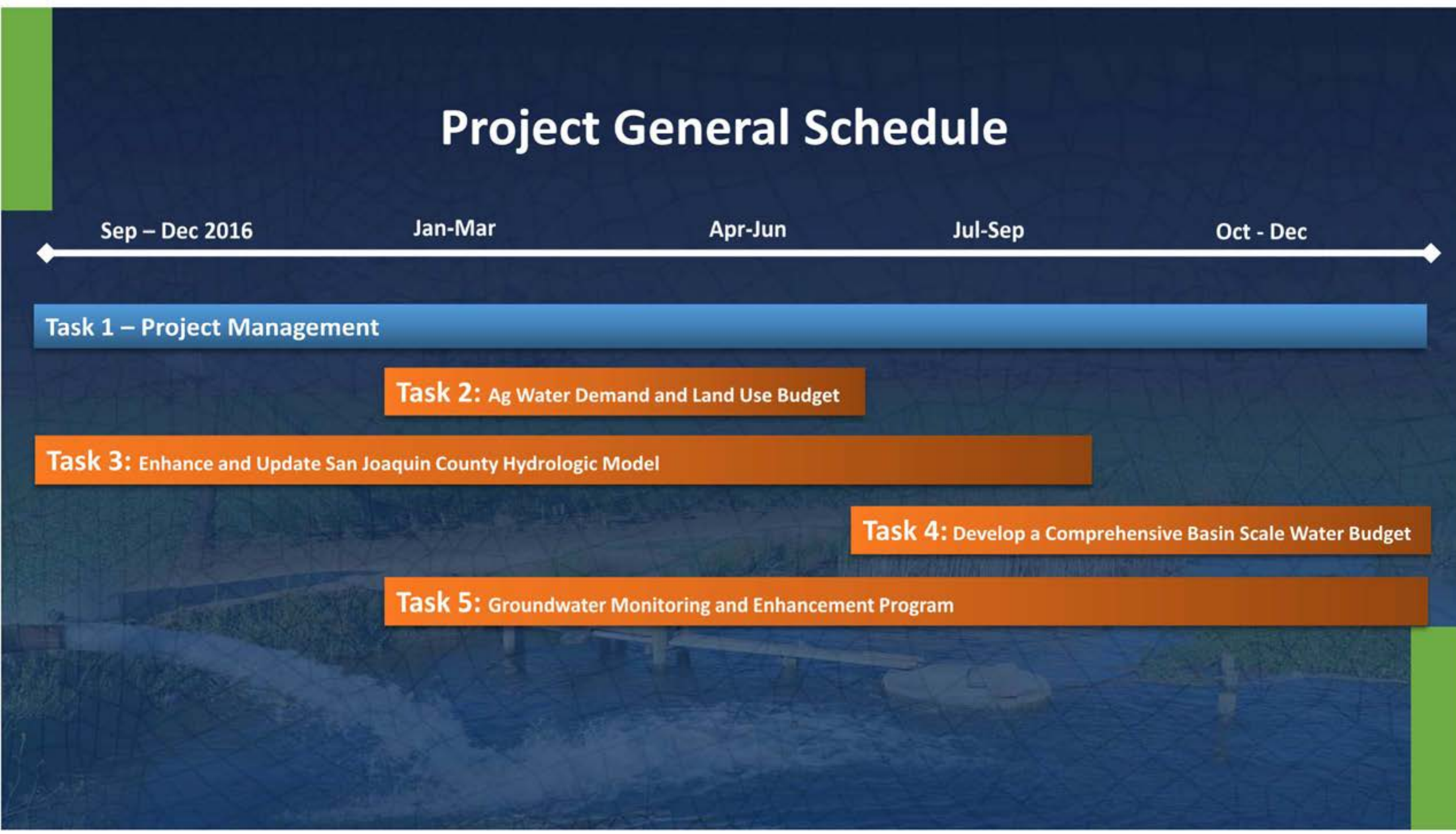
Water Availability

Urban Water Supply

Project Beneficiary Assessment

ATTACHMENT 2





ATTACHMENT 2

Sustainable Groundwater Management Act Readiness Project

ESJ Water Resources Model (ESJWRM) IDC Workshop

RMC water and environment

WOODARD & CURRAN

National Experience. Local Focus.

SAN JOAQUIN COUNTY CALIFORNIA

April 25, 2018

Agenda

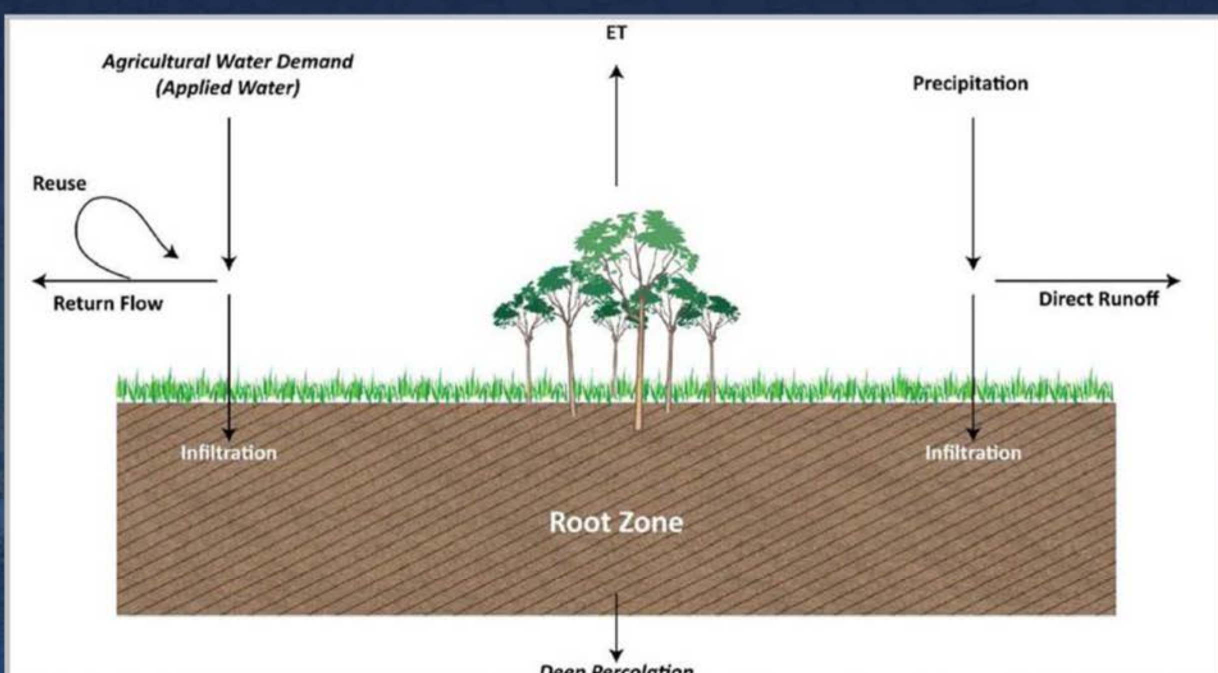
- Introduction
- Review IDC
- Review IDC data
- Review IDC results

ATTACHMENT 2

Stakeholder Collaboration

- Cal Water
- Calaveras County Water District
- Escalon, City of
- Lathrop, City of
- Lockeford Community Services District
- Lodi, City of
- Manteca, City of
- North San Joaquin Water Conservation District
- Oakdale Irrigation District
- San Joaquin County
- South San Joaquin Irrigation District
- Stanislaus County
- Stockton, City of
- Stockton East Water District
- Woodbridge Irrigation District

IWFM Demand Calculator: IDC

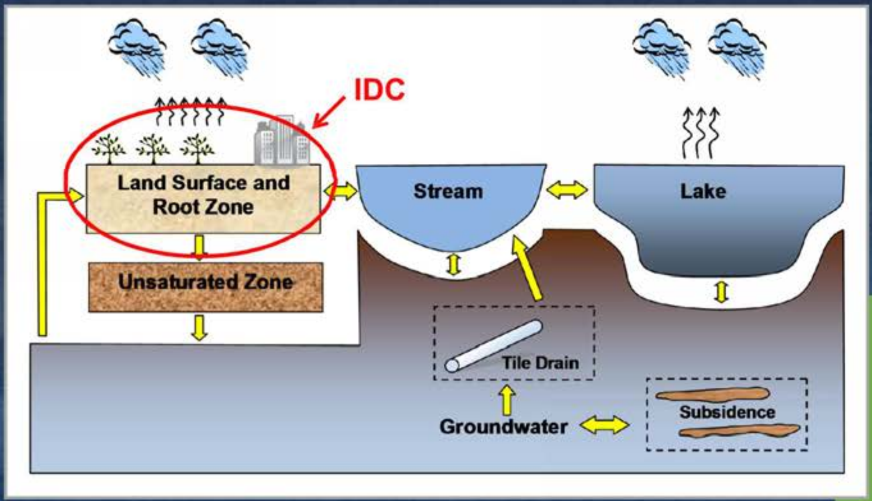


Source: IDC training workshop (Emin Can Dogrul, DWR)

ATTACHMENT 2

Ag Demand Estimation using IDC

- IWFM Demand Calculator (IDC) is a software that calculates land use based water demands and routes water through the land surface and root zone using physically-based simulation methods
- Uses methods from irrigation-scheduling-type models and applies them at regional scales
- Stand-alone executable or root zone module of Integrated Water Flow Model (IWFM) v2015



Source: IDC training workshop (Emin Can Dogrul, DWR)

IDC Background

- IDC was initially developed to…
  - Maintain consistency between C2VSim and CalSim
  - Calculate downstream water demands for CalSim under current conditions and future scenarios
- First version of IDC did not have rice and refuge simulations, had incompatible calculations for daily runs
- IDC v4.0 was developed to improve upon the initial version of IDC
- With alternative root zone routing schemes developed (v4.0, v4.1 and v3.02) IDC-2015 became a container for different root zone routing methods

Source: IDC training workshop (Emin Can Dogrul, DWR)

Features of IDC-2015

- Use of a computational grid, finite-element or finite-difference, to represent spatial distribution of land-use, climatic, soil and farm management properties; each cell can have multiple land-use types specified as time-series data
- Simulation of land surface and root zone flow processes as well as water demand computations are done at each grid cell for each land-use type
- Irrigation-scheduling-type approach at each grid cell for each agricultural crop
- Direct representation of rice fields (including simulation of flooded decomposition, non-flooded decomposition and no decomposition) and refuges (seasonal and permanent)
- Riparian vegetation access to stream flows and simulation of evapotranspiration from groundwater
- Urban water demand computation based on population and per capita water usage
- Simulation of ETAW and effective precipitation
- Simulation of re-use of irrigation return flow that takes place at a grid cell, between grid cells or between subregions
- Budget output includes soil moisture, and land and water use budgets for individual crops at each subregion

Source: IDC training workshop (Emin Can Dogrul, DWR)

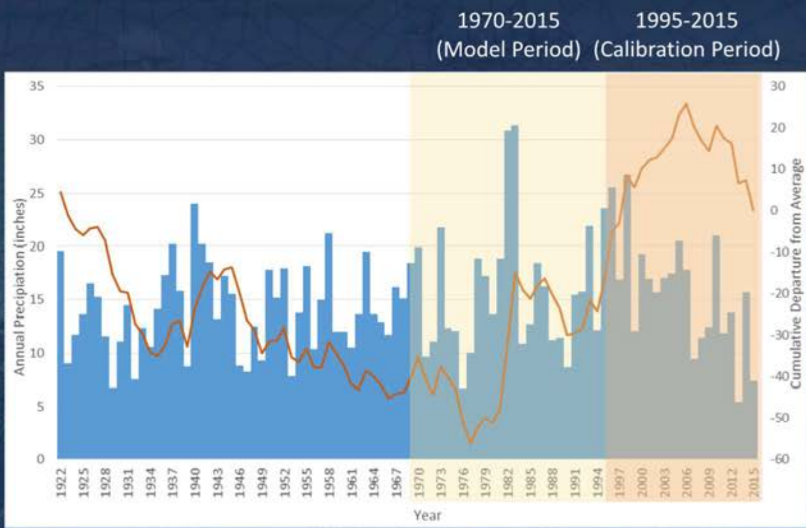
Key Parameters and Data in IDC

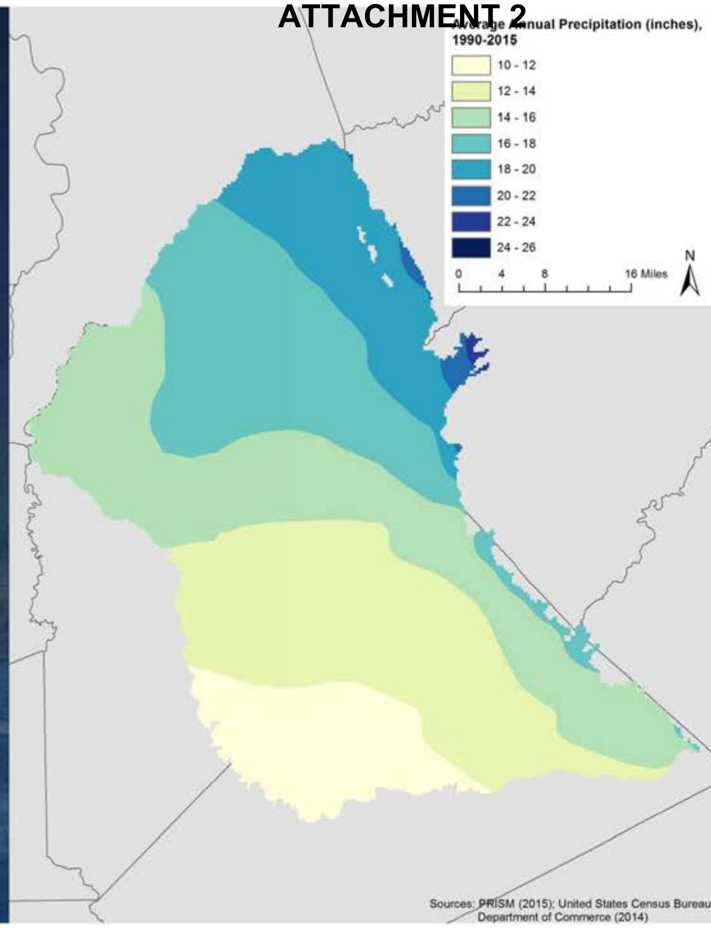
- Monthly Rainfall
- Crop Evapotranspiration, Et_c
- Return and reuse fractions
- Irrigation period
- Land use and crop acreages
- Urban population and per capita water use
- Soil Properties:
  - Hydraulic Conductivity
  - Pore Size Distribution Index
  - Others: Wilting Point, Field Capacity, Total Porosity

ATTACHMENT 2

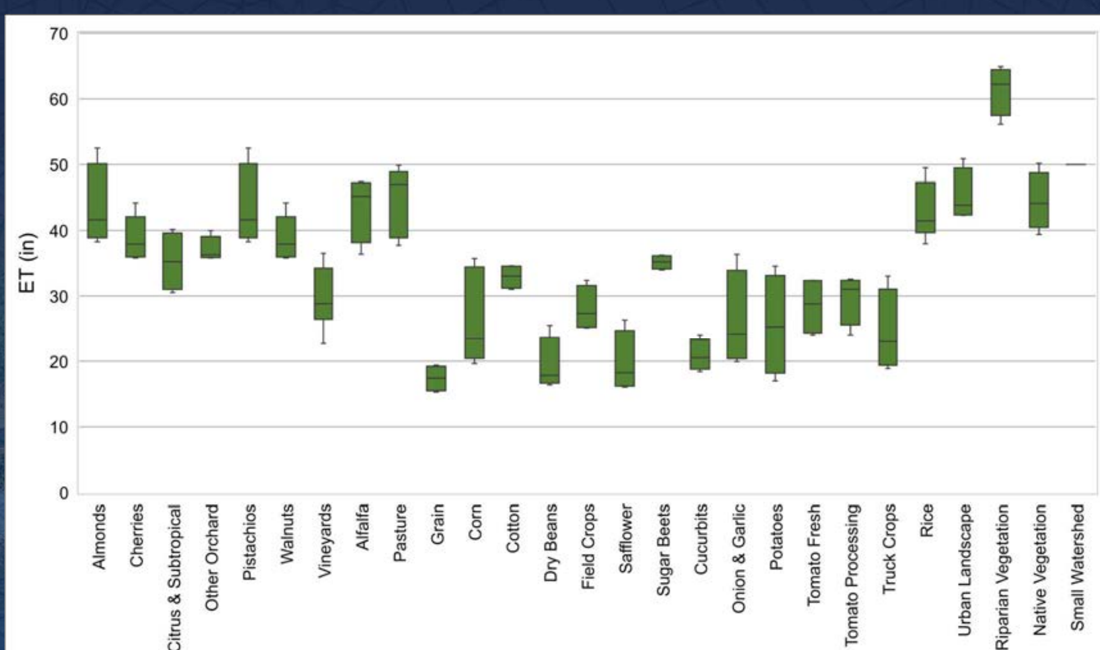
Precipitation

- Source of Data: PRISM for entire model period (1970-2015)





Crop Evapotranspiration, ET_c



Recap of Land Use and Cropping Patterns

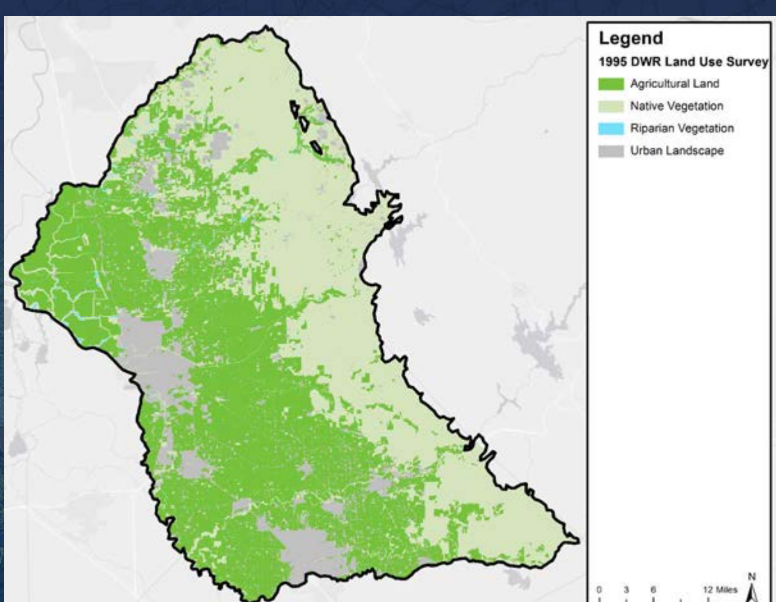
1. DWR Land Use Surveys (Representing ~1995 Era)
   - San Joaquin County (1996)
   - Sacramento County (1993)
   - Amador County (1997)
   - Calaveras County (2000)
   - Stanislaus County (1996)
2. Remote Sensing Data:
   - USDA's CropScape
   - DWR's LandIQ Survey; 2014
3. Local Data Sources

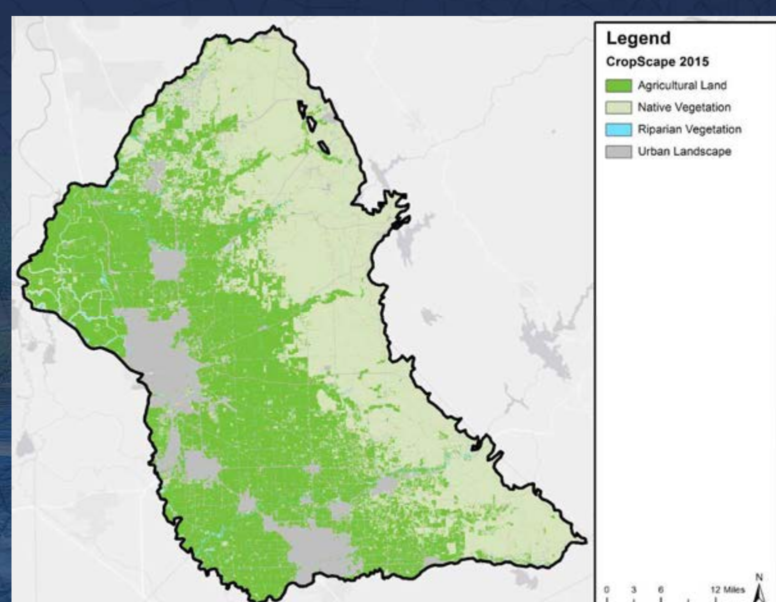
ESJWRM:

- 23 irrigated crop categories
  - Form 7 high-level categories used for verification purposes
- 4 other land use categories

Model Crop Category	Grouped Crop Categories
Almonds Cherries Citrus & Subtropical Other Orchard Pistachios Walnuts	Fruit and Nut Trees
Vineyards	Vineyards
Alfalfa Pasture	Alfalfa and Irrigated Pasture
Grain	Grain
Corn Cotton Dry Beans Field Crops Safflower Sugar Beets	Field Crops
Cucurbits Onion & Garlic Potatoes Tomato Fresh Tomato Processing Truck Crops	Truck Crops
Rice	Rice
Urban Landscape Water Surface Riparian Vegetation Native Vegetation	Other Land Use

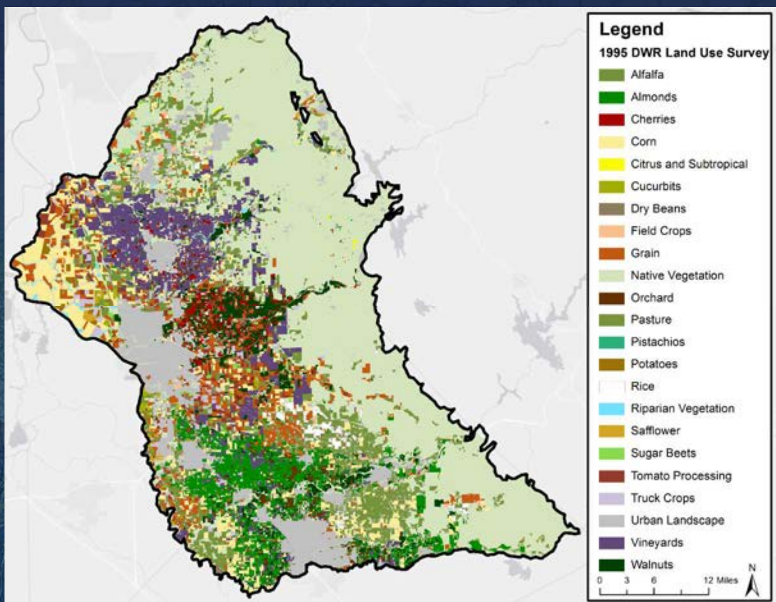
ESJ Model Area Land Use (1995 & 2015)

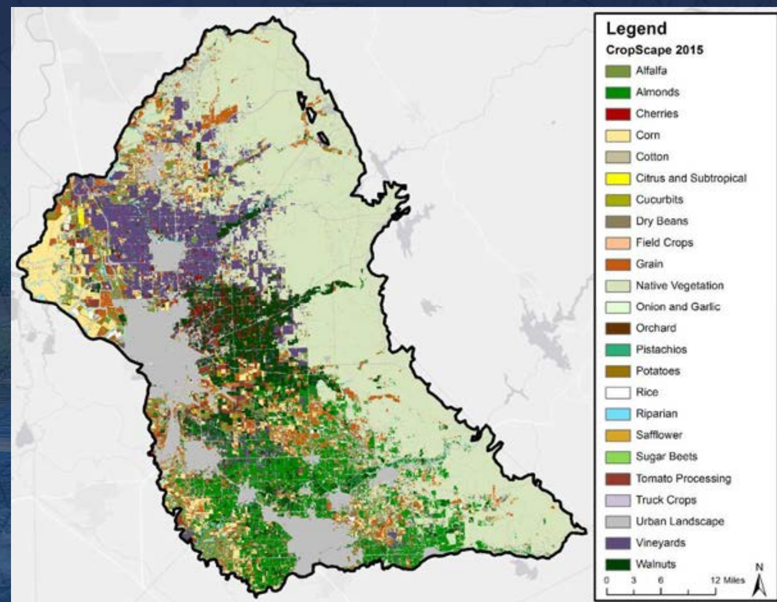




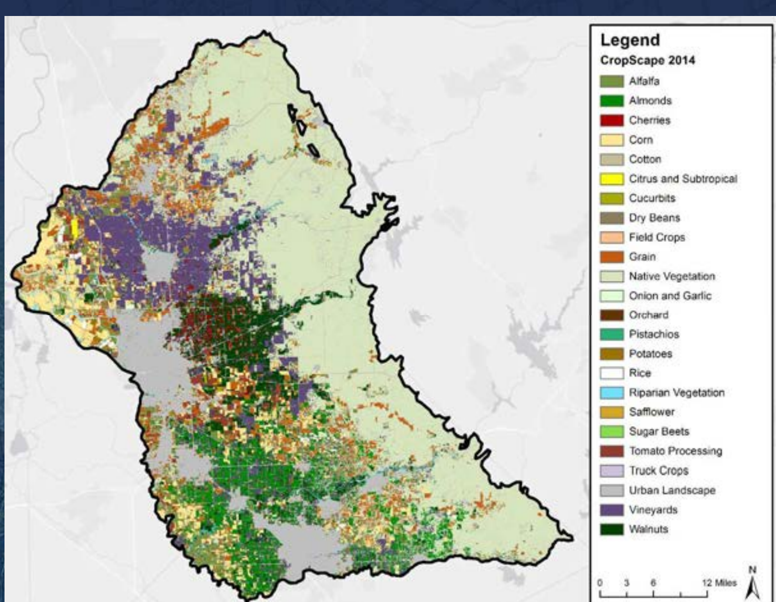
ATTACHMENT 2

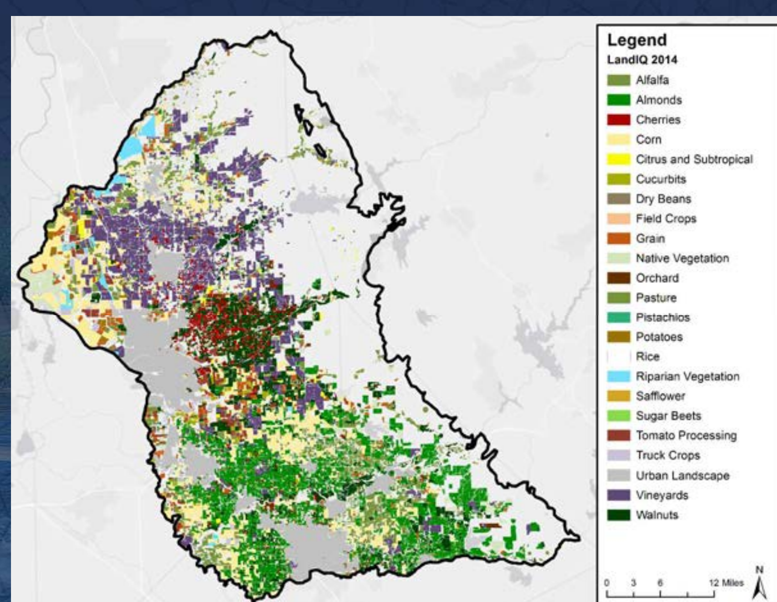
ESJ Model Area Cropping Pattern (1995 & 2015)





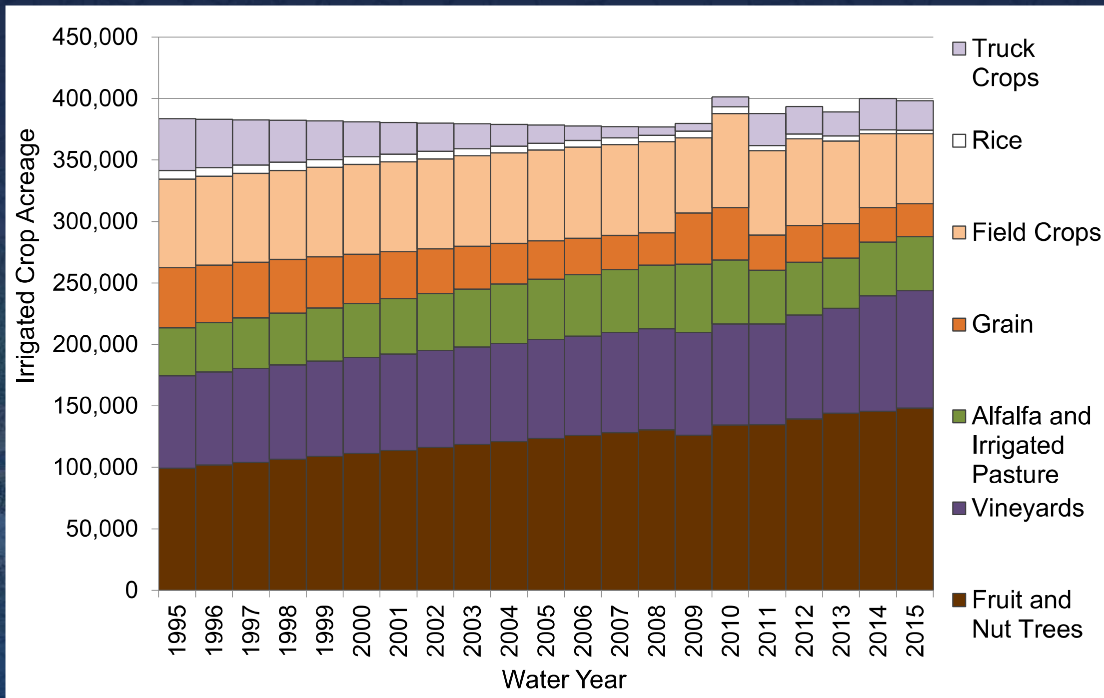
2014 Cropping Pattern (CropScape & LandIQ)



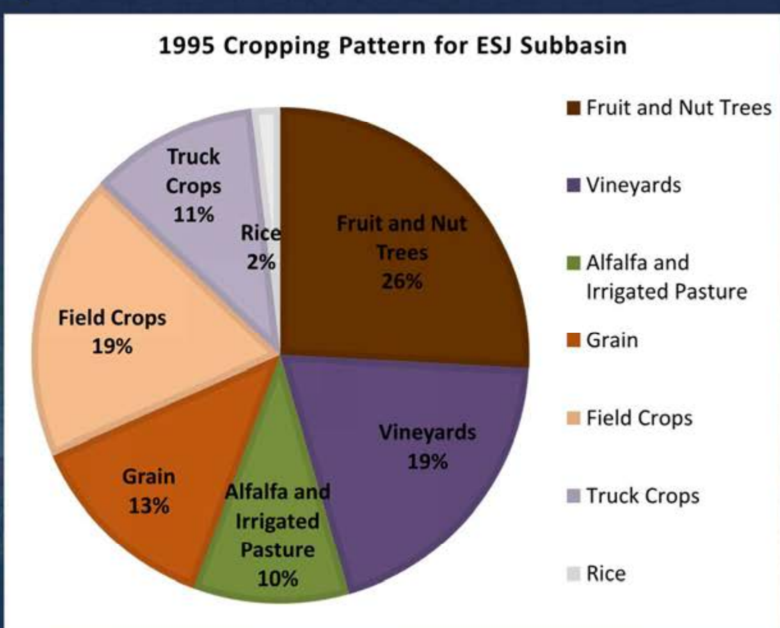


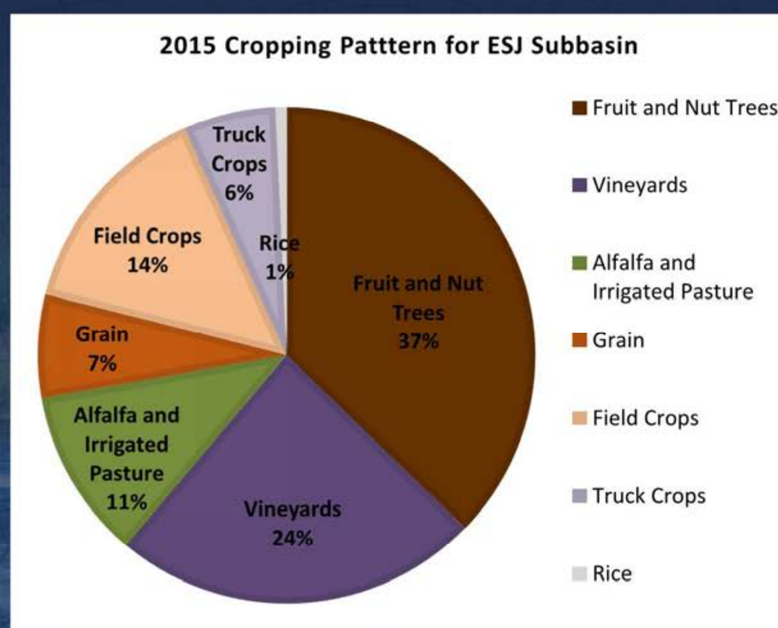
ATTACHMENT 2

Primary Cropping Pattern in ESJ Subbasin



Primary Cropping Pattern in ESJ Subbasin





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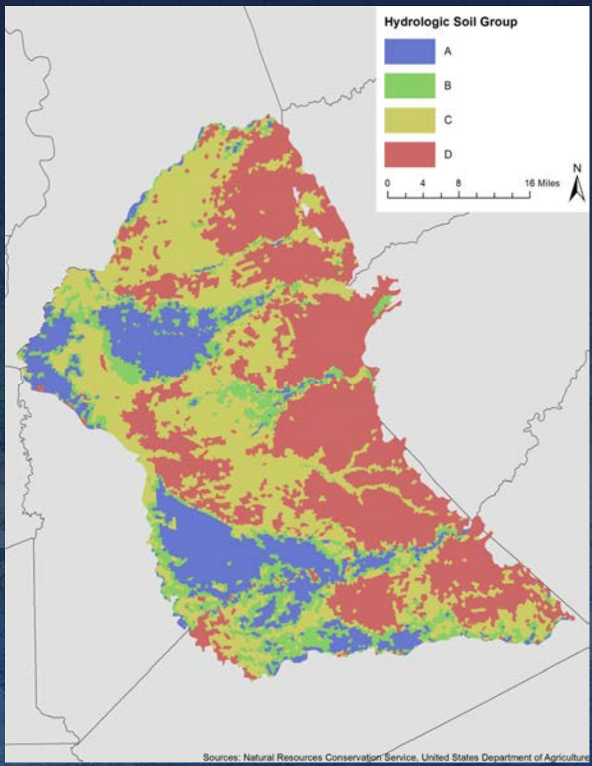
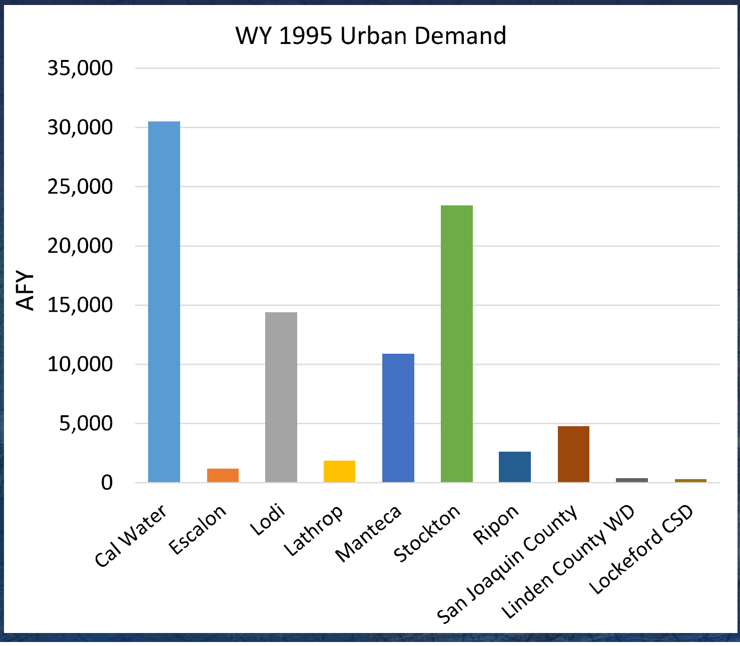
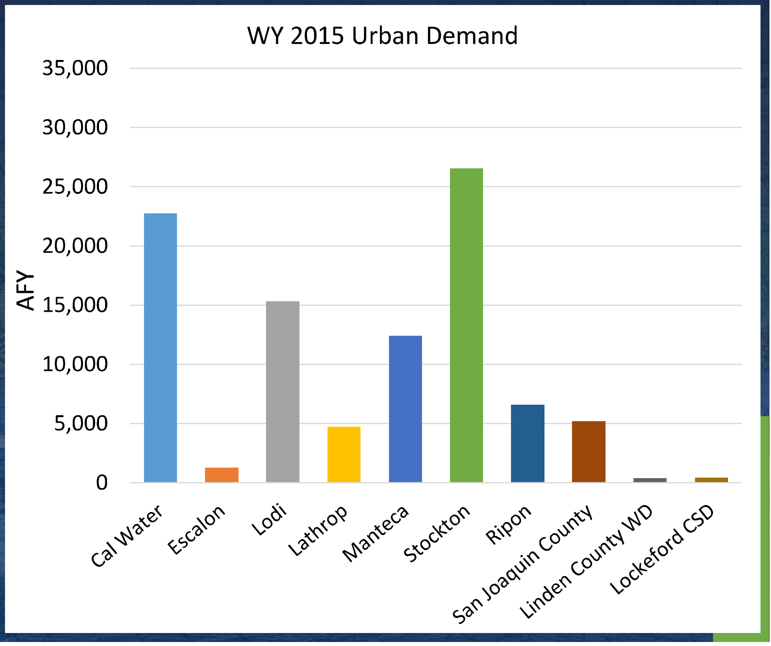
Root Zone Parameters



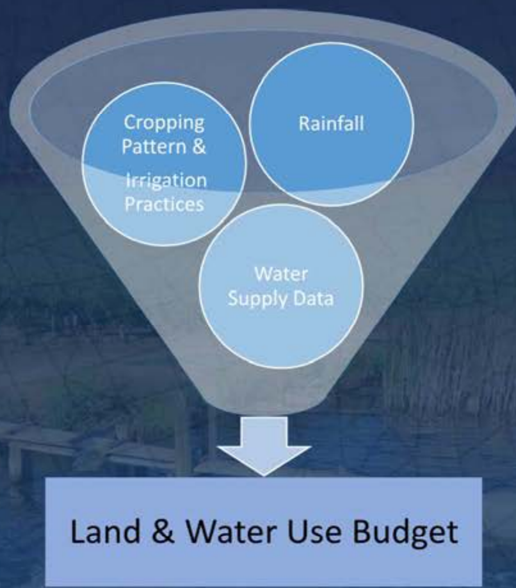
Urban Water Demand

- Based on GPCD and population if water demand information unavailable



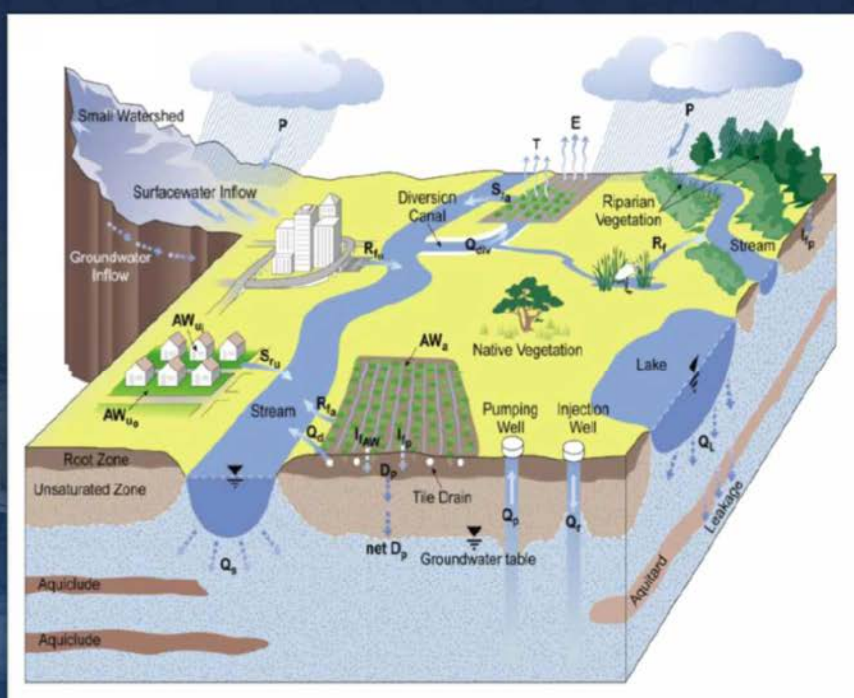


Land & Water Use Budget Components



Integrated Hydrologic Processes

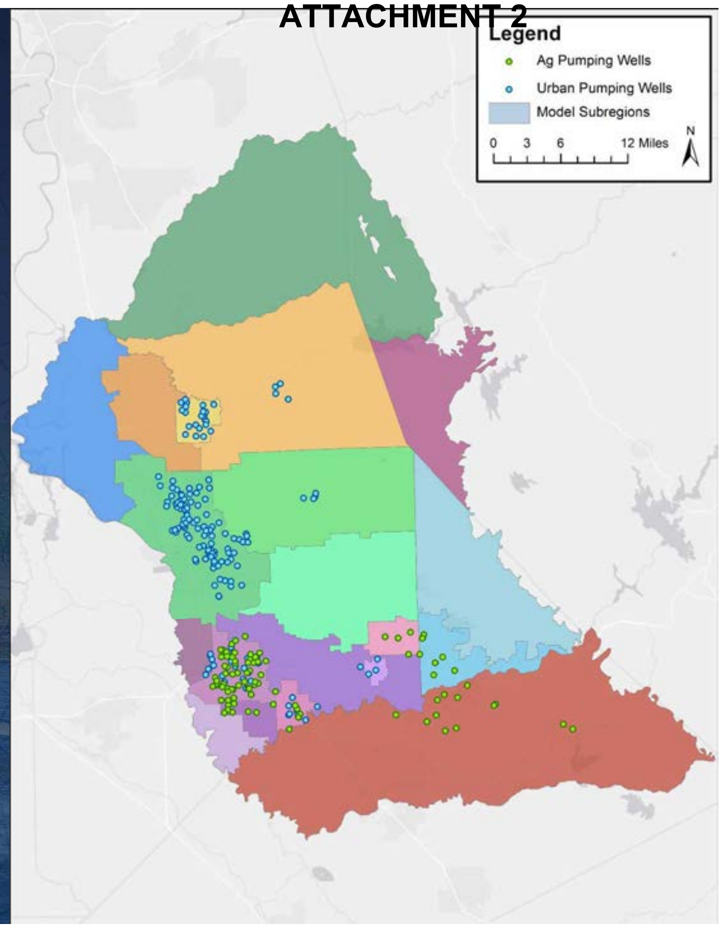
- Land Surface Processes
- Groundwater Flow
- Streamflow
- Physical Systems Integration
- Water Budgets



ATTACHMENT 2

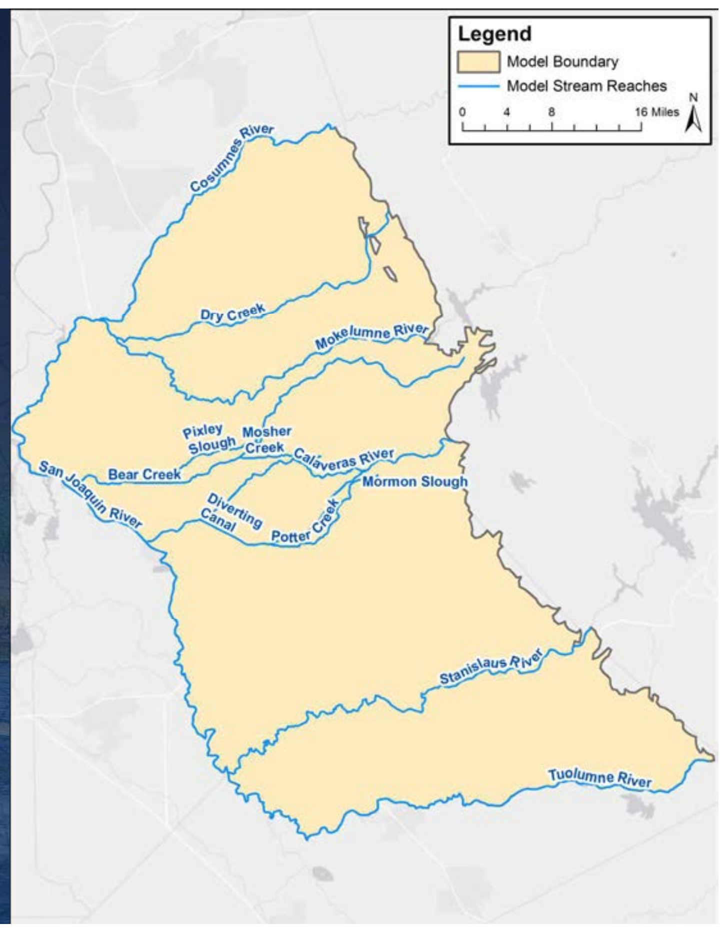
Water Supply Data Sources

- Groundwater pumping for ag or urban purposes:
  - Cal Water
  - Escalon
  - Lathrop
  - Linden County
  - Lockeford CSD
  - Lodi
  - Manteca
  - Oakdale ID
  - Ripon
  - Stockton East WD
  - South San Joaquin ID
  - Stockton



Water Supply Data Sources

- Surface water deliveries for ag or urban purposes:
  - North Delta
  - Woodbridge ID
  - Lodi
  - North San Joaquin WCD
  - Calaveras County WD
  - Stockton/Cal Water
  - Stockton East WD
  - Central San Joaquin WCD
  - Lathrop
  - Manteca
  - Escalon
  - South San Joaquin ID
  - Oakdale ID
  - Modesto ID/Modesto
  - Riparian

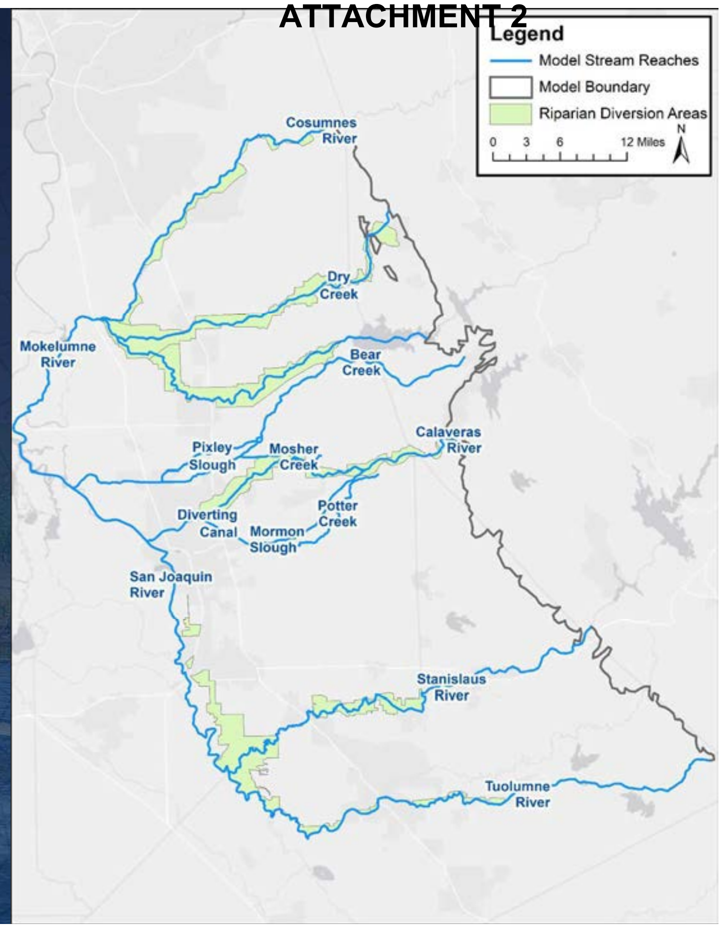


ATTACHMENT 2

Riparian Diversions

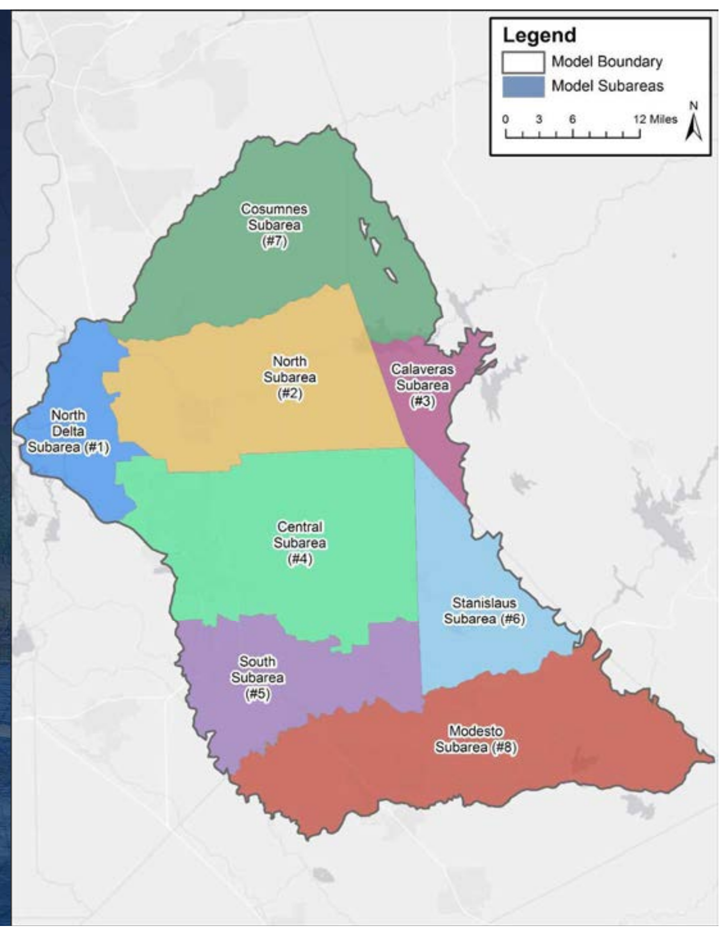
- Accounts for non-district SW users with access to streams
- From C2VSim-2015
  - Recoverable Loss: 10-15%
  - Non-recoverable Loss: 2-3%
- Delivery areas pers. comm. Charlie Brush (DWR)

Stream	Annual Average (AFY)
Cosumnes River	4,283
Dry Creek	6,026
Mokelumne River	9,724
Calaveras River	20,356
Stanislaus River	20,705
Tuolumne River	2,547
San Joaquin River	6,210



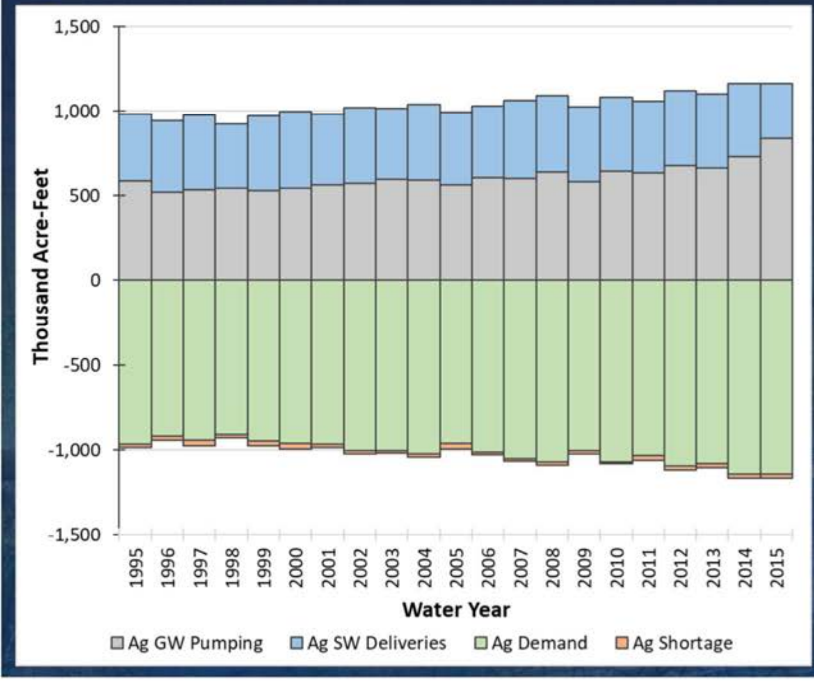
Model Subareas

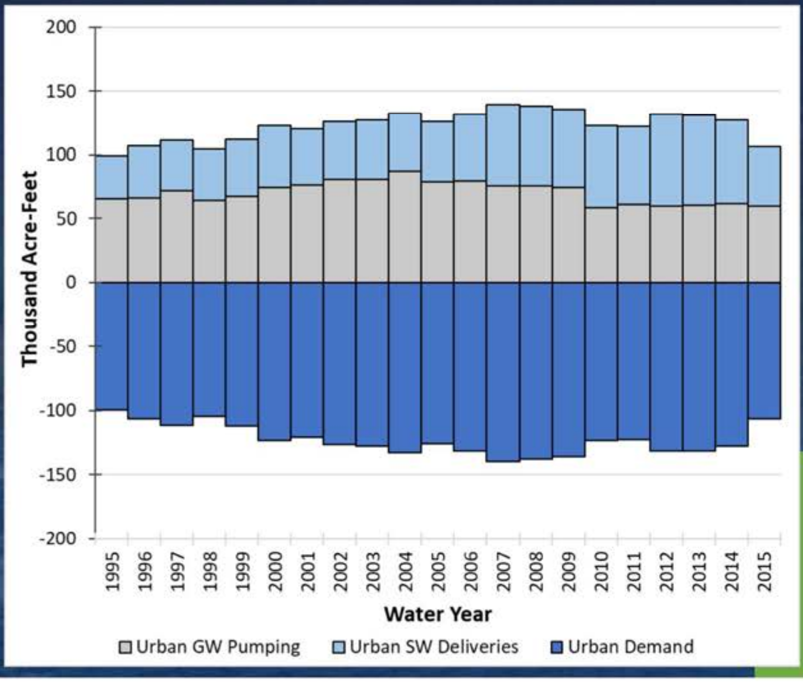
- 8 subareas
- For model output and reporting of results



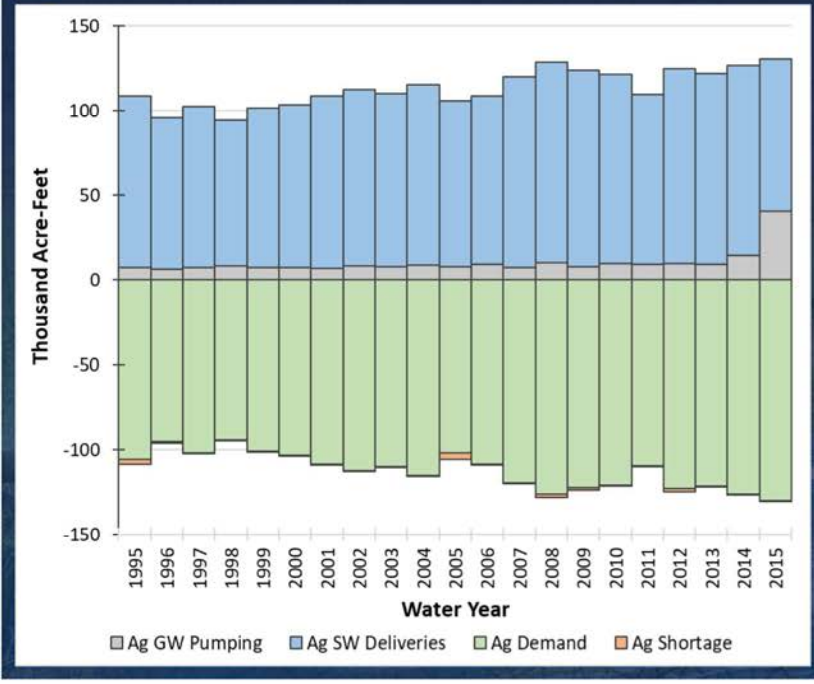
ATTACHMENT 2

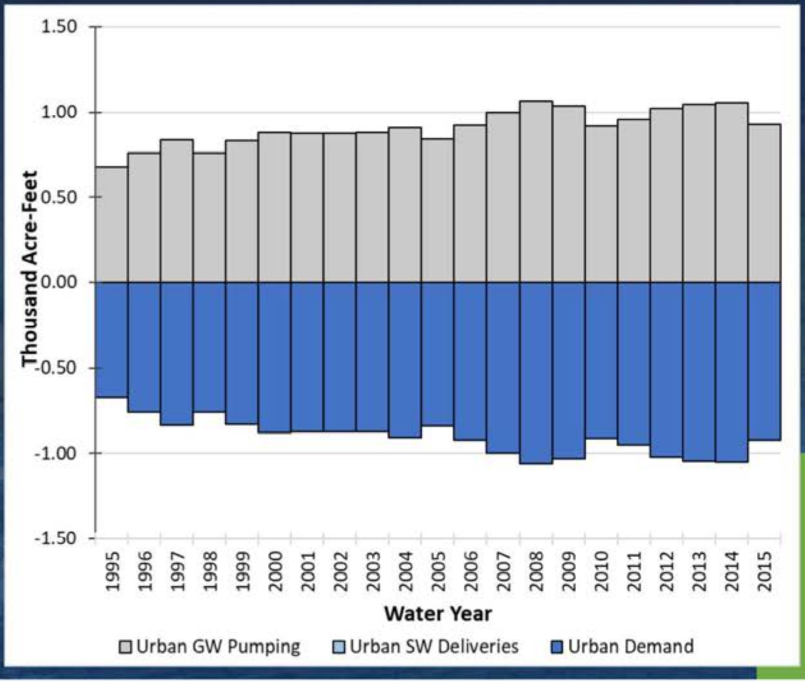
L&WU Budget- ESJ Subbasin





North Delta Subarea





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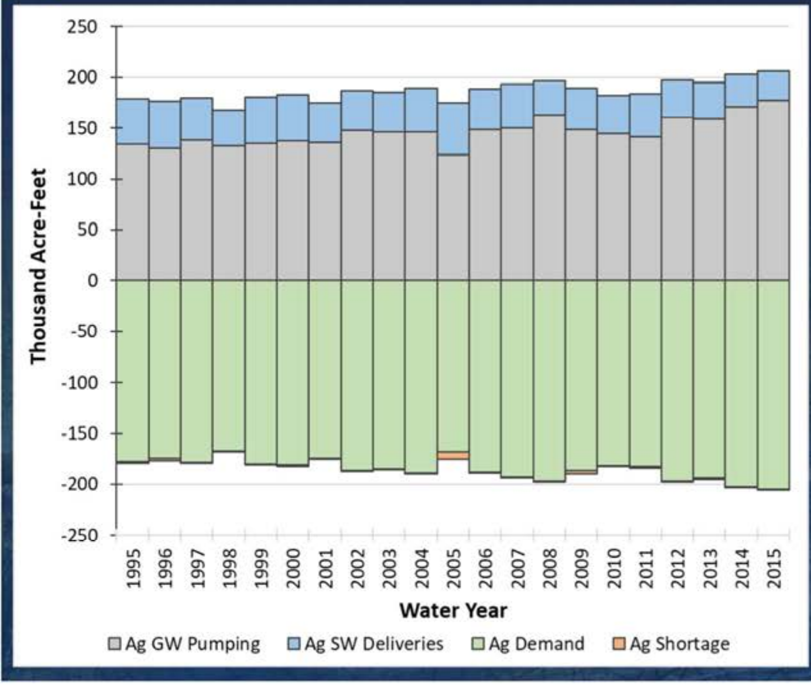
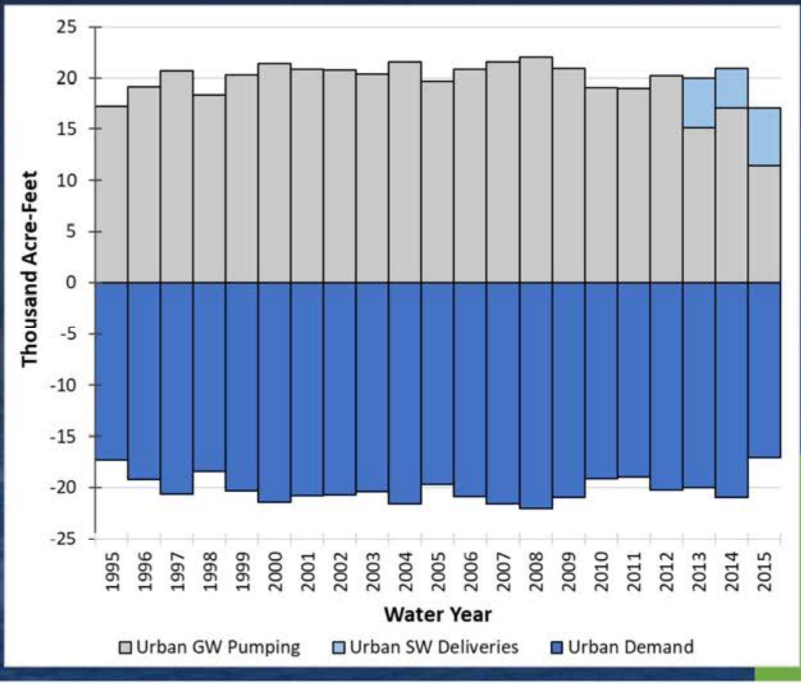
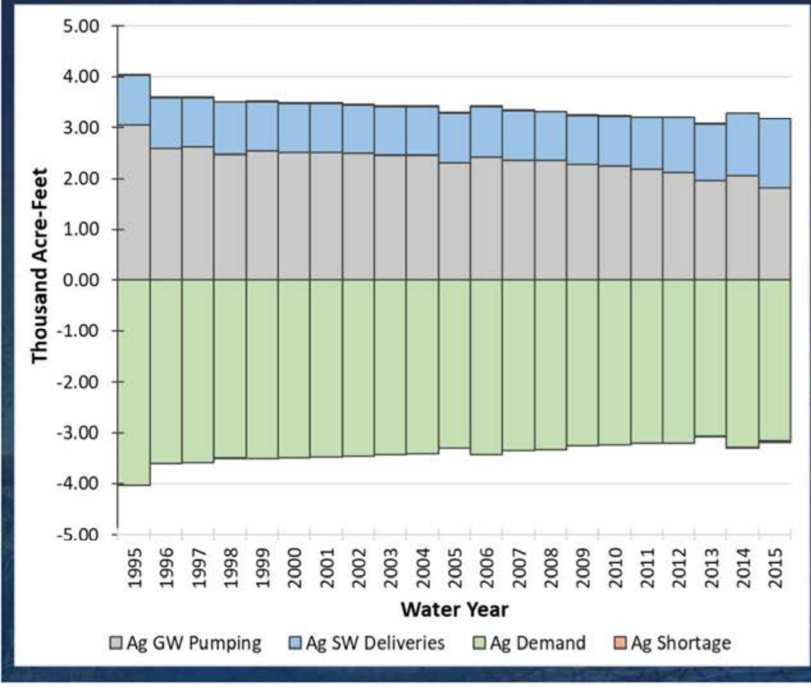
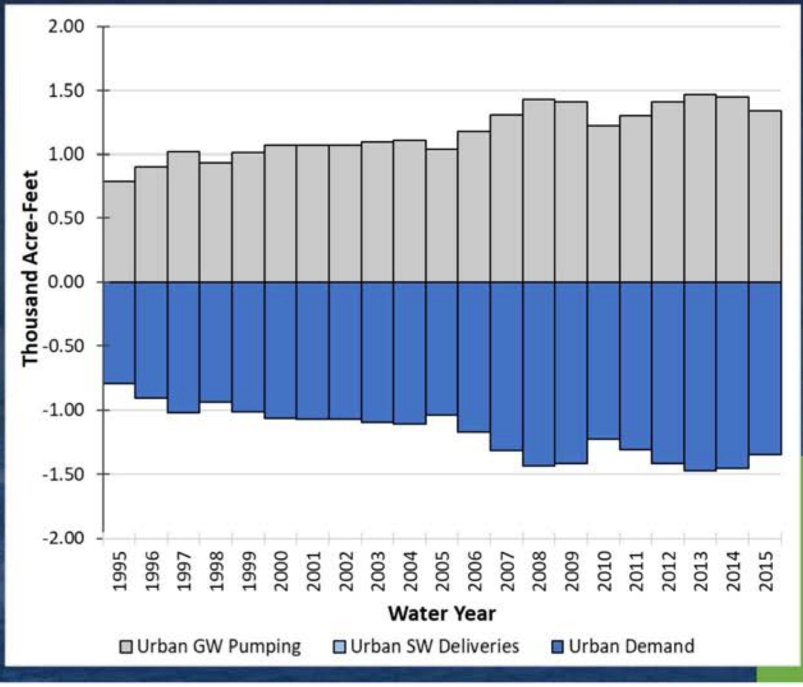
North Subarea





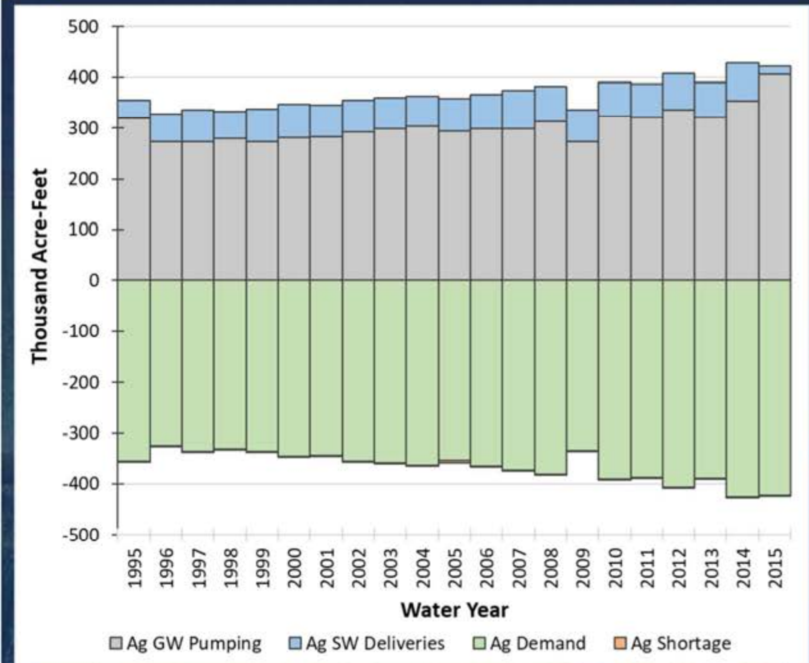
Calaveras Subarea

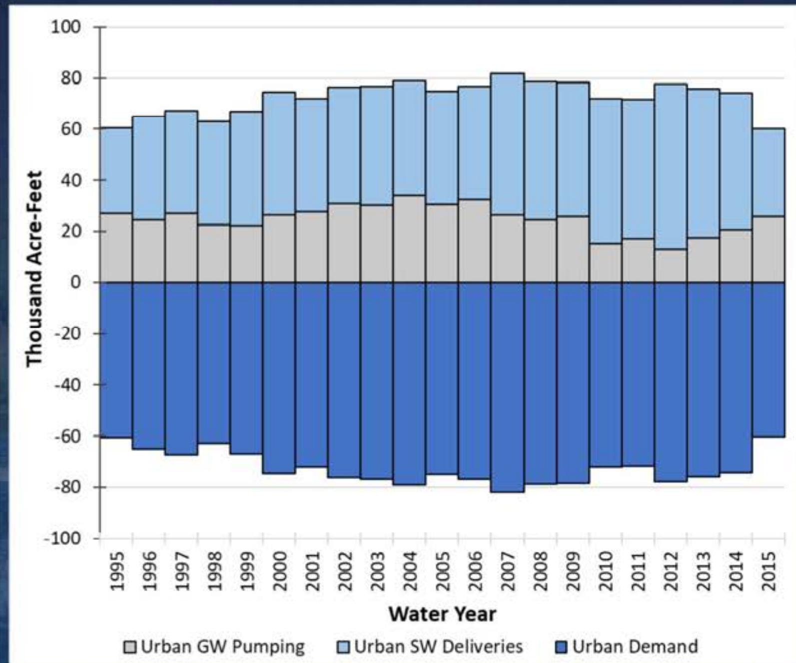




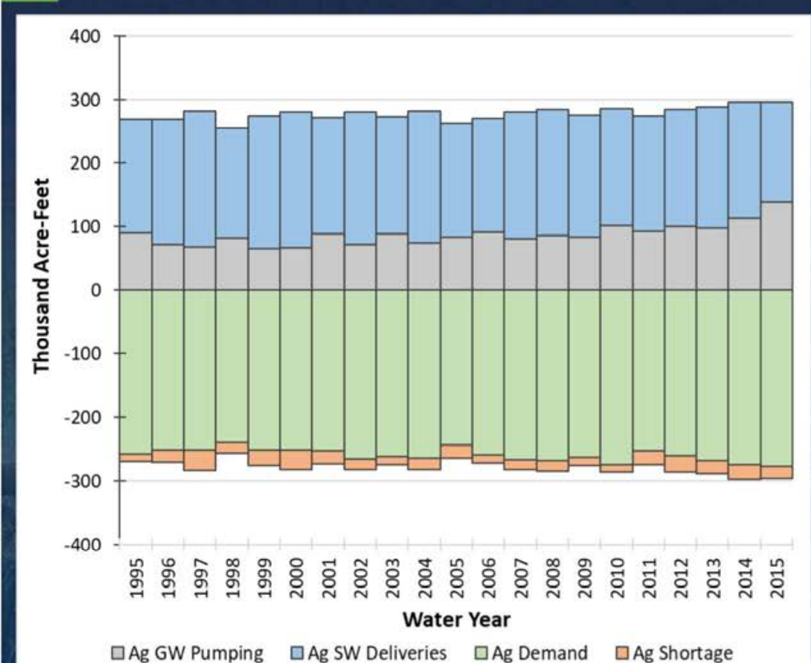
ATTACHMENT 2

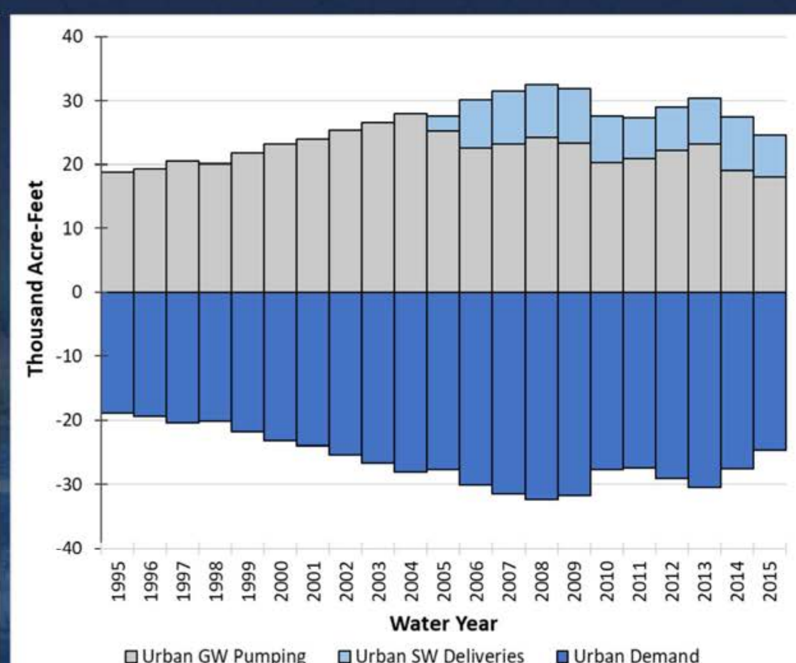
Central Subarea



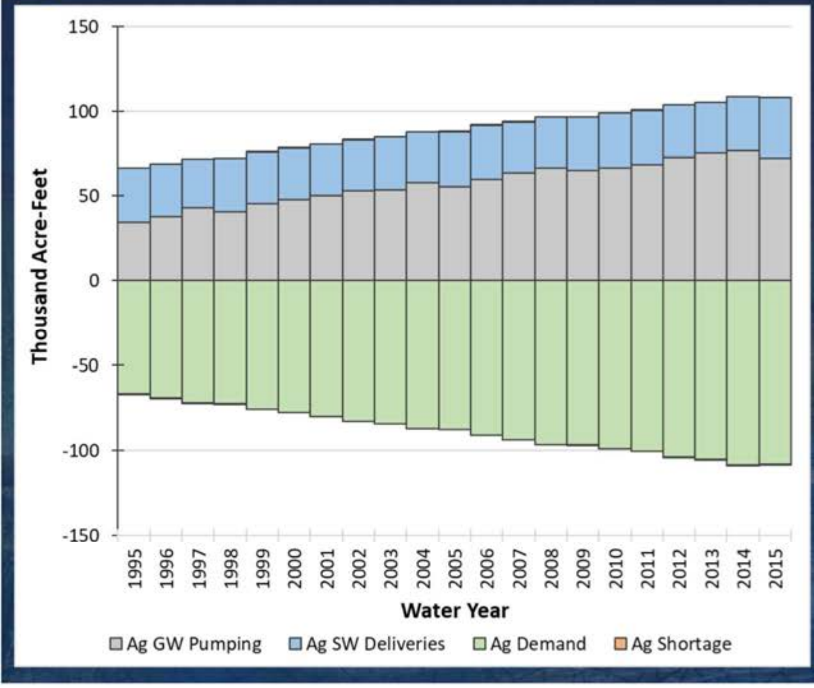


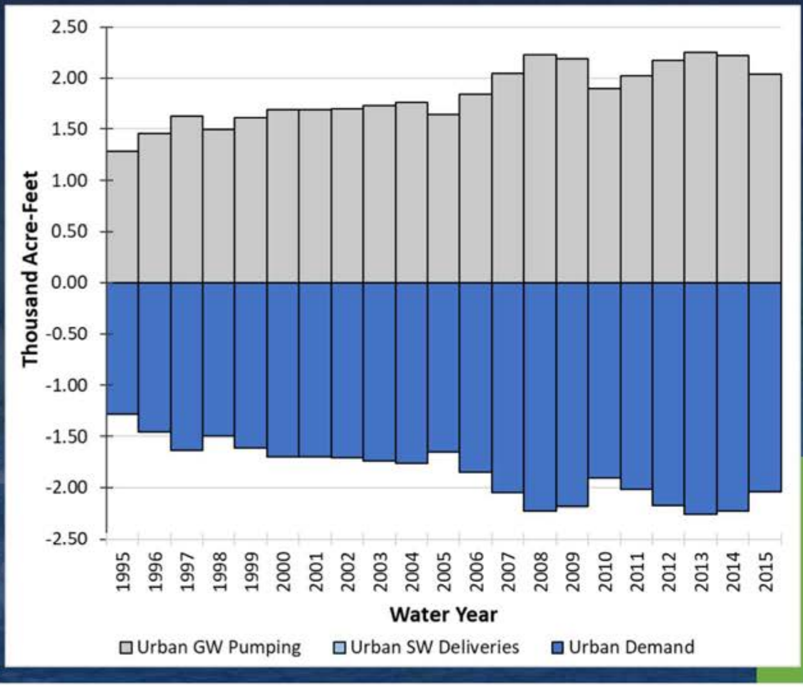
South Subarea





Stanislaus Subarea





Summary

- The **I**WFM **D**emand **C**alculator (IDC) simulates the agricultural and urban water demands in the ESJ model area
- The IDC input data and parameters, assumptions and results have been reviewed by the irrigation districts and agricultural community in the ESJ Subbasin
- The IDC data, assumptions and results have also been presented in a number of stakeholder workshops at the SJ County
- There is general consensus that the IDC reasonably simulates the agricultural and urban water use in the ESJ Subbasin
- The IDC will be incorporated in the ESJWRM to simulate the integrated SW/GW conditions in the ESJ Subbasin

ATTACHMENT 2

Sustainable Groundwater Management Act Readiness Project

ESJ Water Resources Model (ESJWRM) Development Update- Calibration Workshop

RMC water and environment

WOODARD & CURRAN

National Experience. Local Focus.

SAN JOAQUIN COUNTY CALIFORNIA

April 25, 2018

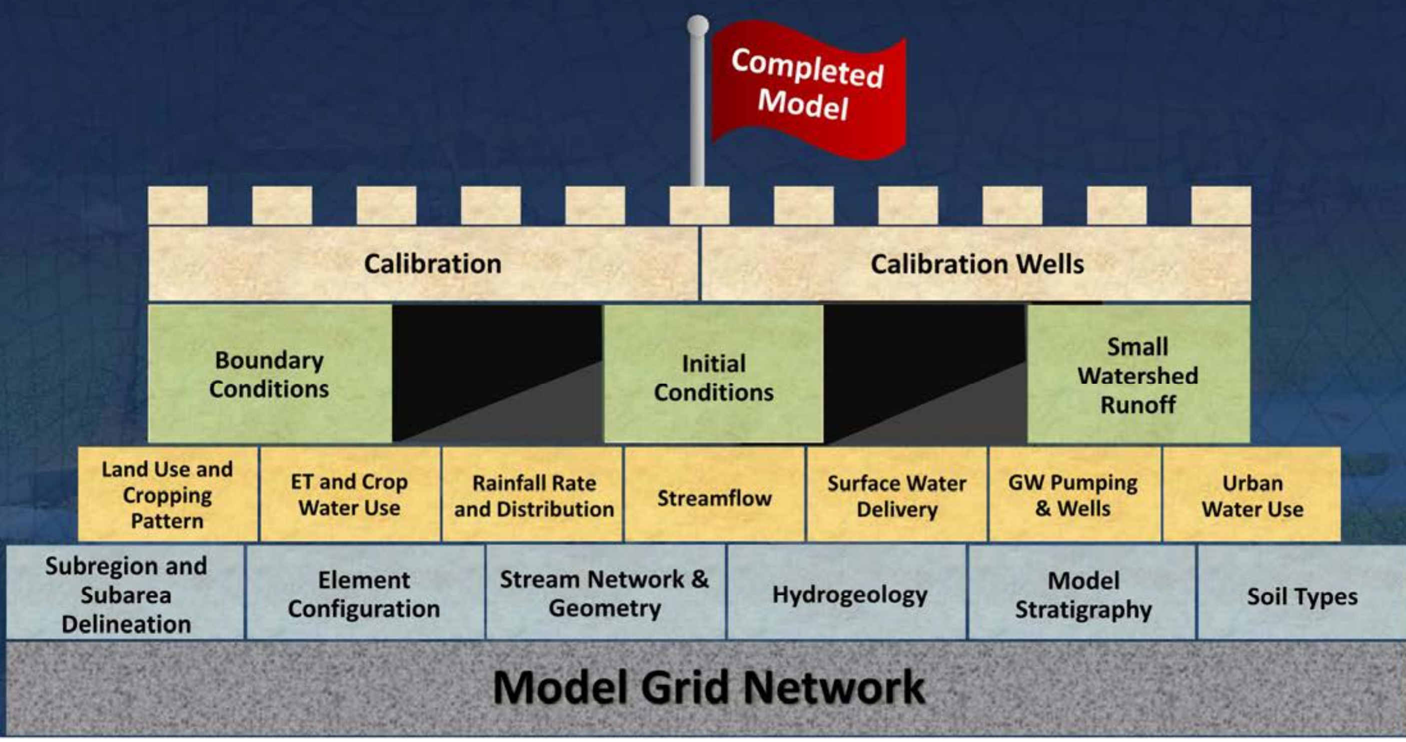
Agenda

1. Stakeholder Workshop for IDC
2. Model Calibration Workshop
3. Sustainability Indicator Questionnaire

Calibration Workshop Agenda

- Calibration Process
- GWL Calibration
  - Wells
  - Statistics
  - Hydrographs
  - Contours
- GW Budgets
- Streamflow Calibration
  - Stations
  - Hydrographs
- Next Steps

ESJWRM Construction

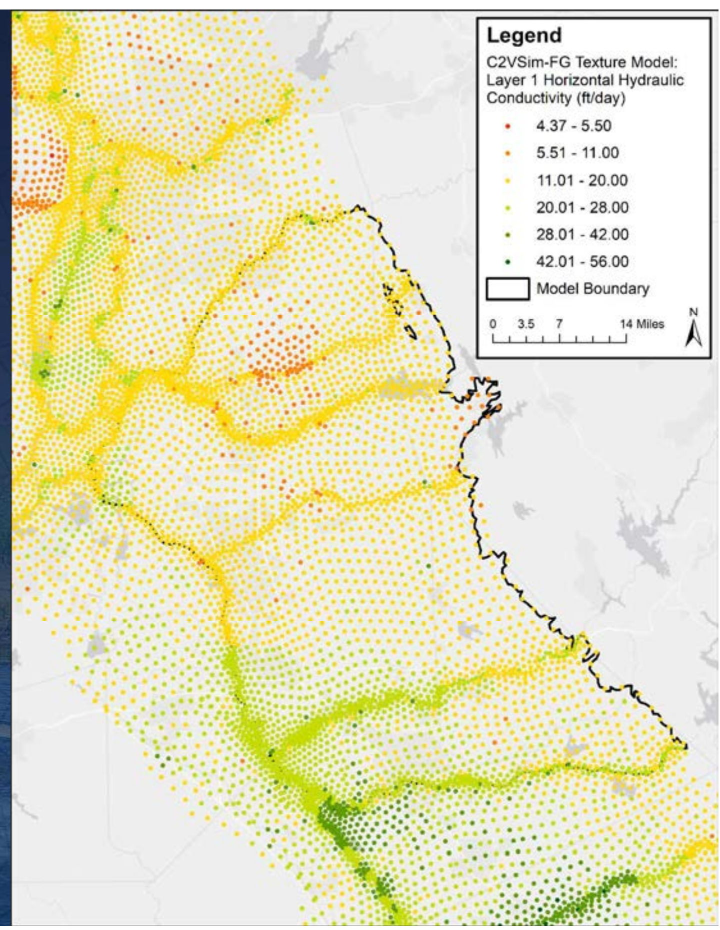


Calibration Process

- Identify:
  - Target calibration wells
  - Target streamflow gaging stations
- Review observed data and set calibration targets
- Calibrate model by adjusting model parameters to attain reasonable match between modeled and observed data for:
  - Water budgets for each component of the hydrologic cycle modeled
  - GW levels at select wells
  - Streamflows at select gaging stations
- Compare calibration performance with calibration targets
- Conduct additional refinements as necessary

Calibration Process

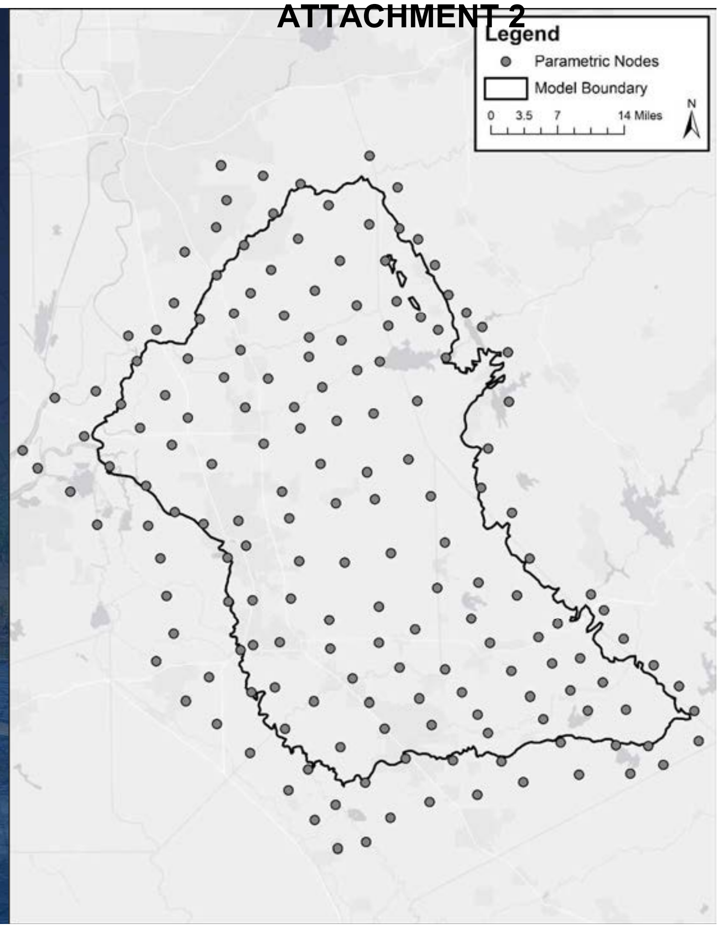
- Assign initial aquifer parameters using texture model
- Aquifer parameters include:
  - Horizontal hydraulic conductivity
  - Vertical hydraulic conductivity (both aquifer and aquitard)
  - Specific storage
  - Specific yield



ATTACHMENT 2

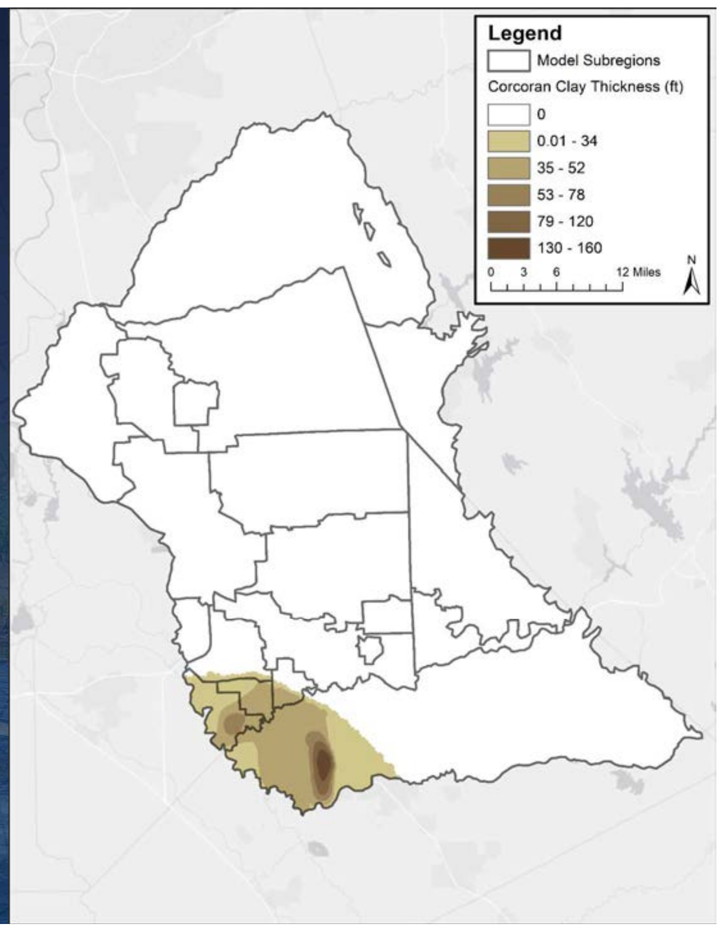
Calibration Process

- Aquifer parameters assigned for each of the four model stratigraphic layers by parametric node
- Texture-based parameters are mapped to the ESJWRM Parametric nodes, which are the C2VSim-CG groundwater nodes in the ESJWRM area (171 C2VSim-CG nodes)



Calibration Process

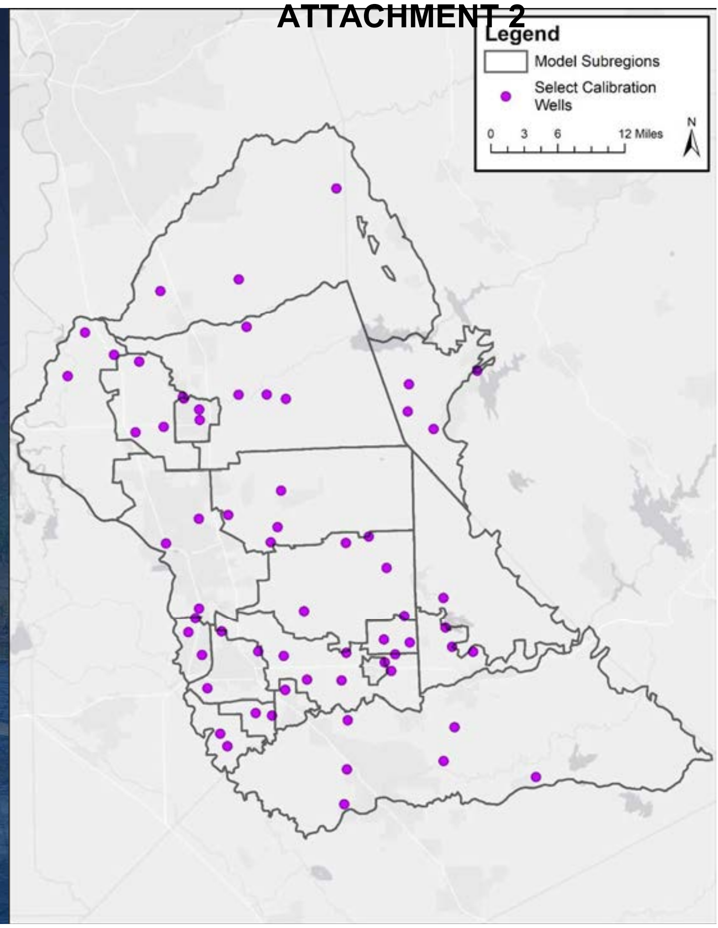
- Determined model sensitivity to editing parameters:
  - Horizontal hydraulic conductivity
    - Affects spatial movement of groundwater within model area
  - Vertical hydraulic conductivity (both aquifer and aquitard)
    - Aquitard only for area with Corcoran Clay
    - Aquifer affects interaction between layers
  - Specific storage
    - Affects confined aquifer (Layers 2, 3, and 4)
  - Specific yield
    - Affects unconfined aquifer (Layer 1)



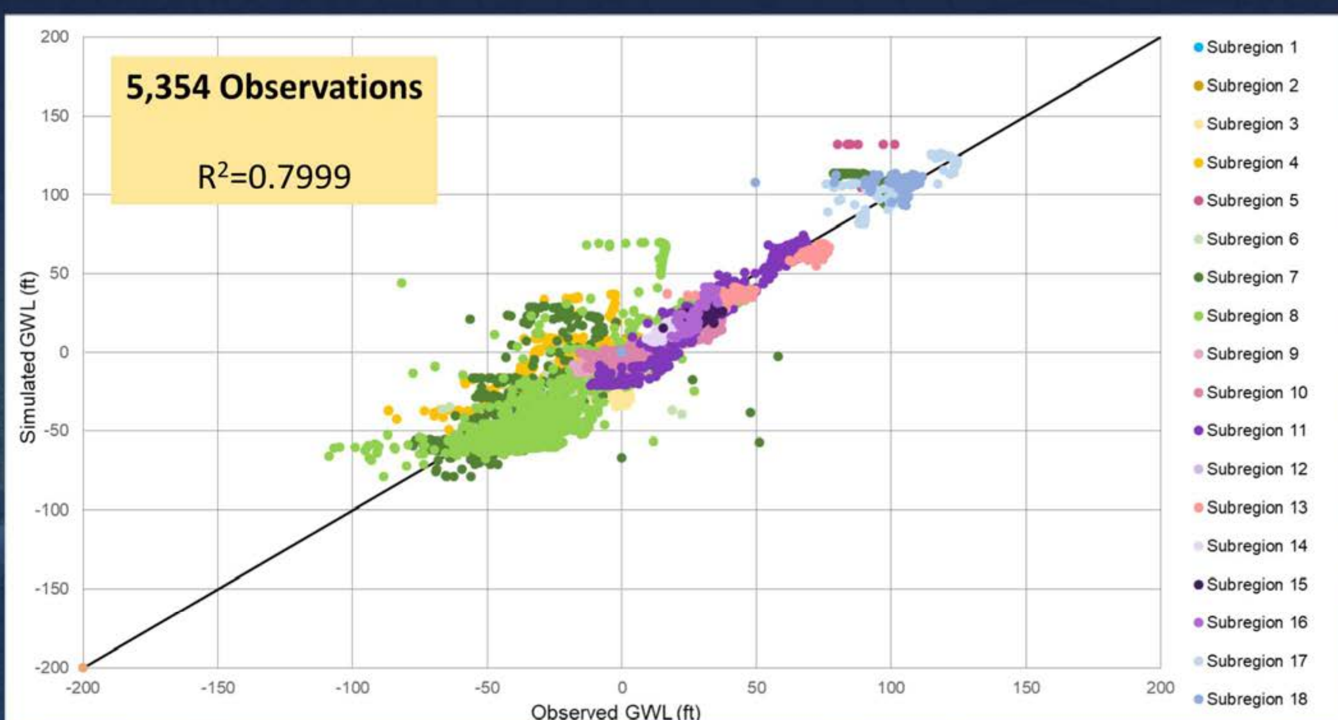
ATTACHMENT 2

GWL Calibration Wells

- 160 model calibration wells selected to represent spatial and temporal variability across model time period
- As many as 63 model calibration wells selected to represent calibration and GWL trends across the model area

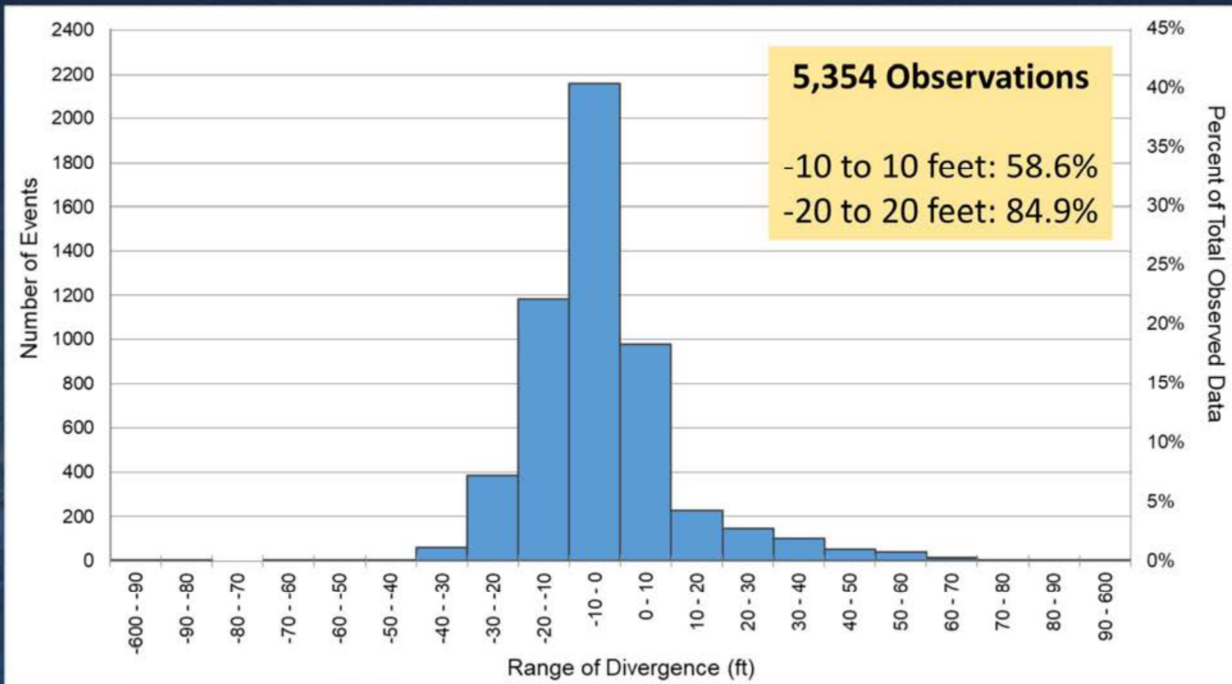


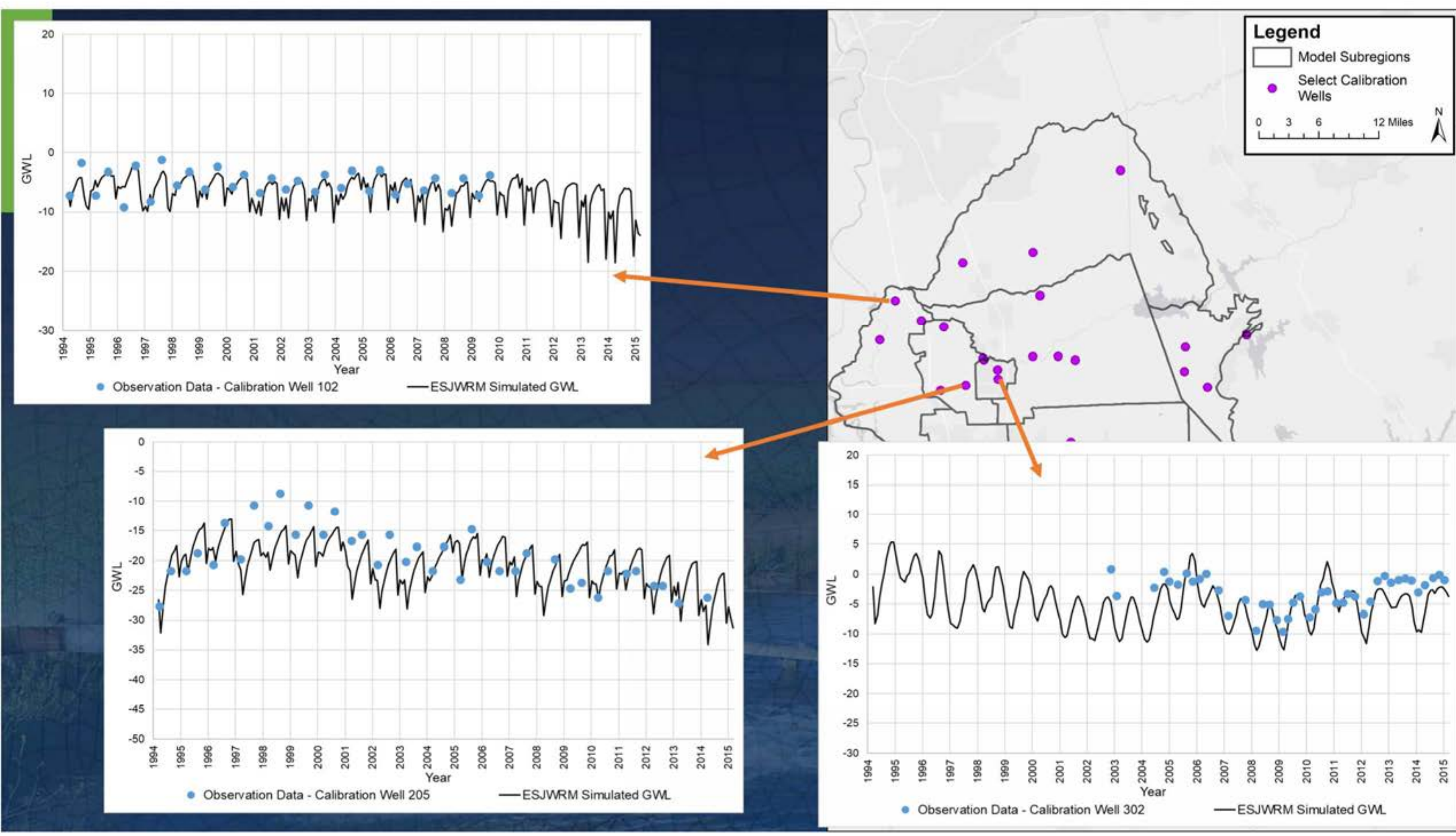
GWL Calibration Statistics



ATTACHMENT 2

GWL Calibration Statistics





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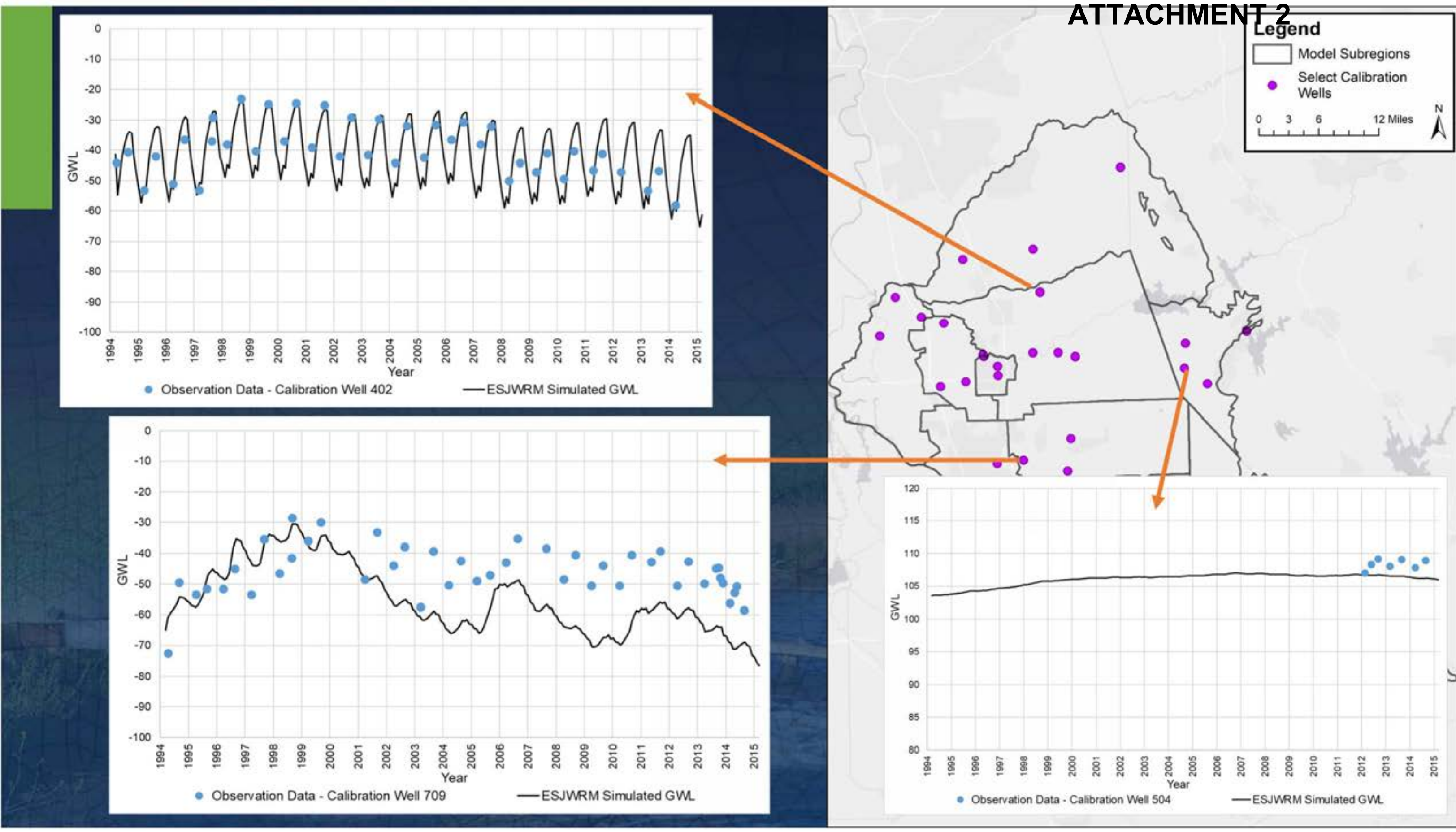

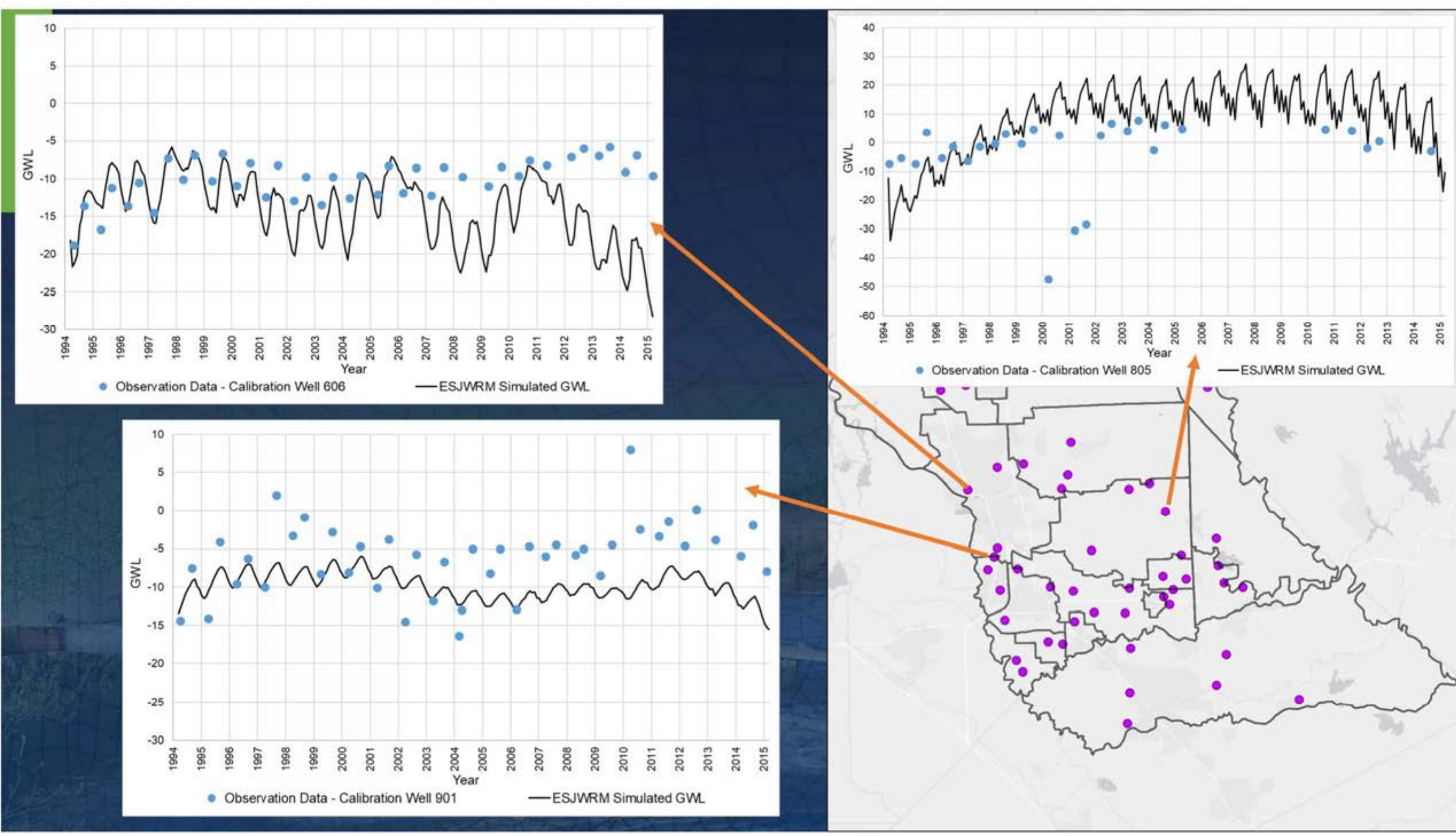

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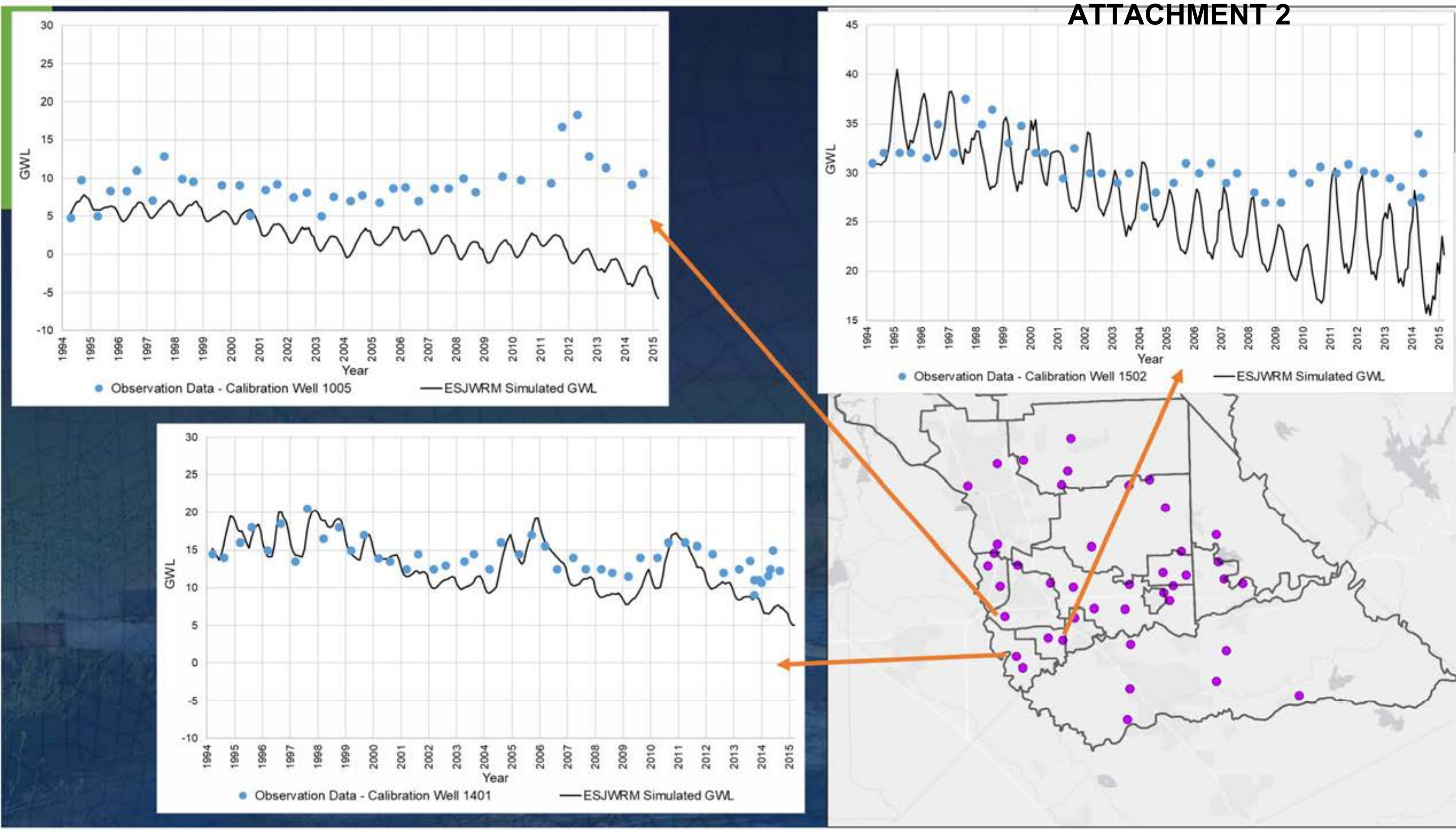
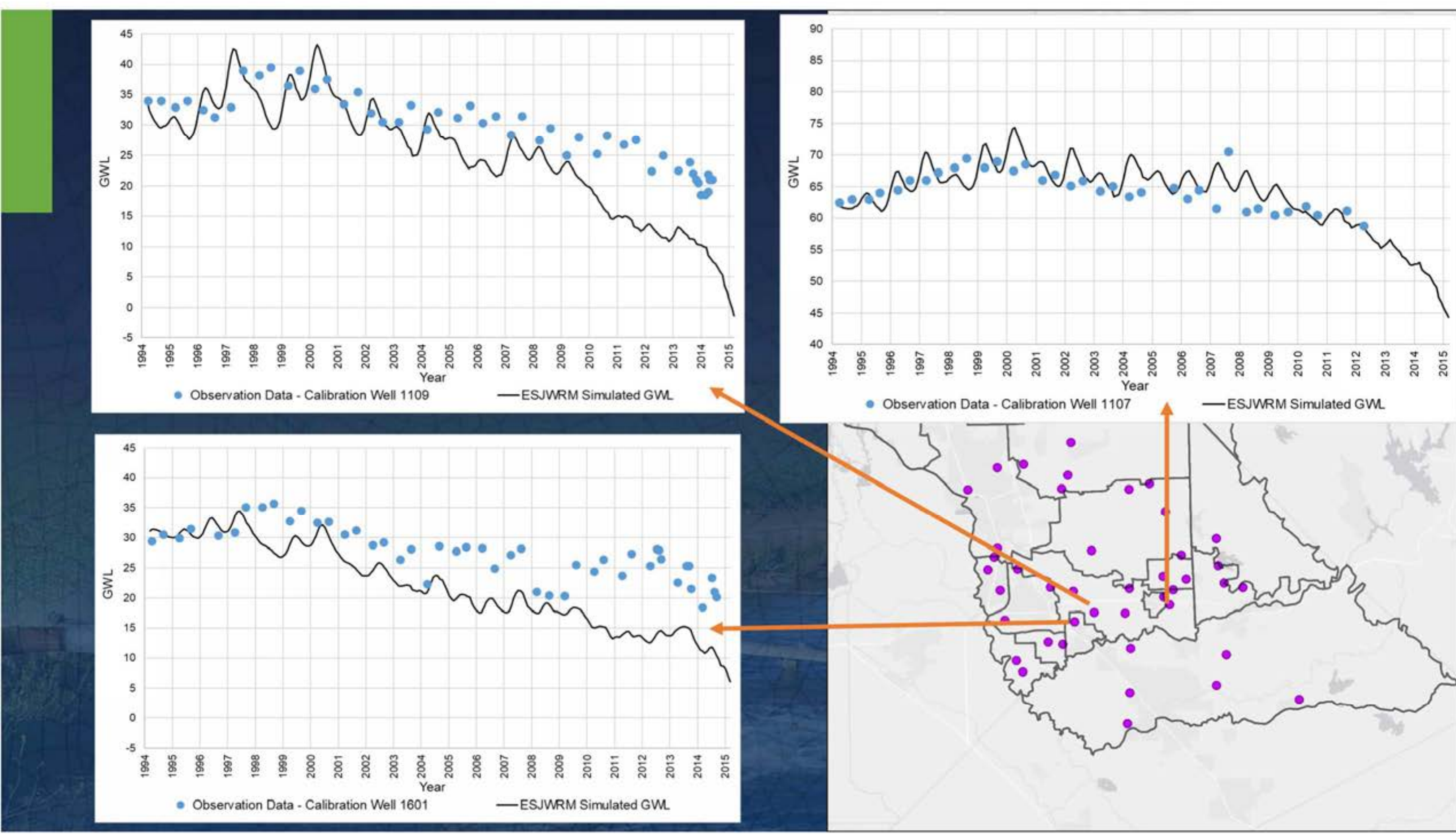
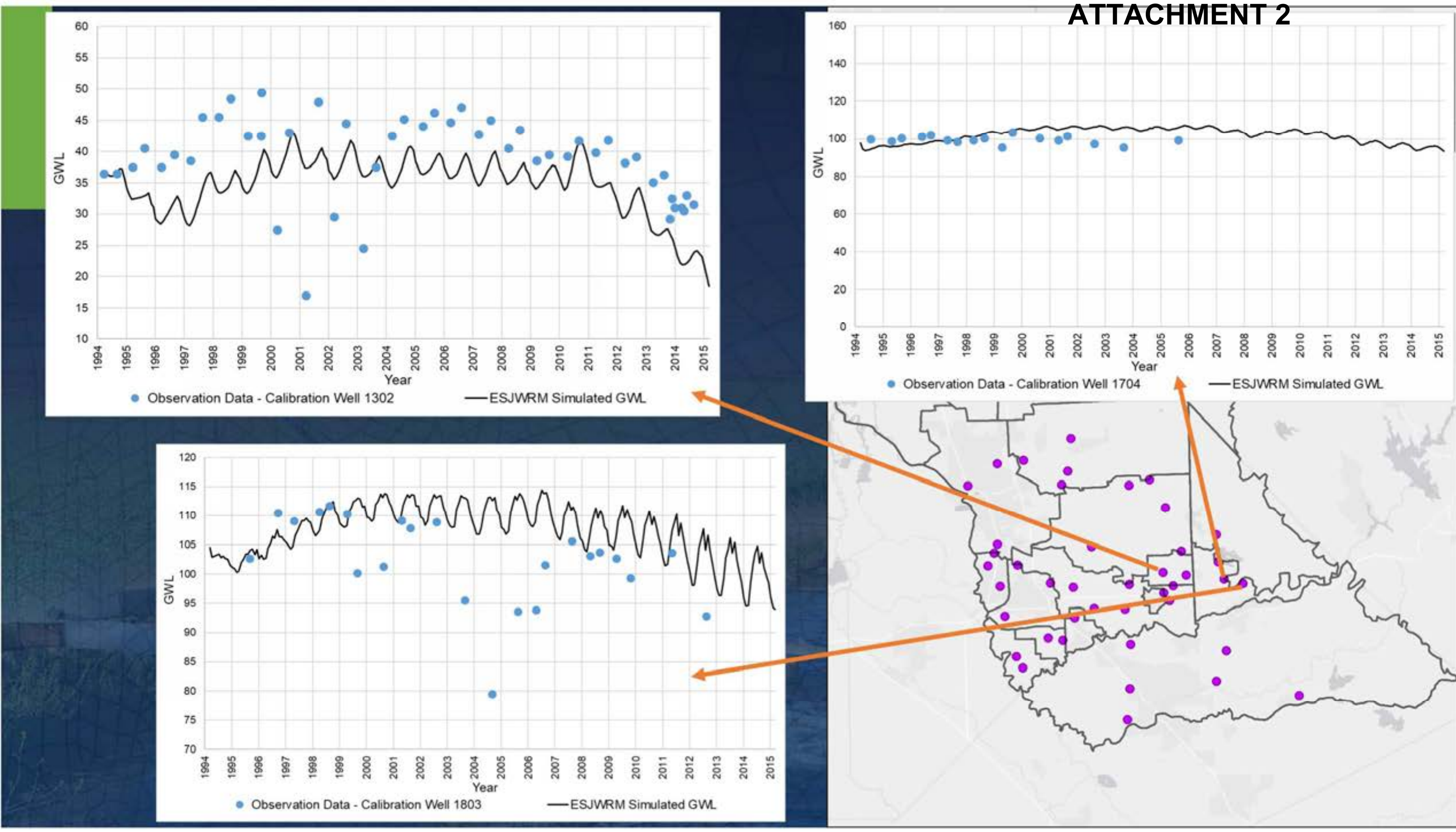
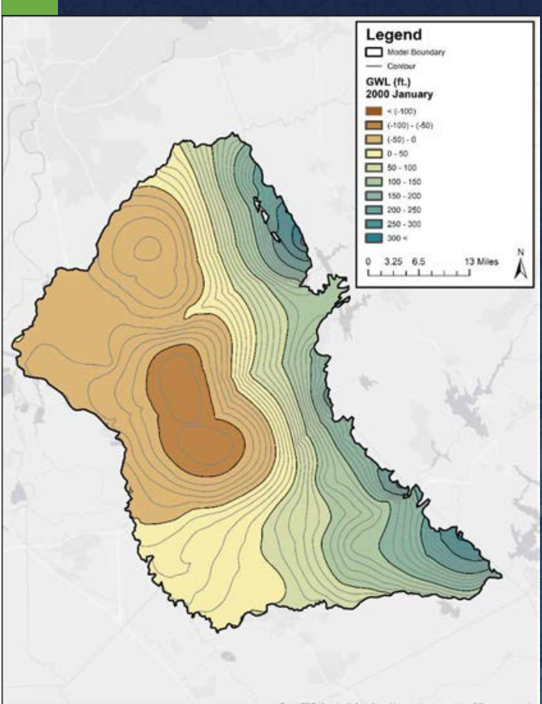




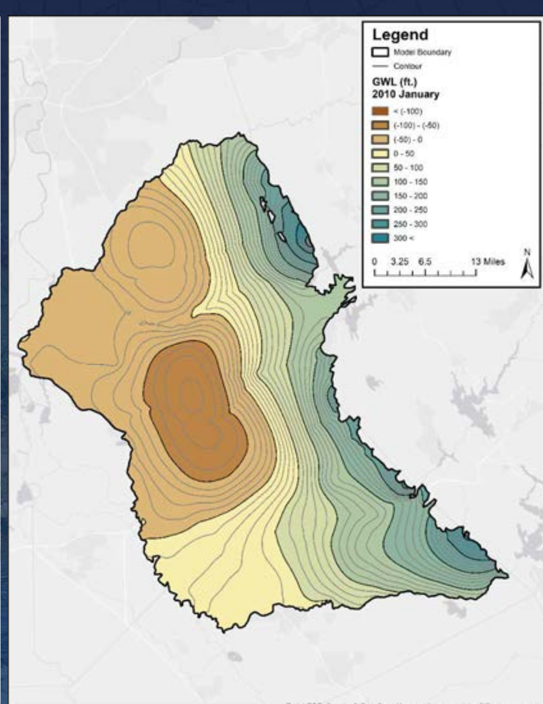
ATTACHMENT 2



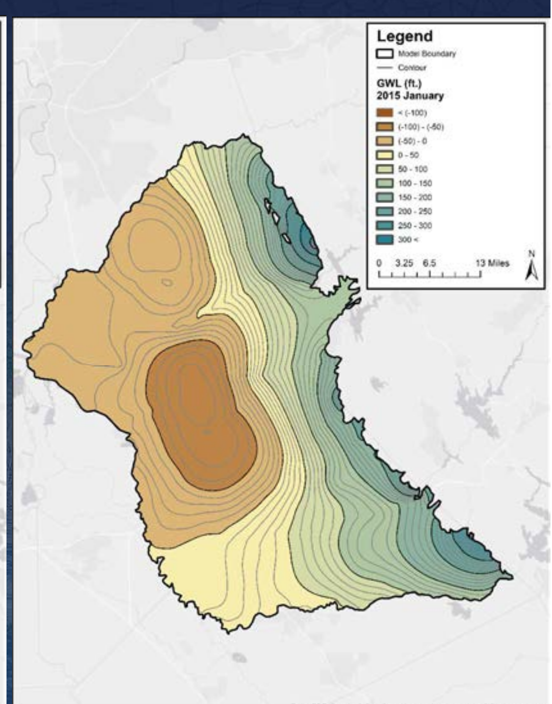
GWL Contours



January 2000



January 2010

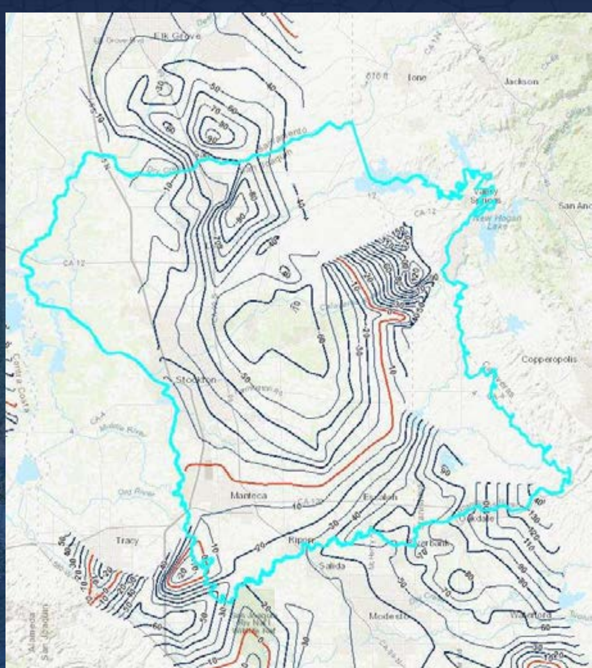


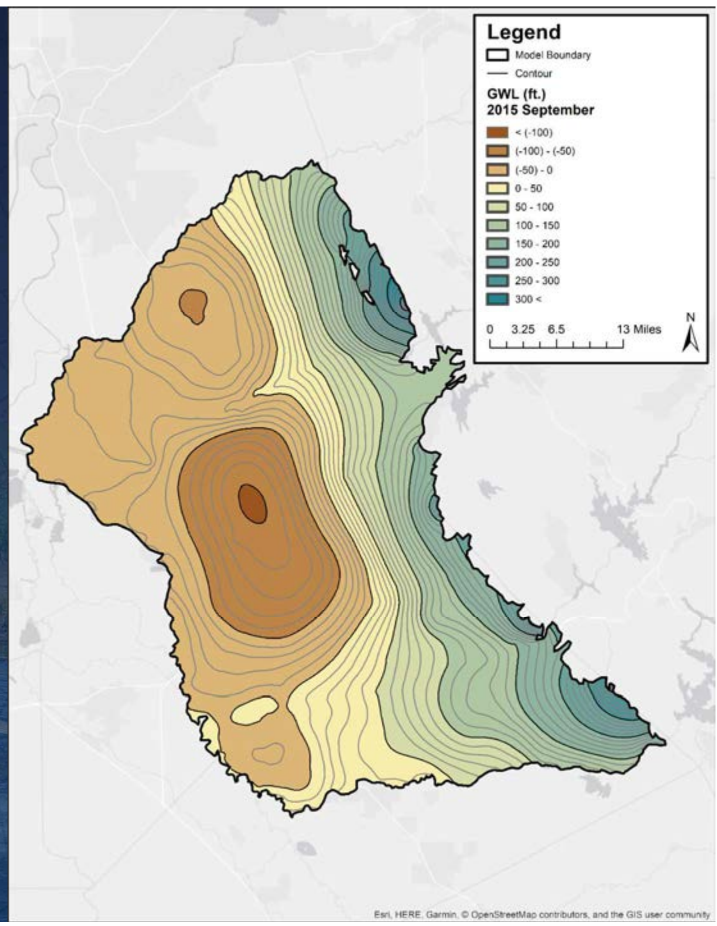
January 2015

ATTACHMENT 2

GW Level Animation

Fall 2015

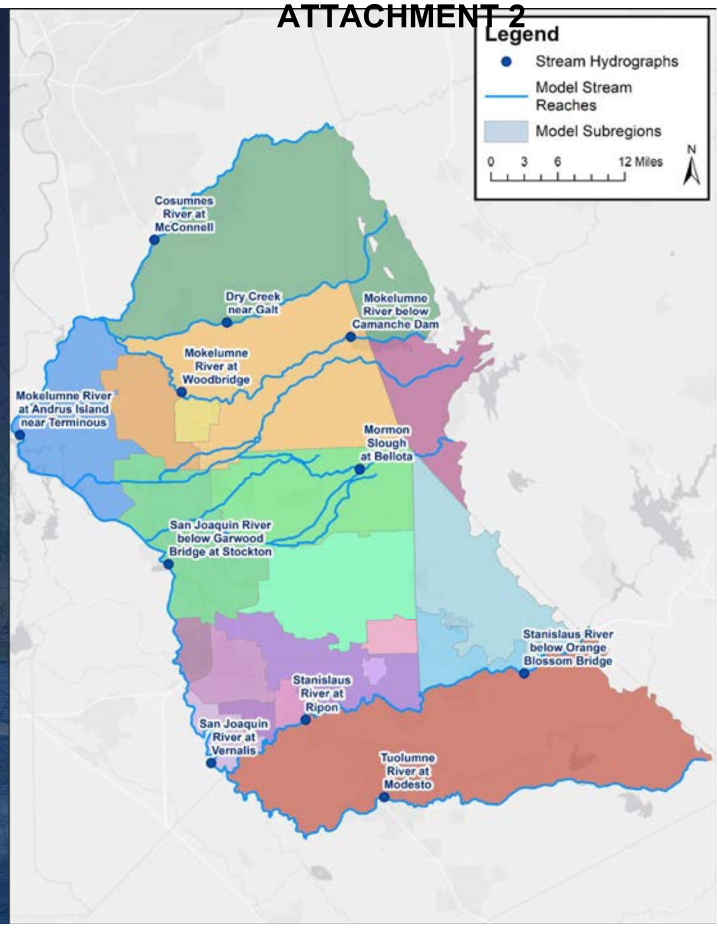


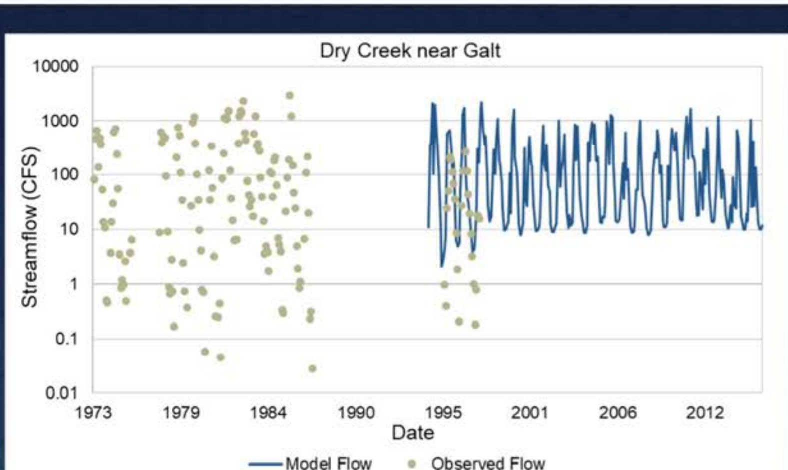


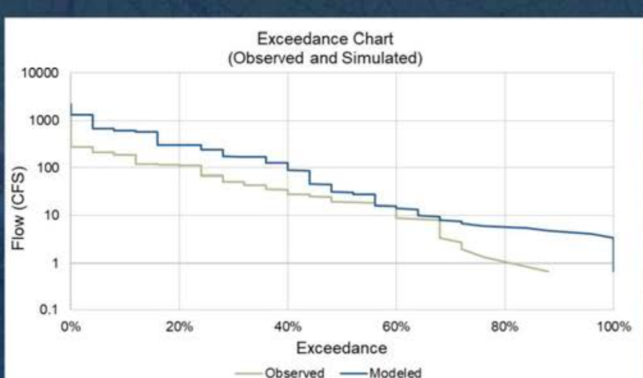
ATTACHMENT 2

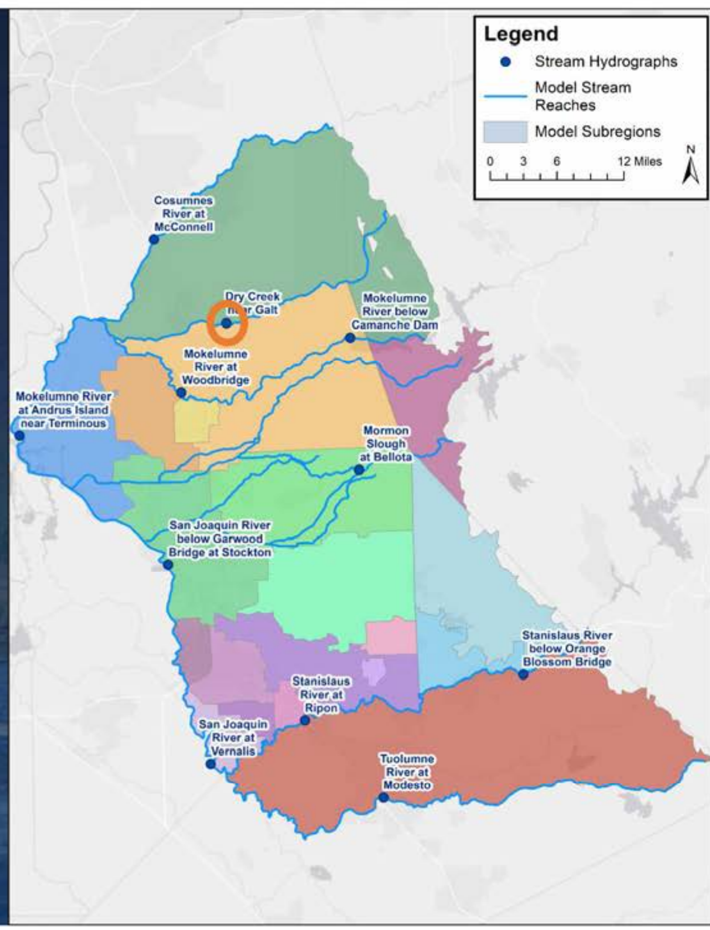
Streamflow Calibration Stations

- 11 streamflow calibration stations
  - USGS, USACE, or DWR CDEC
- Since boundary of model is largely controlled by boundary conditions, important stations are those interior in the model









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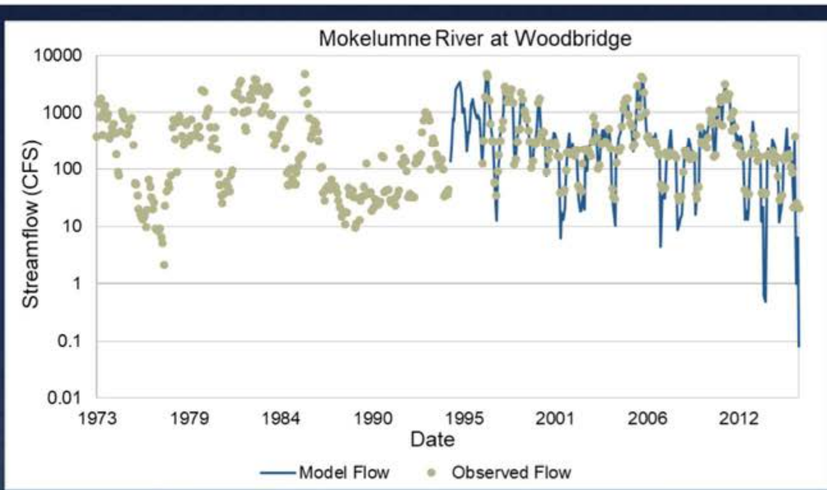

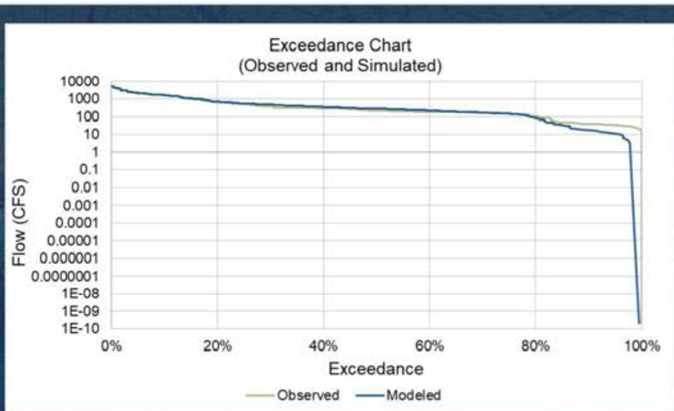

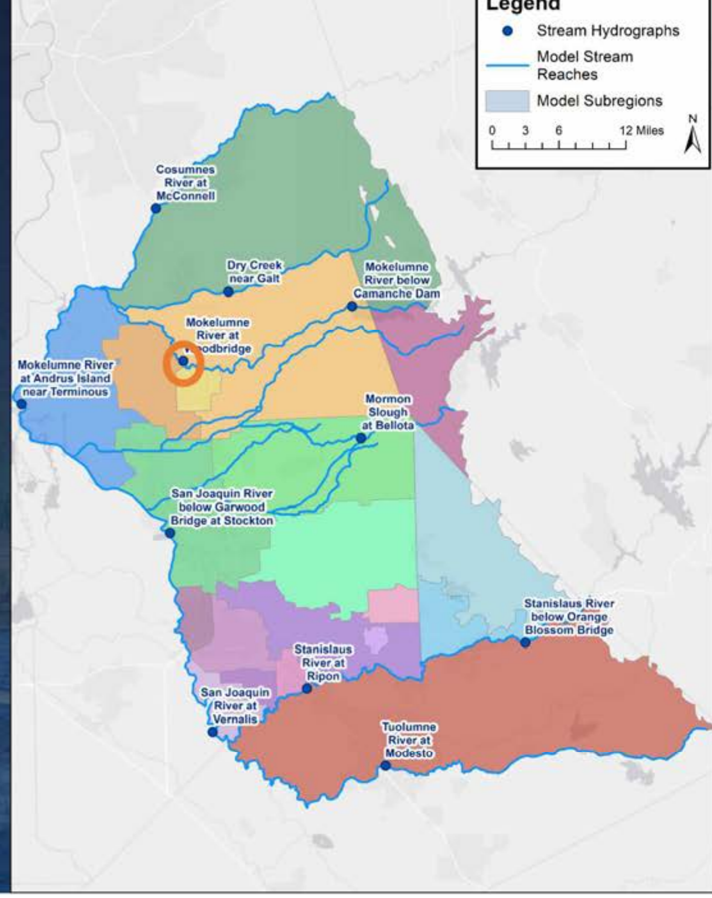

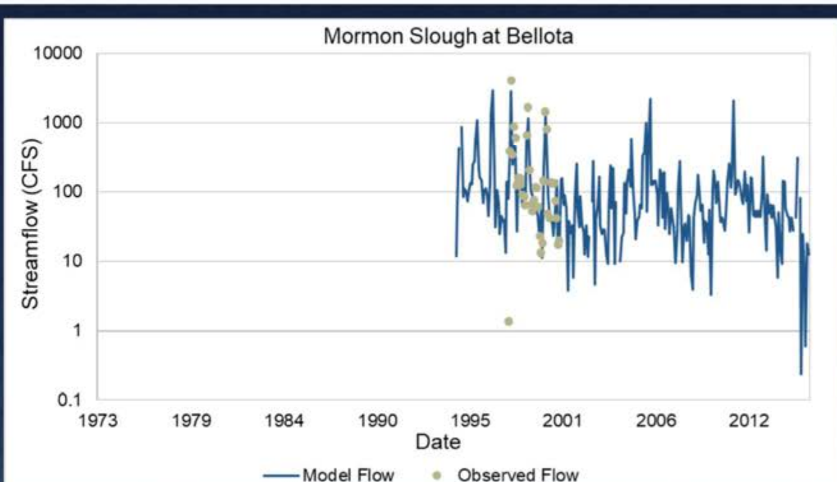

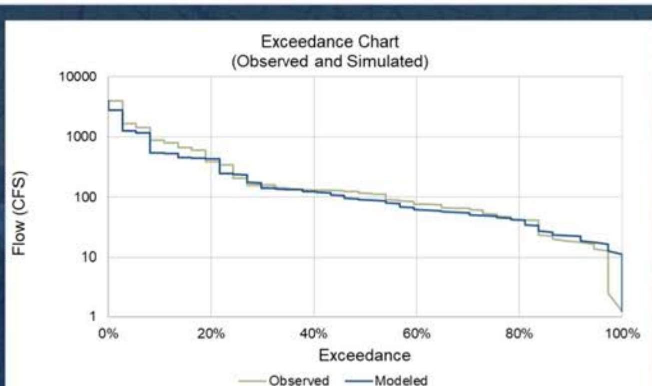

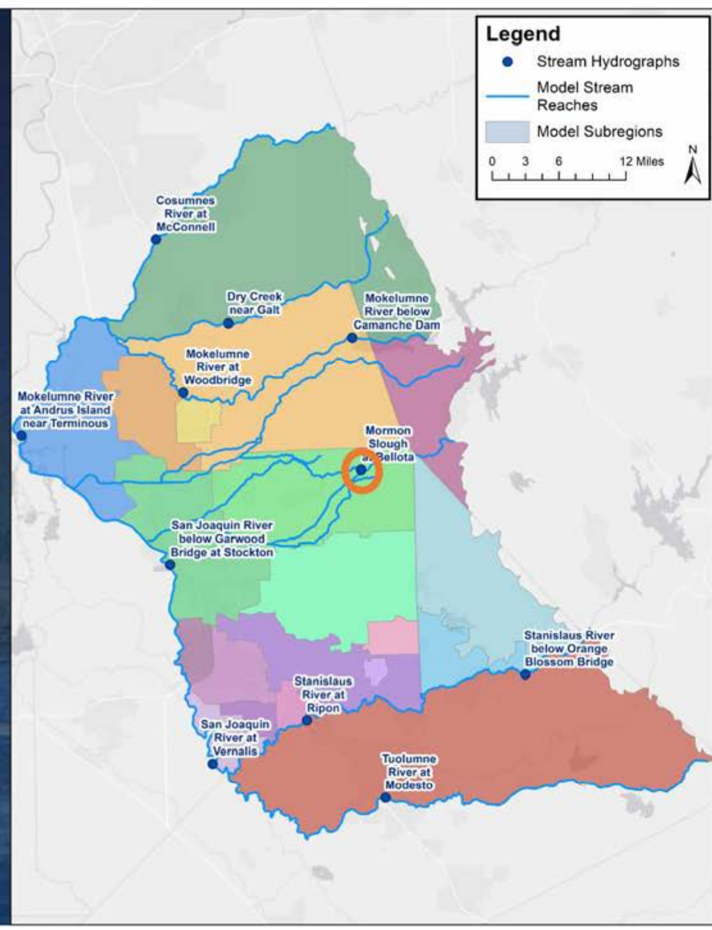

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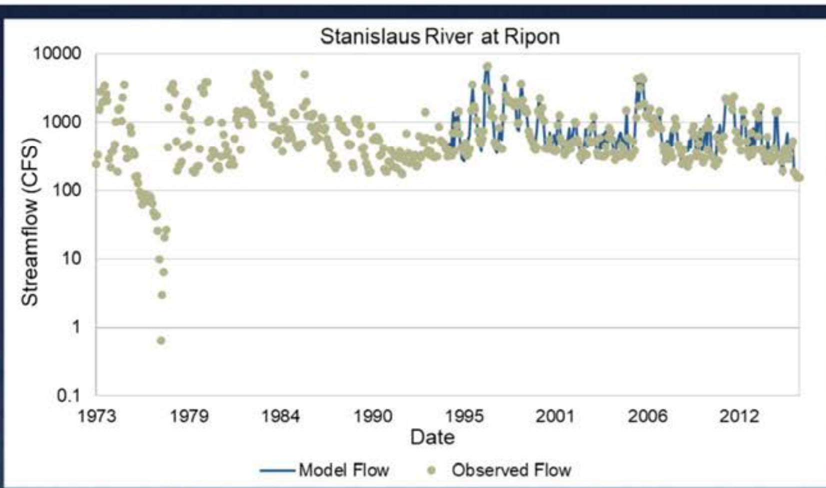
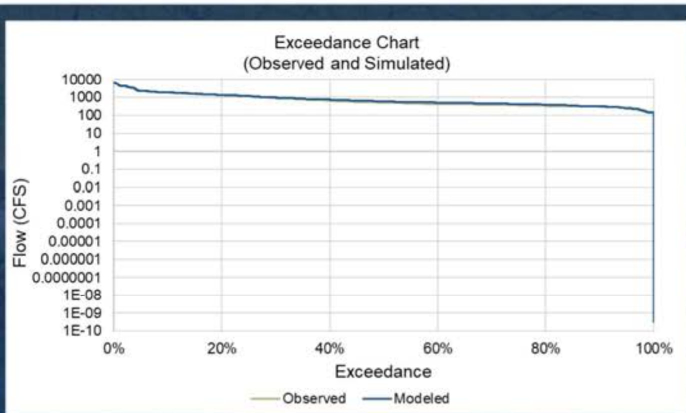
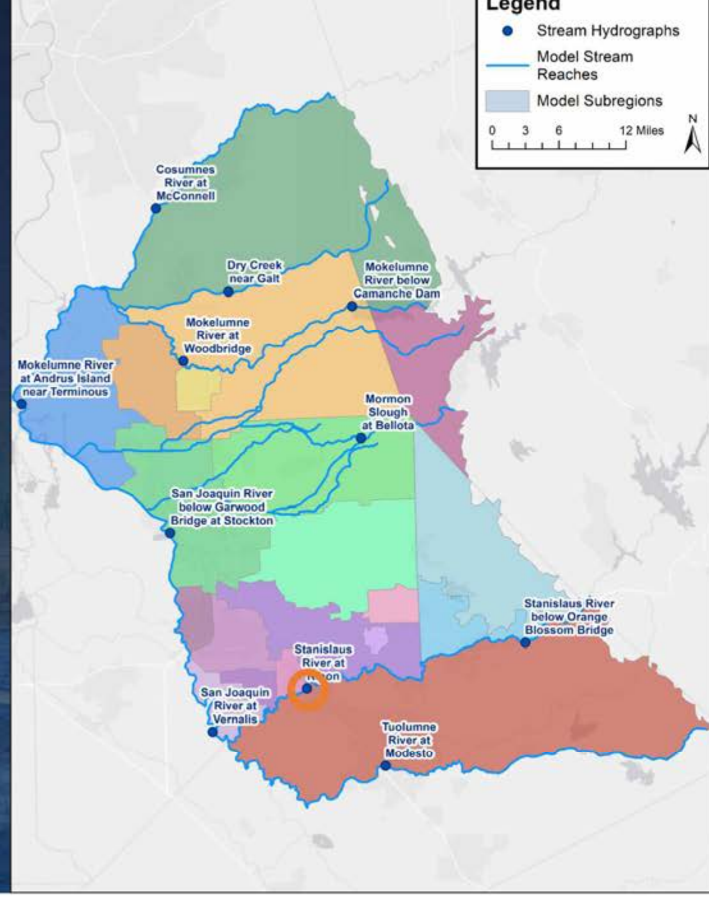
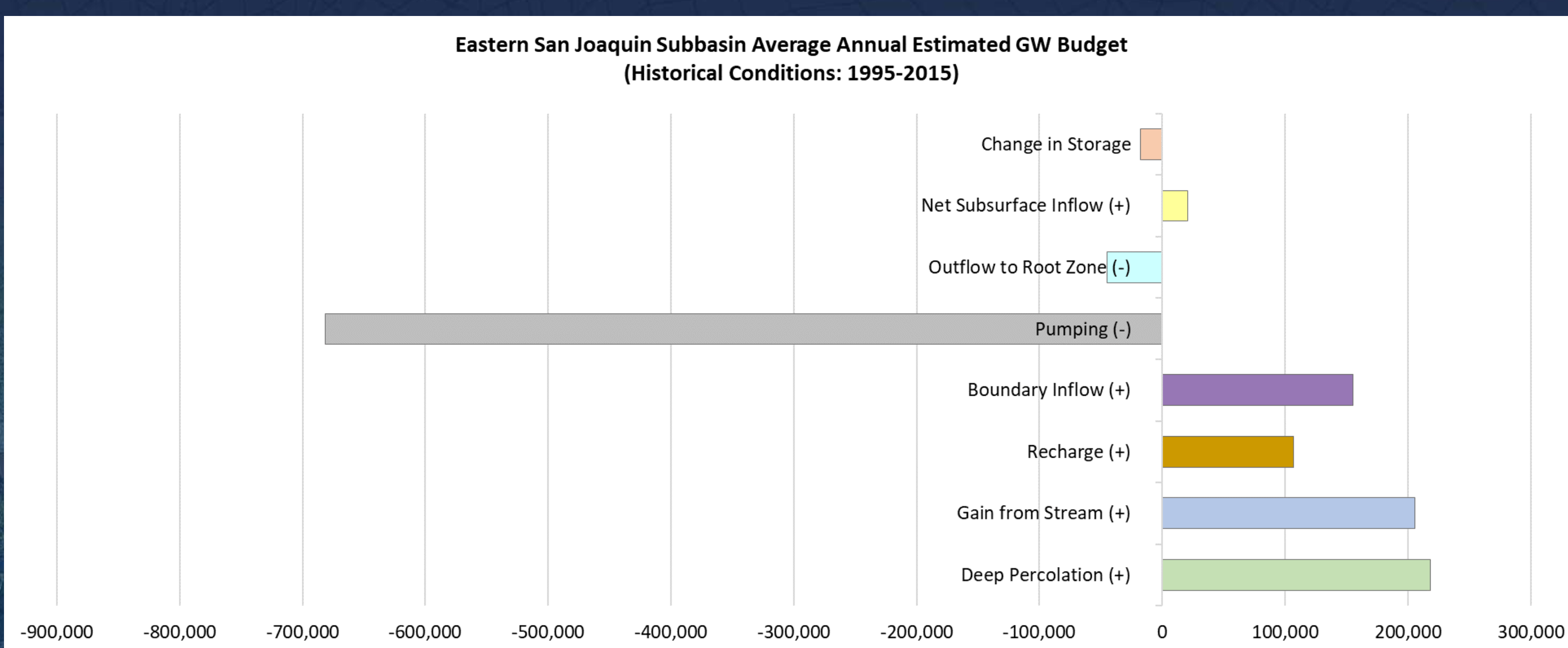




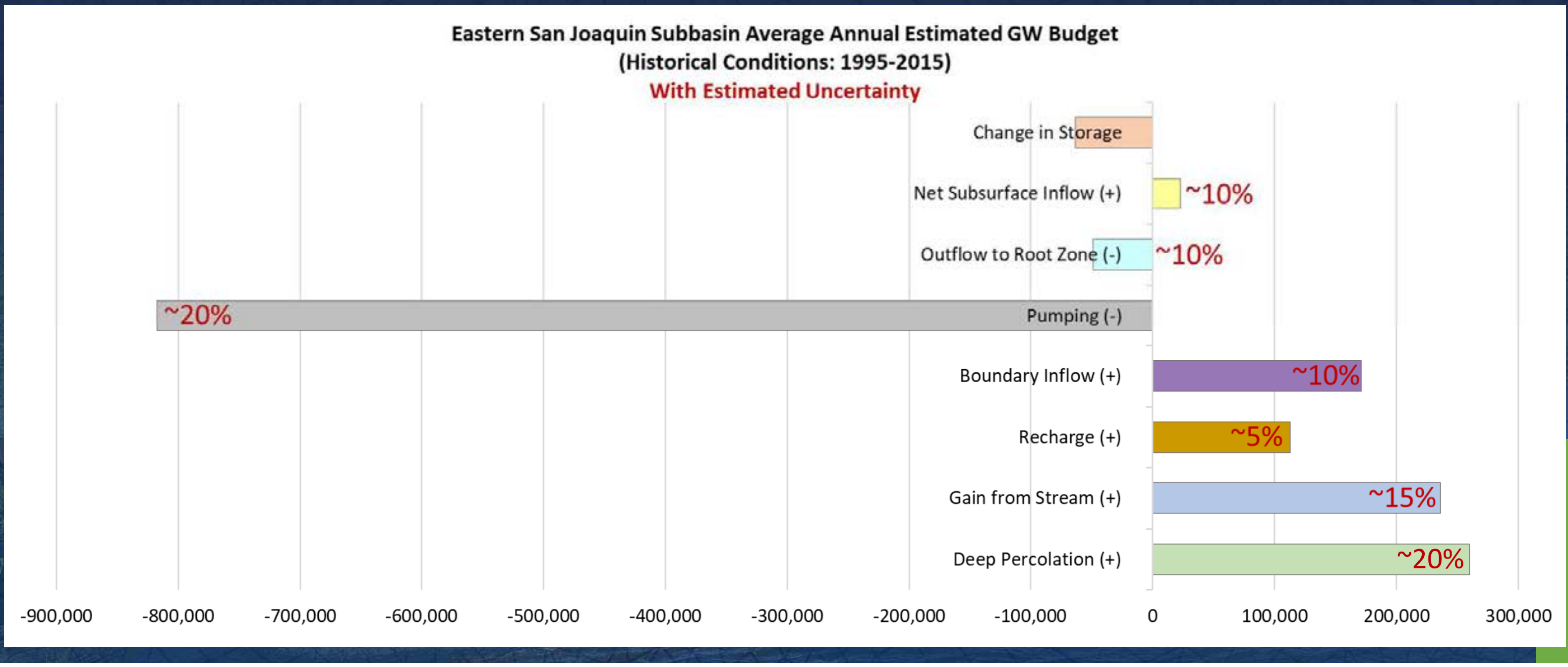


ESJ Subbasin Estimated Average Annual GW Budget Historical Conditions

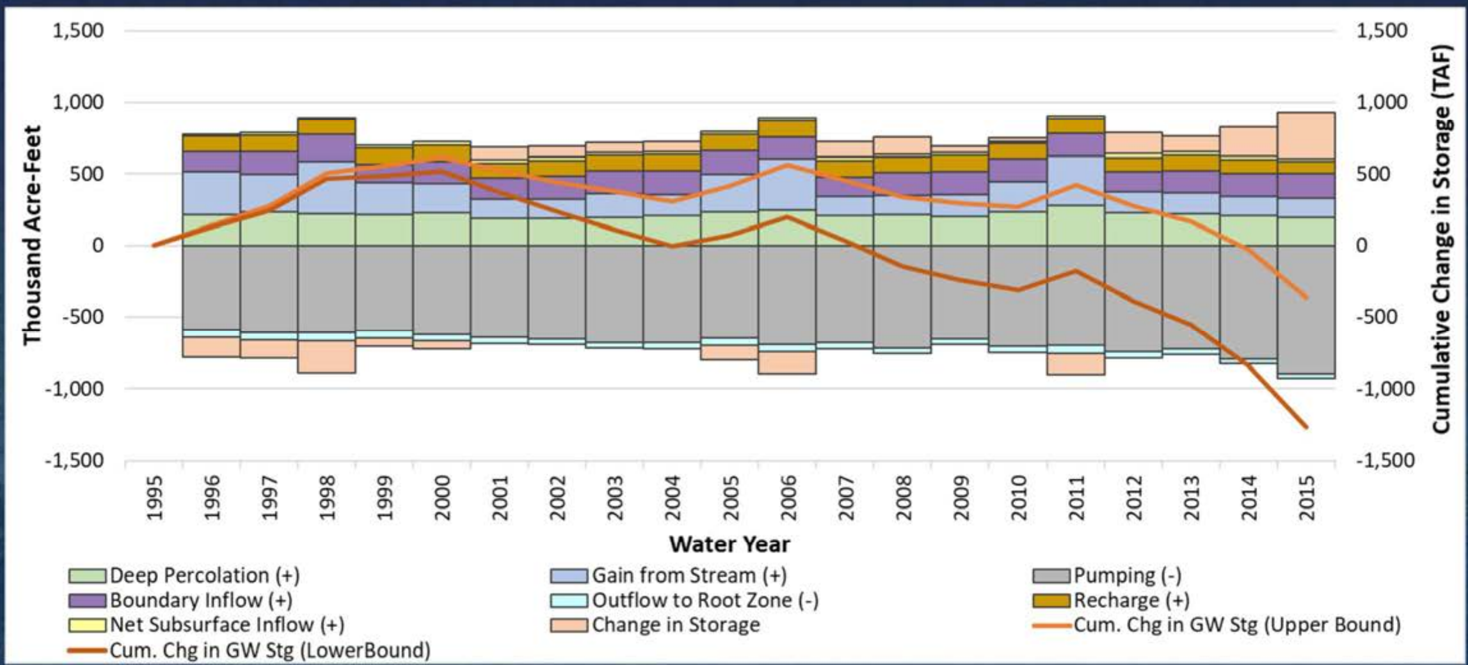


ATTACHMENT 2

ESJ Subbasin Estimated Average Annual GW Budget Historical Conditions



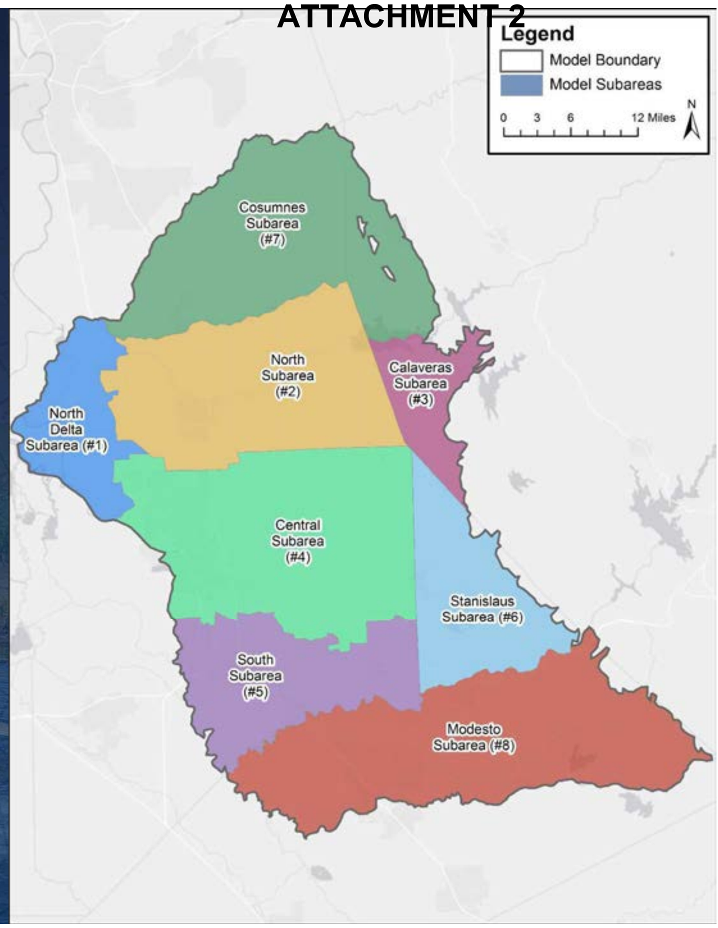
ESJ Subbasin Estimated Average Annual GW Budget Historical Conditions



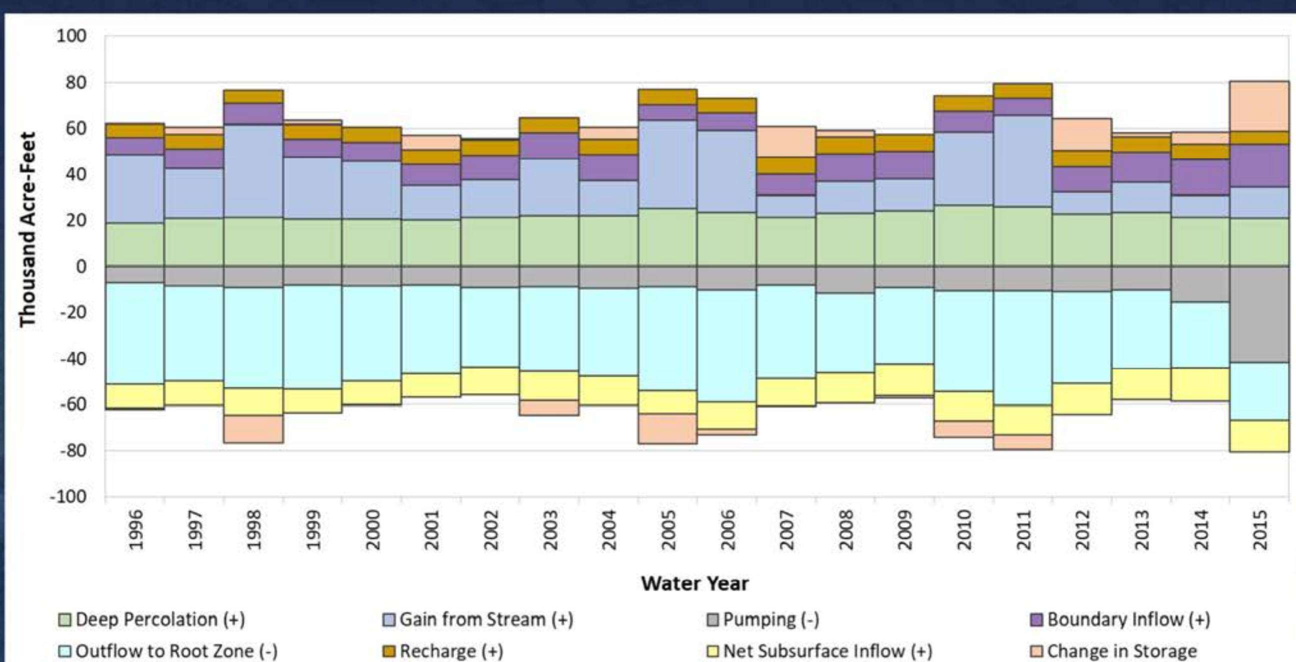
ATTACHMENT 2

Budgets by Subarea

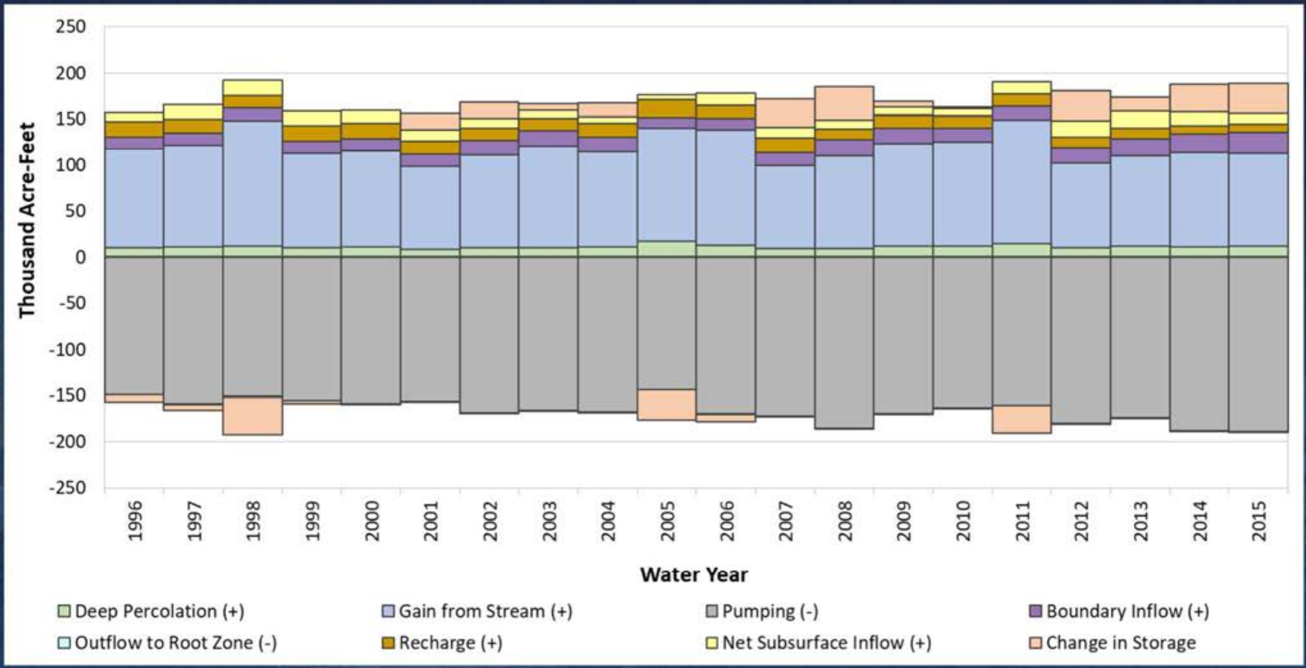
- Data input subregions versus model output subareas
  - For data verification and QA/QC, focus has been on data input subregions
  - Model output subareas are the scale for output of results



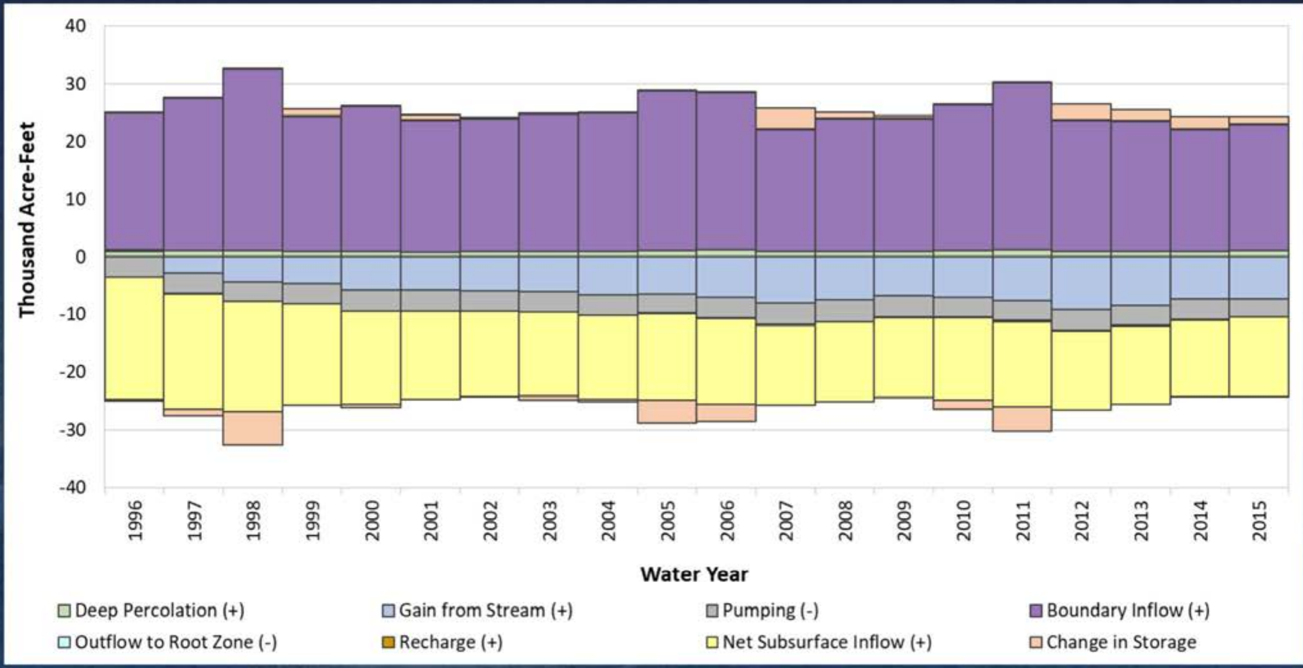
North Delta Subarea



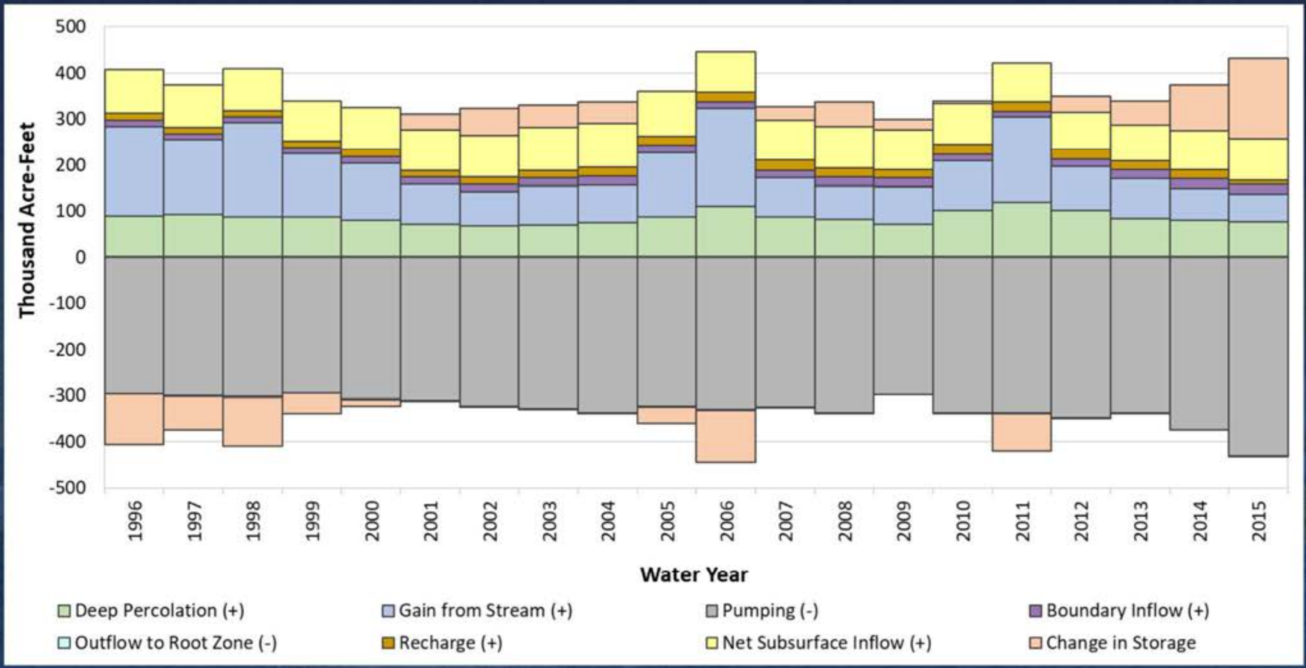
North Subarea



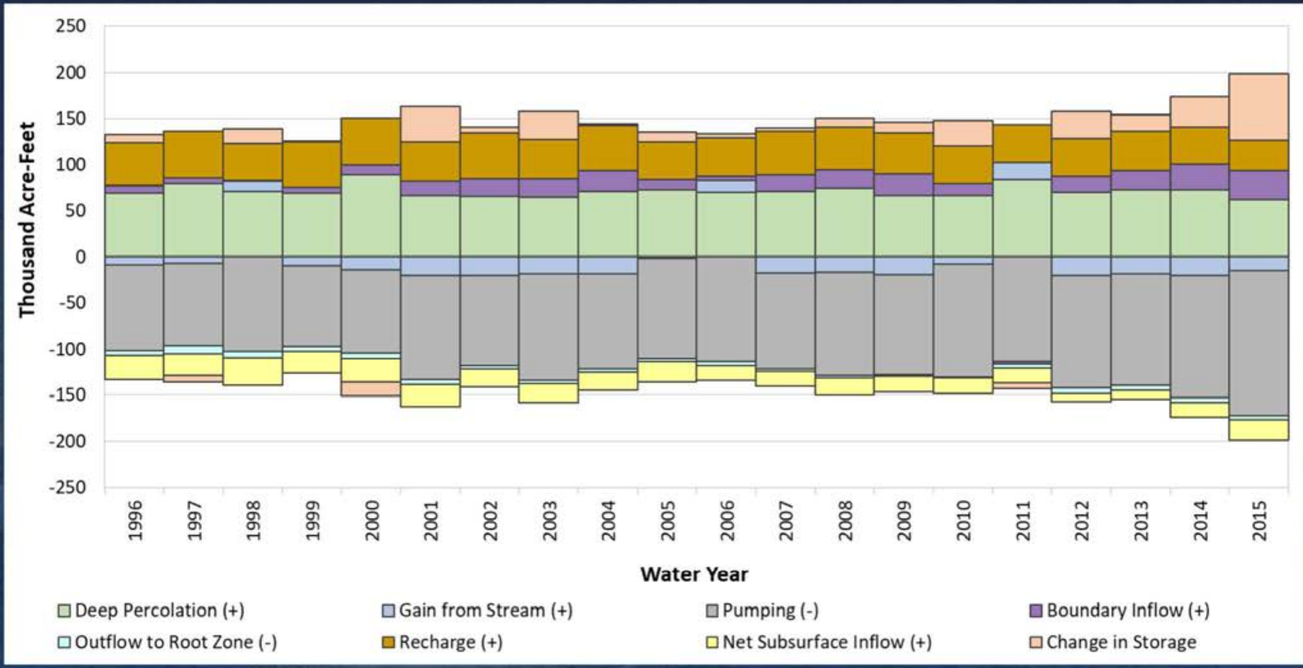
Calaveras Subarea



Central Subarea

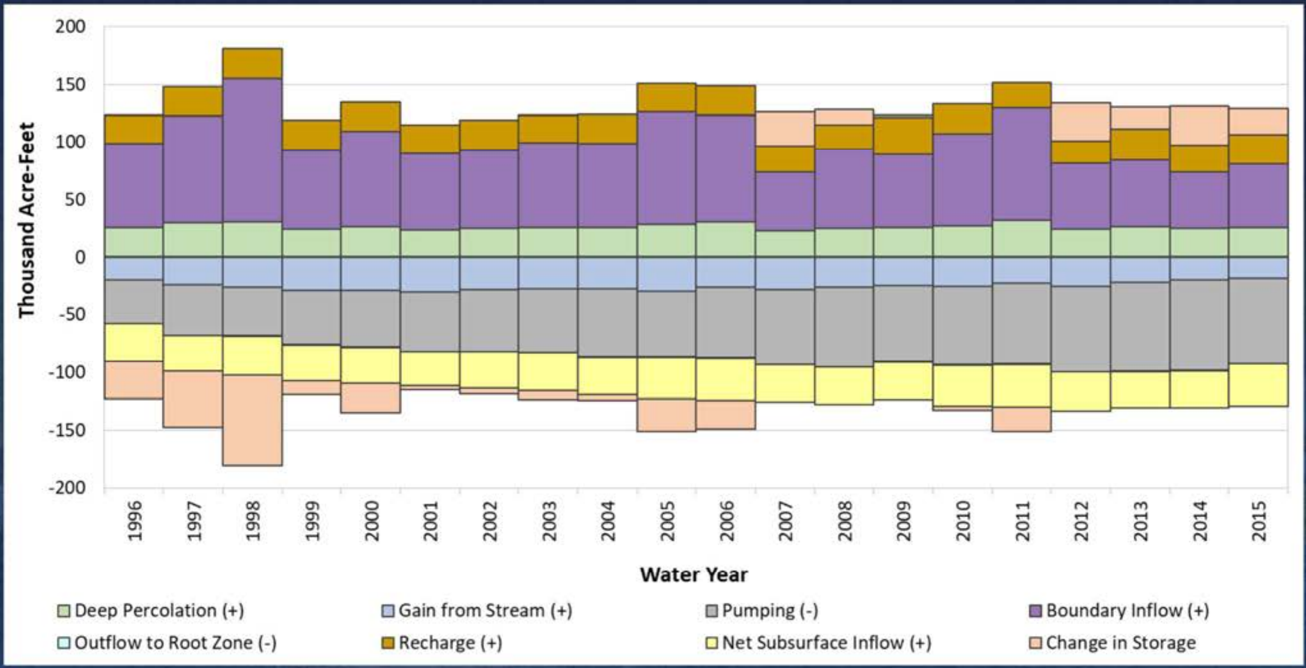


South Subarea

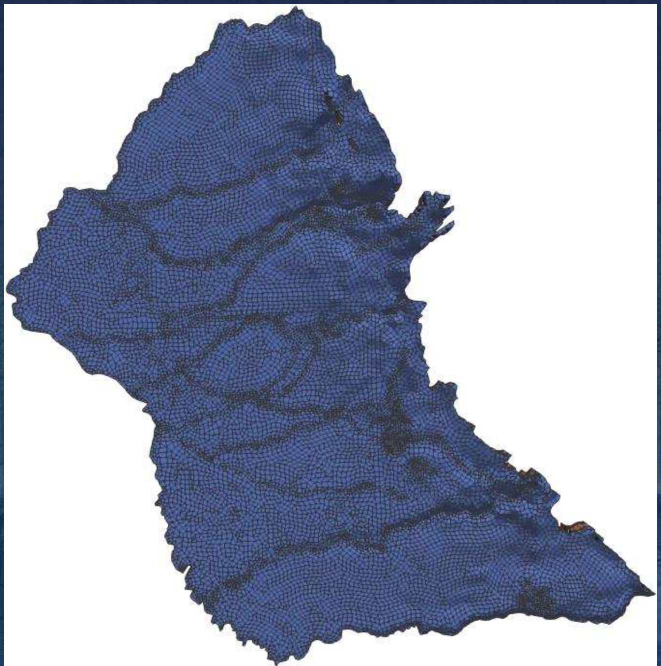


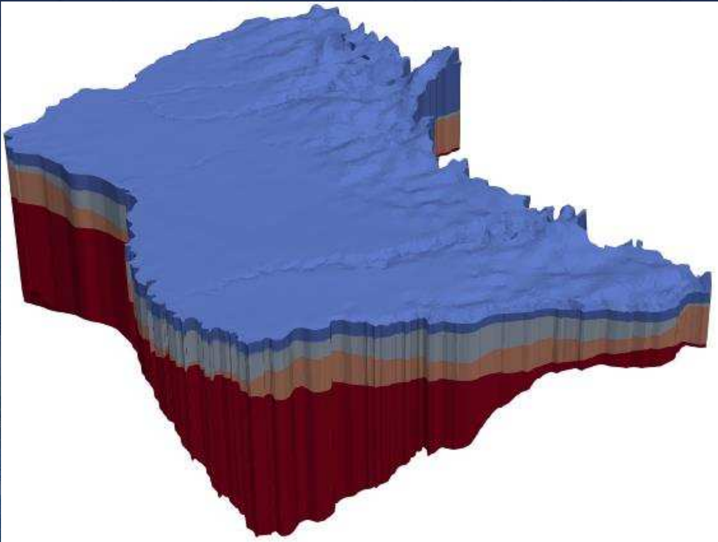
ATTACHMENT 2

Stanislaus Subarea

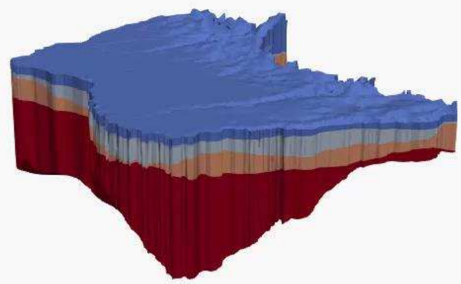


Model Stratigraphy





Model Stratigraphy: Rotation Around Model Edges

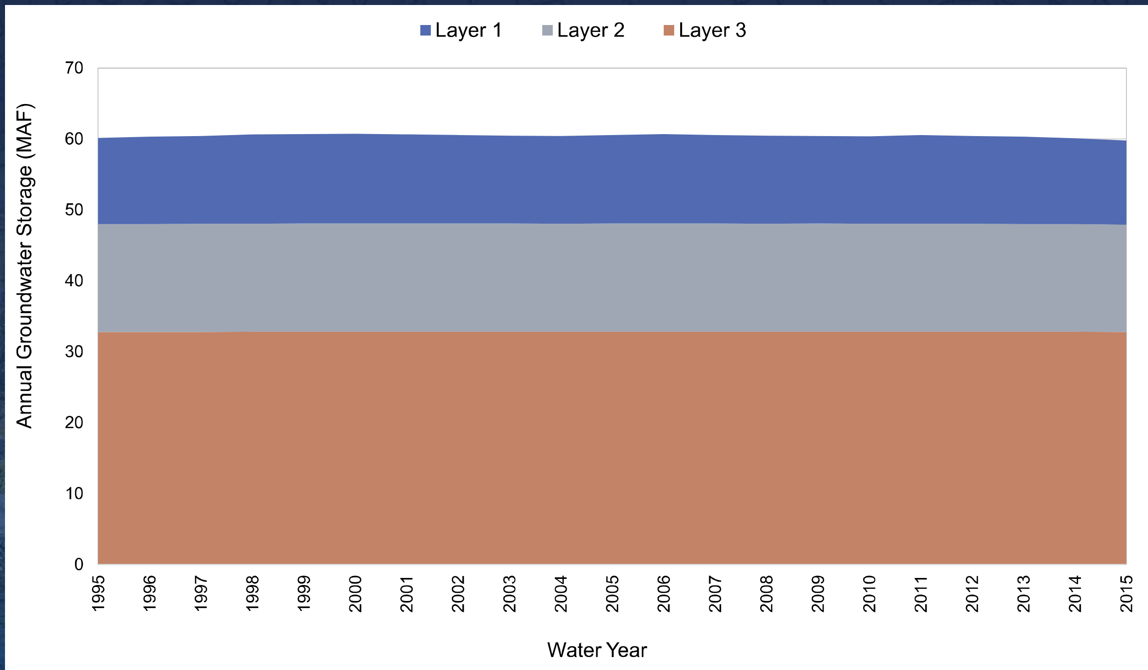


Estimates of Groundwater Storage

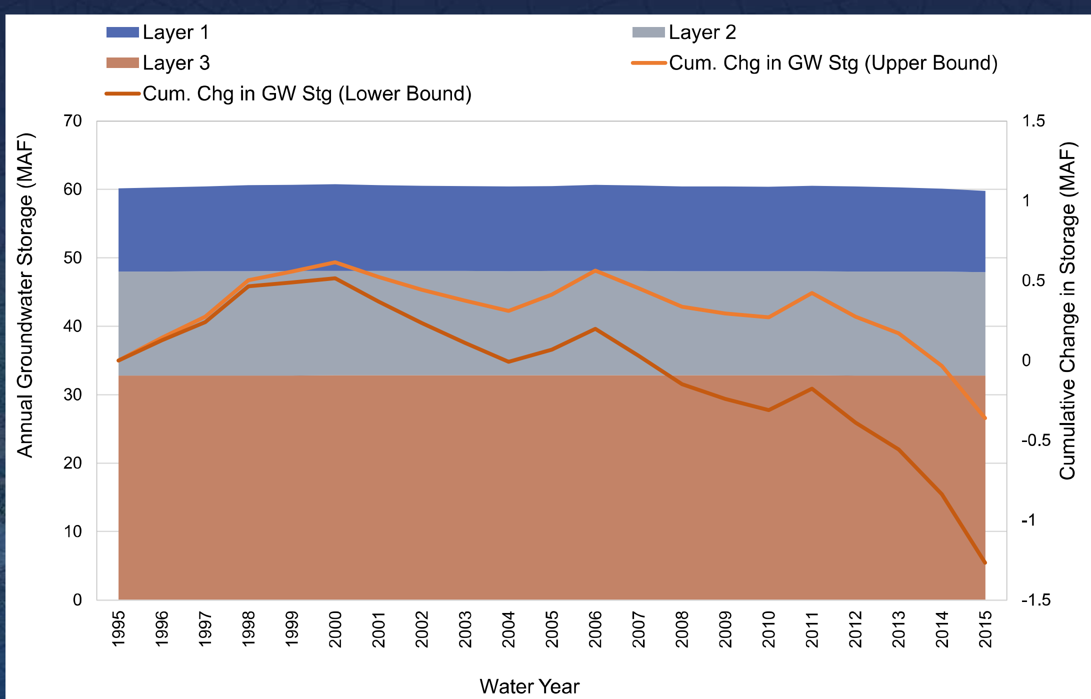
Bulletin 118 (1/20/2006)

Groundwater Storage Capacity. The total available groundwater storage capacity from a depth of 20 feet to the base of the groundwater basin is about 42,400,000 af based on a total aquifer material volume of 579,900,000 af and an average specific yield of 7.3 percent (DWR 1967). This estimate was based on a study area that encompassed approximately 586,000 acres. Since the currently defined subbasin size is over 707,000 acres, the storage value mentioned above underestimates the total storage capacity for the subbasin as defined in Bulletin 118 – Update 2002.

Groundwater Storage



Change in Groundwater Storage



Next Steps

- Finalize Calibration
- Prepare Model Report
- Present Model Development and Results to ESJ GWA Board
- Support GSP Development
  - Develop Baseline Scenarios
    - Current Conditions
    - Future Conditions
  - Perform Sustainability Scenarios

APPENDIX B: ESJWRM IDC TECHNICAL MEMORANDUM

Technical Memorandum

SGMA Readiness Project

Subject:	**Eastern San Joaquin Water Resources Model** **Agricultural and Urban Demand Estimates (Task 2 Deliverable)**
Prepared For:	San Joaquin County
Prepared by:	Sara Miller
Reviewed by:	Ali Taghavi
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1 Introduction

The purpose of this Technical Memorandum is to document the data and information used in analyzing land surface processes, to briefly discuss the analytical tools used, and to present estimates of the agricultural and urban water use in the Eastern San Joaquin Groundwater Subbasin (ESJ Subbasin) as part of the development of the Eastern San Joaquin Water Resources Model (ESJWRM).

The IWFM Demand Calculator (IDC) (Dogrul et al., 2017) is used to estimate the agricultural and urban water use in the ESJ Subbasin portion of ESJWRM. IDC, the stand-alone version of the Integrated Water Flow Model's (IWFM) root zone component, calculates agricultural and urban water demands with major inputs including climate conditions, soil parameters, and land use types and distribution. The hydrologic period of the ESJWRM spans from October 1994 though September 2015 and covers water years 1995 through 2015.

The ESJWRM boundaries include the ESJ Subbasin (primary model area), as well as the Cosumnes Subbasin to the north and the Modesto Subbasin to the south. The model network is a Finite Element based grid that contains 16,054 elements and 15,302 nodes. The model elements are grouped into 20 model subregions that are used to organize input data for the model and to report standard model output water budgets (Figure 1). These subregions are aggregated into 8 larger units (model subareas) used to output model results for basin-scale planning (Figure 2). ESJ Subbasin, the primary model area, is made up of 18 subregions and is the focus of this Technical Memorandum.

2 Technical Review and Oversight

The development of the ESJWRM, including the development and calibration of IDC, is taking place in an open and transparent process. The Eastern San Joaquin County Groundwater Basin Authority (GBA) was the organizational structure for model development coordination before the creation of the Eastern San Joaquin Groundwater Authority (GWA). The GBA's Ad Hoc Technical Review Committee was the forum to review model input data and assumptions, as well as calibration results. The monthly committee meetings were open to all interested parties and generally consisted of technical representatives from local agencies, consultants with knowledge of the area, representatives for neighboring groundwater subbasins, DWR staff, and San Joaquin County personnel.

Local agencies with consistent representation included San Joaquin County, Woodbridge Irrigation District, City of Lodi, North San Joaquin Water Conservation District, Lockeford Community Services District, Calaveras County Water District, City of Stockton, Cal Water, Stockton East Water District, City of

Lathrop, City of Manteca, South San Joaquin Irrigation District, City of Escalon, Oakdale Irrigation District, and Stanislaus County.

3 Land Use

Spatial land use data was used to develop land use and crop acreages for each model element. Model element acreages were then aggregated by subregion for reporting and verification purposes.

The Department of Water Resources (DWR) conducts periodic land use surveys for each county that include over 70 different crop categories, as well as urban and native vegetation (DWR, 1993-2000). DWR land use surveys by county were merged and assumed to represent water year 1995 in the model. The surveys used include:

1. San Joaquin County (1996)
2. Sacramento County (1993)
3. Amador County (1997)
4. Calaveras County (2000)
5. Stanislaus County (1996)

Data for water years 2007 through 2015 are from the United States Department of Agriculture's remote sensing CropScape data (USDA NASS, 2007-2015). CropScape includes 256 land use categories that come from annual satellite imagery collected during the growing season on 30 meter by 30 meter pixels. Based on reports on the CropScape website, the level of accuracy for this data is about 85-97% for crop-specific land cover categories. Although this level of accuracy is high, the accuracy varies depending on many factors, including the time of the satellite image, growing season timing, cloud cover, type of crop, and maturity state of the crop.

DWR retained LandIQ, LLC to develop a statewide assessment of agricultural land use in summer 2014. LandIQ used remote sensing methods to collect and process the data, which was then ground truthed for a reported overall accuracy of 96.6% (DWR, 2014). In ESJWRM, this data was broadly used as verification of CropScape 2014 data and, in a few specific cases, as replacement or enhancement of the CropScape data.

Local data and knowledge was also utilized to refine and correct, as needed, the cropping acreages developed based on the DWR land use surveys and CropScape years. ESJWRM includes 23 irrigated crop categories and 4 general land use categories. The irrigated crop categories were combined into 6 high-level groupings of crops with similar water use or irrigation practices. Table 1 lists the land use categories.

To fill the gap between 1995 and 2007, all land use and crop categories were interpolated at the spatial resolution level of the model element. Thus, the geographic distribution of interpolated land use and cropping patterns are honored. Adjustments were made, as needed, at the element level to ensure that the land use and cropping pattern trends over time are reflective of local data. These adjustments were mostly based on local knowledge and information received from various entities, including irrigation districts, water districts, and municipalities.

Figure 3 and Figure 4 show the spatial distribution of the major land use categories in the ESJ Subbasin. Figure 5 shows the annual trends of land use categories in the ESJ Subbasin.

Figure 6, Figure 7, and Figure 8 show the spatial distribution of the irrigated crops for 1995, 2014, and 2015. Figure 9a-9m show the annual cropping patterns, by high level categories, for the ESJ Subbasin and those major model input subregions that are not predominantly urban centers (i.e., all subregions in the primary model area except subregions 3, 6, 9, 10, 12, and 16).

Table 1: Land Use Categories

Land Use Type	Model Category	Grouped Categories
Irrigated Crops	Almonds Cherries Citrus & Subtropical Other Orchard Pistachios Walnuts	Fruit and Nut Trees
	Vineyards	Vineyards
	Alfalfa Pasture	Alfalfa and Irrigated Pasture
	Grain	Grain
	Corn Cotton Dry Beans Field Crops Safflower Sugar Beets	Field Crops
	Cucurbits Onion & Garlic Potatoes Tomato Fresh Tomato Processing Truck Crops	Truck Crops
	Rice	Rice
Other Land Use	Urban Landscape Water Surface Riparian Vegetation Native Vegetation	

4 Urban Demand

IDC calculates urban demand based on per capita water use, population, and the breakdown of indoor versus outdoor water use by month. Figure 10 shows the annual population trends for each urban center. Figure 11 shows the annual per capita water use values of these urban centers used in the calculation of urban water demand. Figure 12a-12g show the model estimated annual urban demand for predominantly urban subregions and the total ESJ Subbasin area.

Population and per capita water use for the major urban areas were largely provided directly by the urban areas or were contained in Urban Water Management Plans (UWMPs). Additional annual population, including an estimate for rural urban areas, came from the United States Census Bureau and the California Department of Finance. Monthly per capita water use, commonly reported in gallons per capita per day (GPCD), was generally estimated for each urban entity using the annual population and monthly urban water use (provided by cities based on water delivery records). To estimate the urban water demand of rural domestic water areas, the average major urban area GPCD was combined with the estimated rural population.

It was assumed that an annual average of 60% of urban water was used indoors and 40% was used outdoors. The monthly fractions entered into the model had the majority of urban water demand due to indoor activities from November through March and up to a maximum of 60% of urban water used outdoors for the remainder of the year.

The indoor/outdoor breakdown received concurrence from the urban water providers who attended the Ad Hoc Technical Review Committee meetings. Population and per capita water use data were reviewed by the major urban areas and confirmed at the meetings (pers. comm. Kathryn Garcia, Andrew Richle, Michael Bolzowski, Greg Gibson, and Elba Mijango).

5 Agricultural Demand

IDC estimates agricultural water demand based on model input data for evapotranspiration (ET), monthly precipitation, return and reuse fractions, irrigation period, land use and cropping acreages, and soil properties (e.g., hydraulic conductivity, pore size distribution index, etc.). This data was compiled, analyzed, synthesized, and processed for input in ESJWRM.

The ET requirement is based on a variety of sources, including locally-developed data for the South San Joaquin Irrigation District and the Oakdale Irrigation District Agricultural Water Management Plans (AWMPs) (SJJID, 2015; OID, 2016) and averages for DWR's CIMIS (California Irrigation Management Information System) Zone 12 developed using the METRIC methodology, which is a remote-sensing based technology to estimate crop actual ET. Based on discussions with locals (pers. comm. Jennifer Spaletta and Bryan Thoreson), deficit irrigation of vineyards was simulated in ESJWRM with reference to the growing season ET values in the Lodi area (Prichard). Figure 13 shows the range in annual evapotranspiration rates from the various sources for the 27 model land use categories.

Monthly rainfall data was derived from the PRISM (OSU, 1970-2015) database and mapped to the model element in order to preserve the spatial distribution of the monthly rainfall over the model hydrologic period of 1995 through 2015. Figure 14 shows the annual rainfall in the model area and the cumulative departure from mean, which is an indication of long-term rainfall trends in the area.

The soil properties included in the model for each element are field capacity, wilting point, total porosity, hydraulic conductivity, and pore size distribution index. The soil survey geographic (SSURGO) database was downloaded first from the Web Soil Survey and any gaps in data were filled in using the General Soil Map of the United States (STATSGO2). These spatial datasets were averaged over each model element using IWFM's Soil Data Builder with GIS tool available at http://baydeltaoffice.water.ca.gov/modeling/hydrology/IWFM/SupportTools/index_SupportTools.cfm.

IDC was used to simulate the monthly agricultural demand estimates for each model element. The IDC model was calibrated to agricultural water use values reported by irrigation districts in their AWMPs and then checked against local data with input from irrigation district representatives and consultants (pers. comm. Doug Heberle, Jennifer Spaletta, Tom Flinn, Peter Martin, Cathy Lee, Manuel Verduzco, Sam Bologna, Bryan Thoreson, Emily Sheldon, Eric Thorburn, and Byron Clark). ESJWRM as a whole will undergo a more rigorous calibration process comparing model streamflow and groundwater levels to actual observed data.

The calibrated IDC was used to estimate monthly agricultural water demand at each model element during the model hydrologic period. The element-level estimates were then aggregated to report the information for each model subregion. Figure 15a-15n show the agricultural water demand, unit agricultural water use, and unit evapotranspiration of applied water (ETAW) estimates by the total ESJ Subbasin area and the subregions with irrigation districts who participated in the IDC development and calibration process.

The IDC model will be integrated with the comprehensive IWFM model, ESJWRM, to simulate the surface water and groundwater conditions in the ESJ Subbasin.

6 References

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Figure 1: Model Subregions

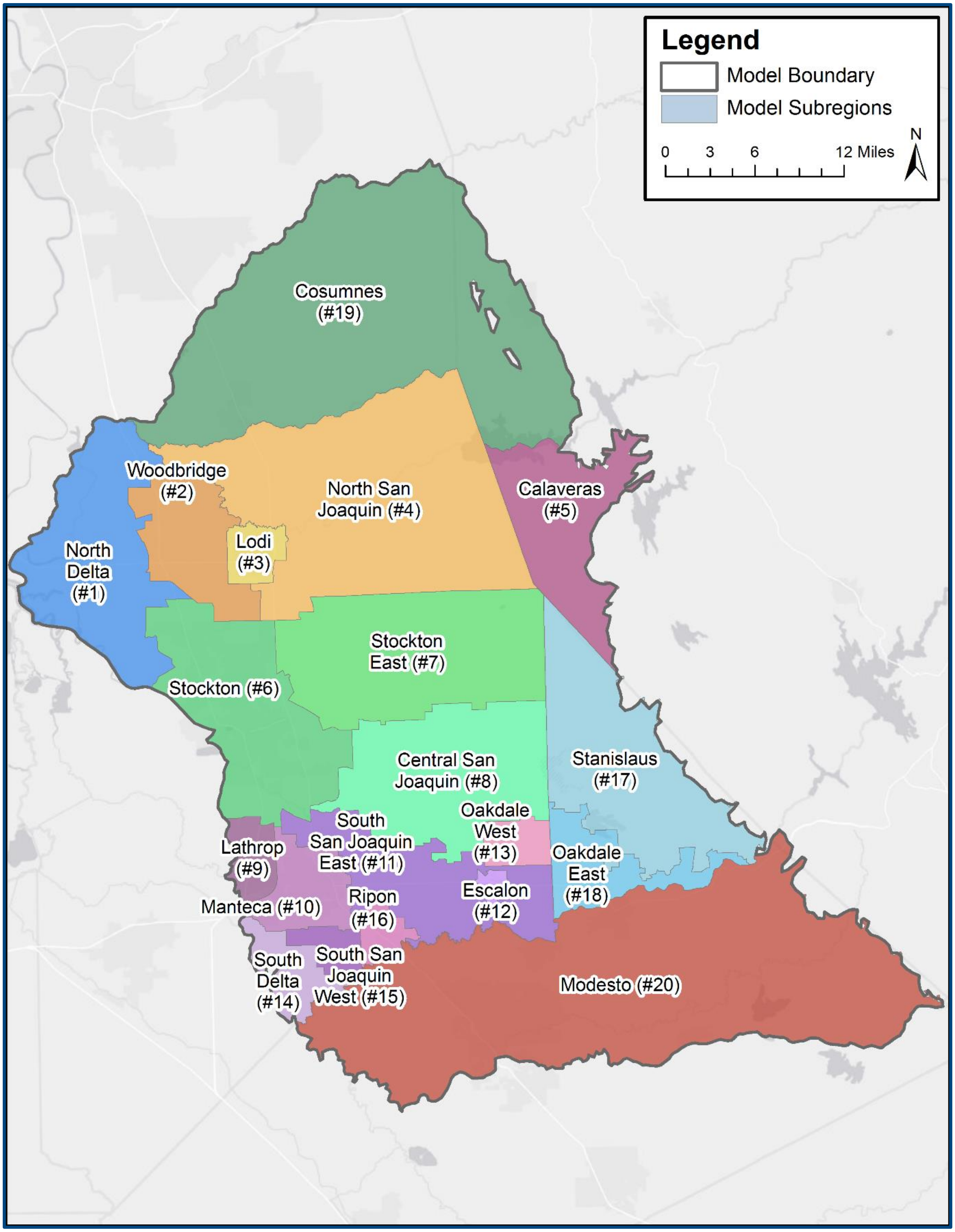


Figure 2: Model Subareas with Eastern San Joaquin Subbasin

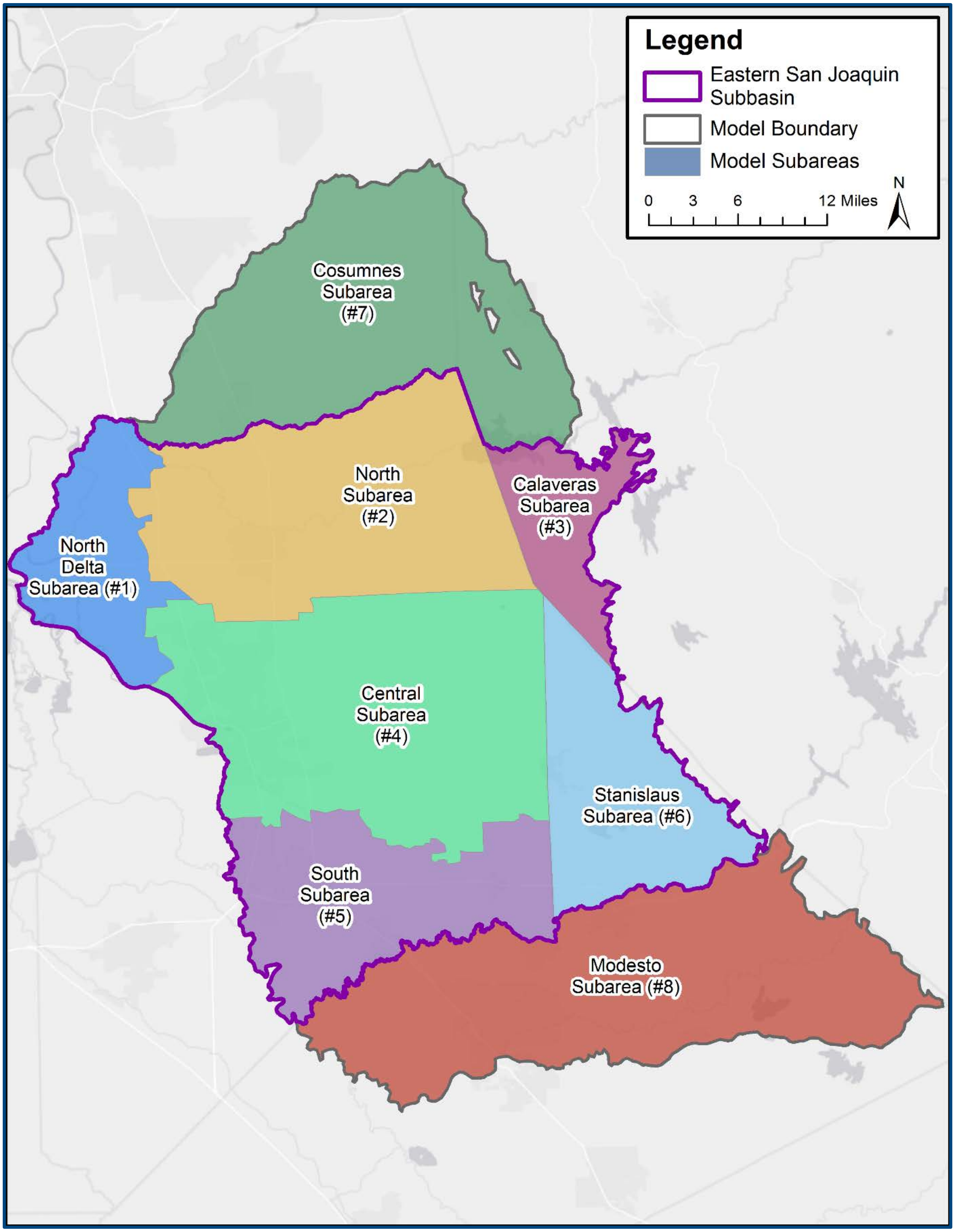


Figure 3: General Land Use in 1995 DWR Land Use Survey

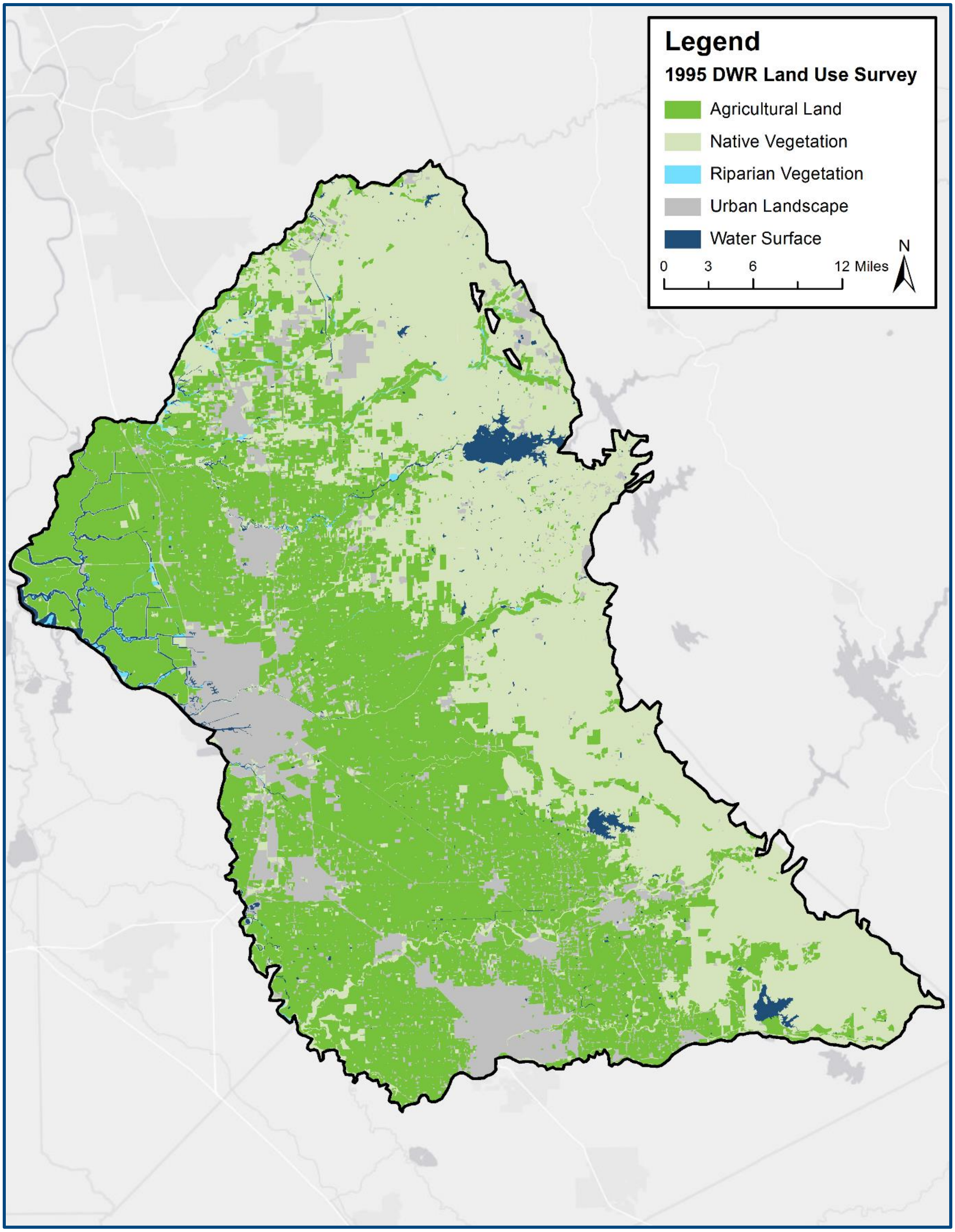


Figure 4: General Land Use in 2015 CropScape

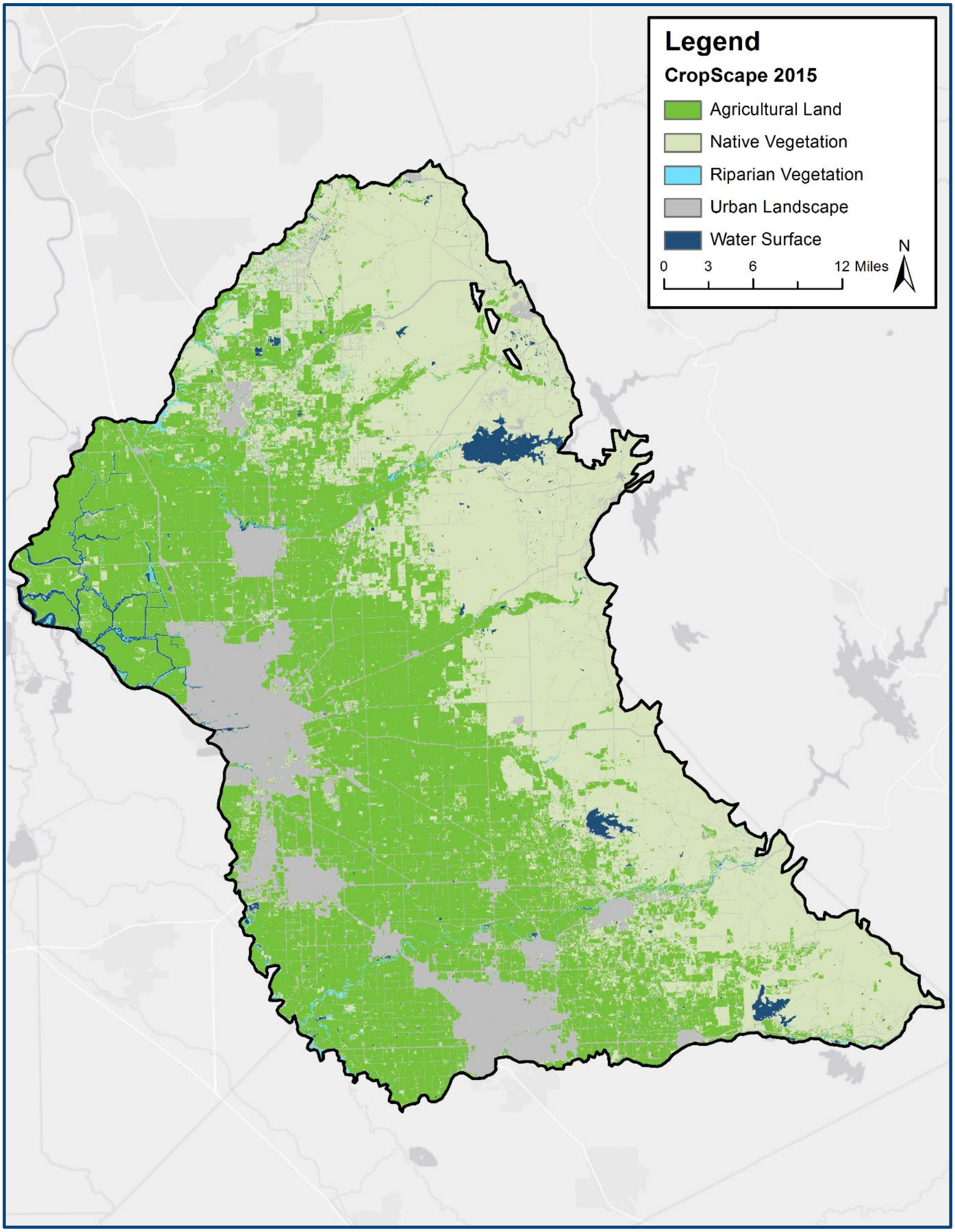


Figure 5: Eastern San Joaquin Subbasin General Land Use Acreages

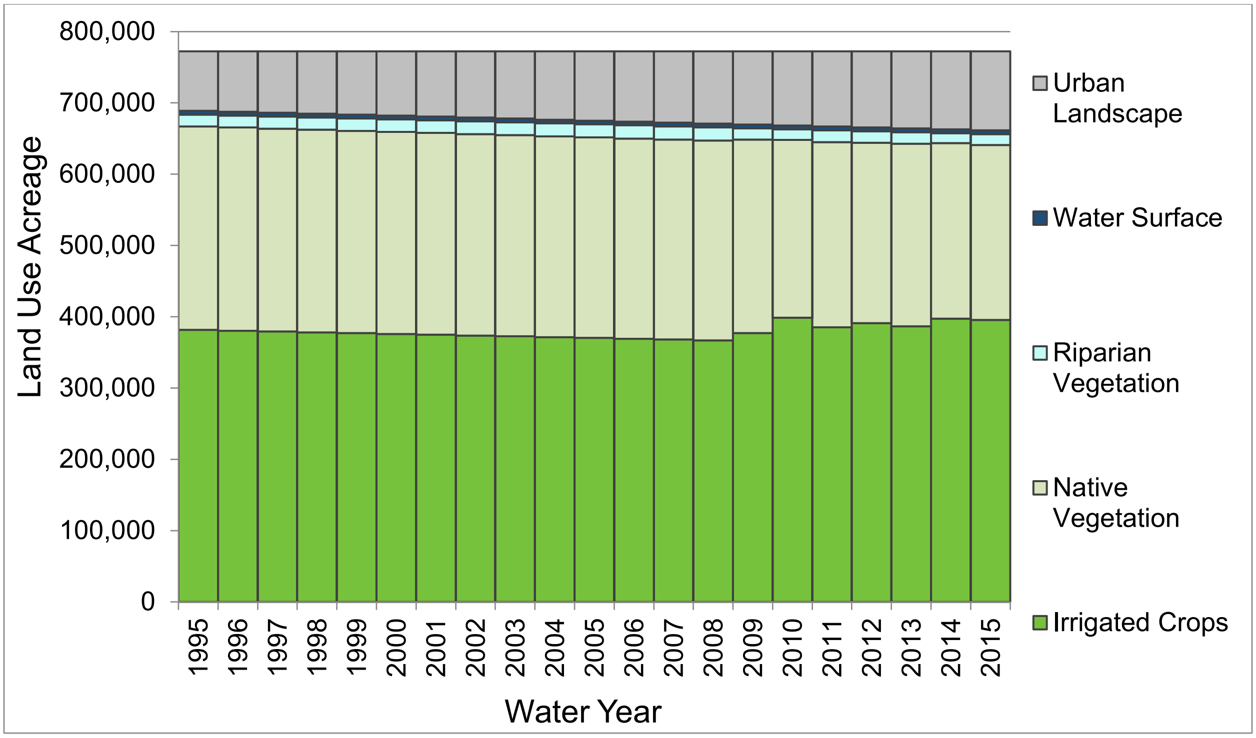


Figure 6: Cropping Pattern in 1995 DWR Land Use Survey

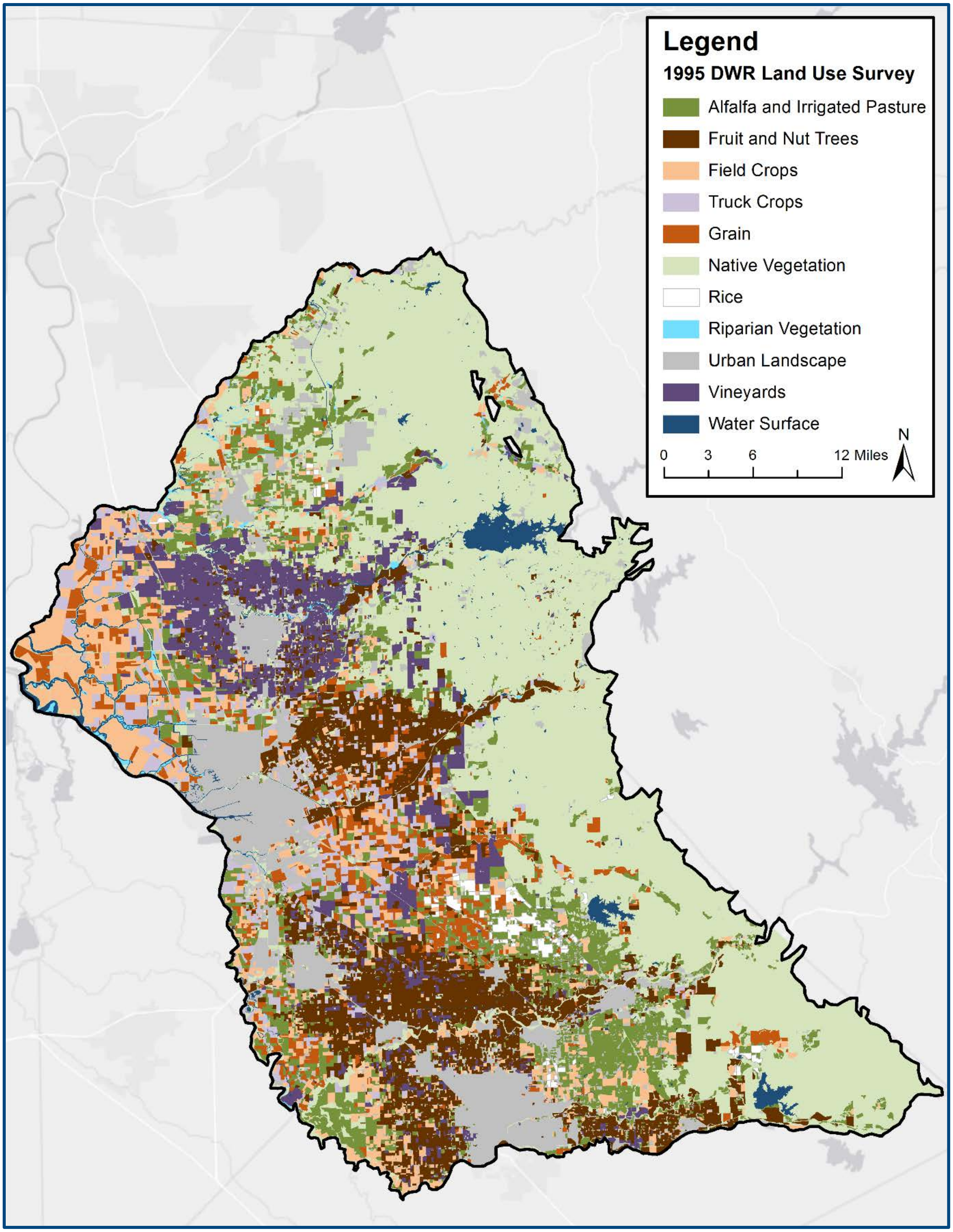


Figure 7: Cropping Pattern in 2014 LandIQ

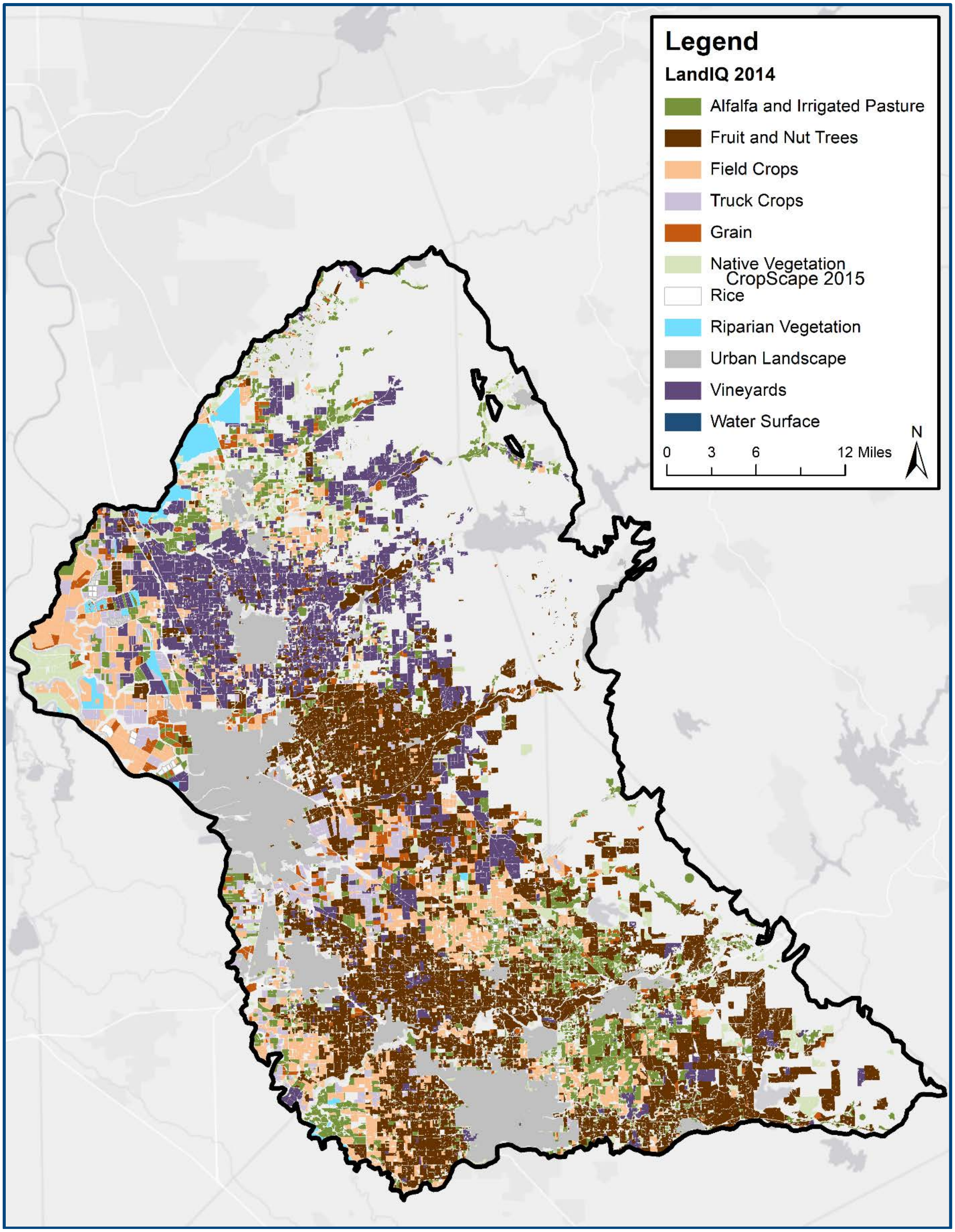


Figure 8: Cropping Pattern in 2015 CropScape

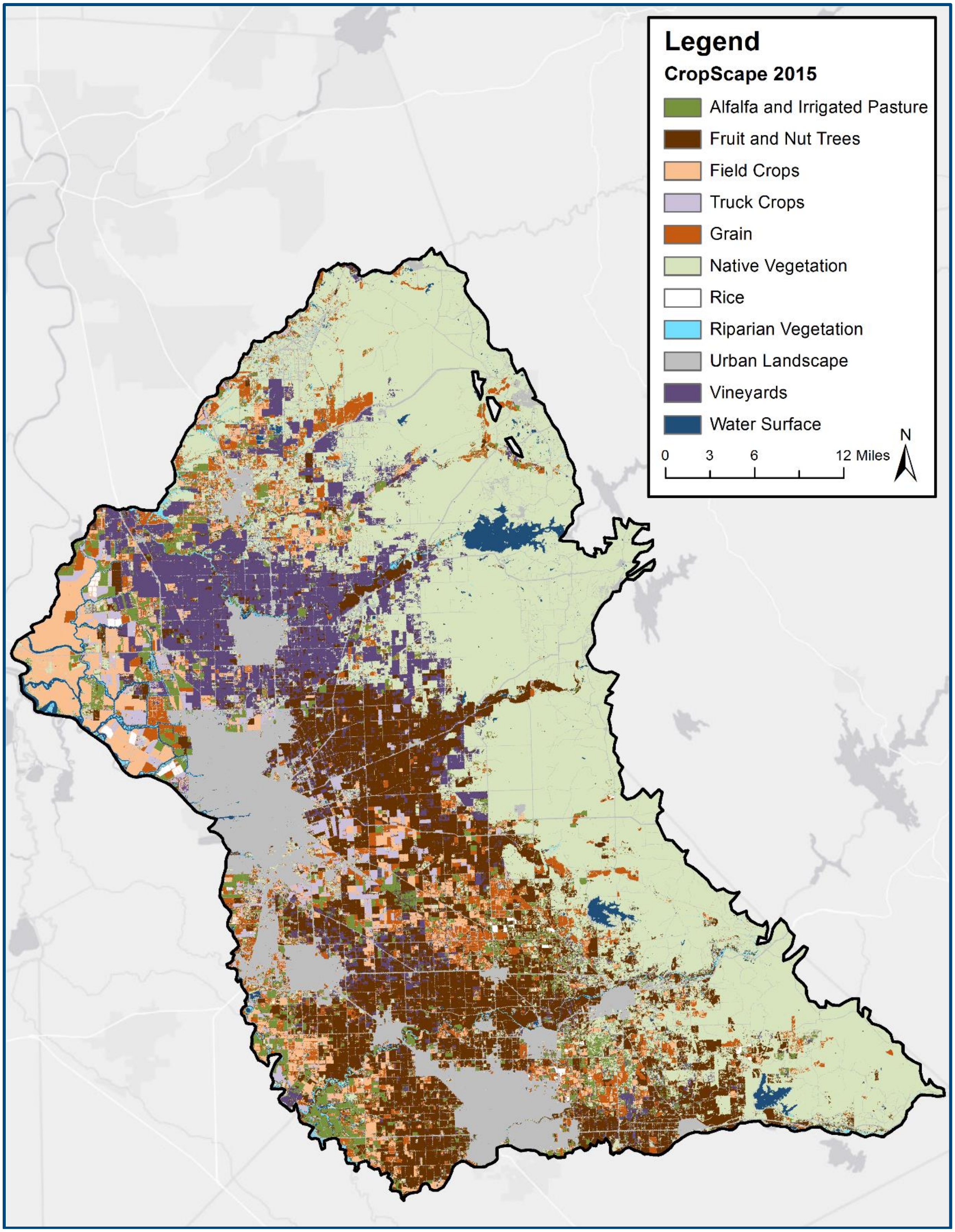


Figure 9a: Irrigated Crop Acreages- Eastern San Joaquin Subbasin

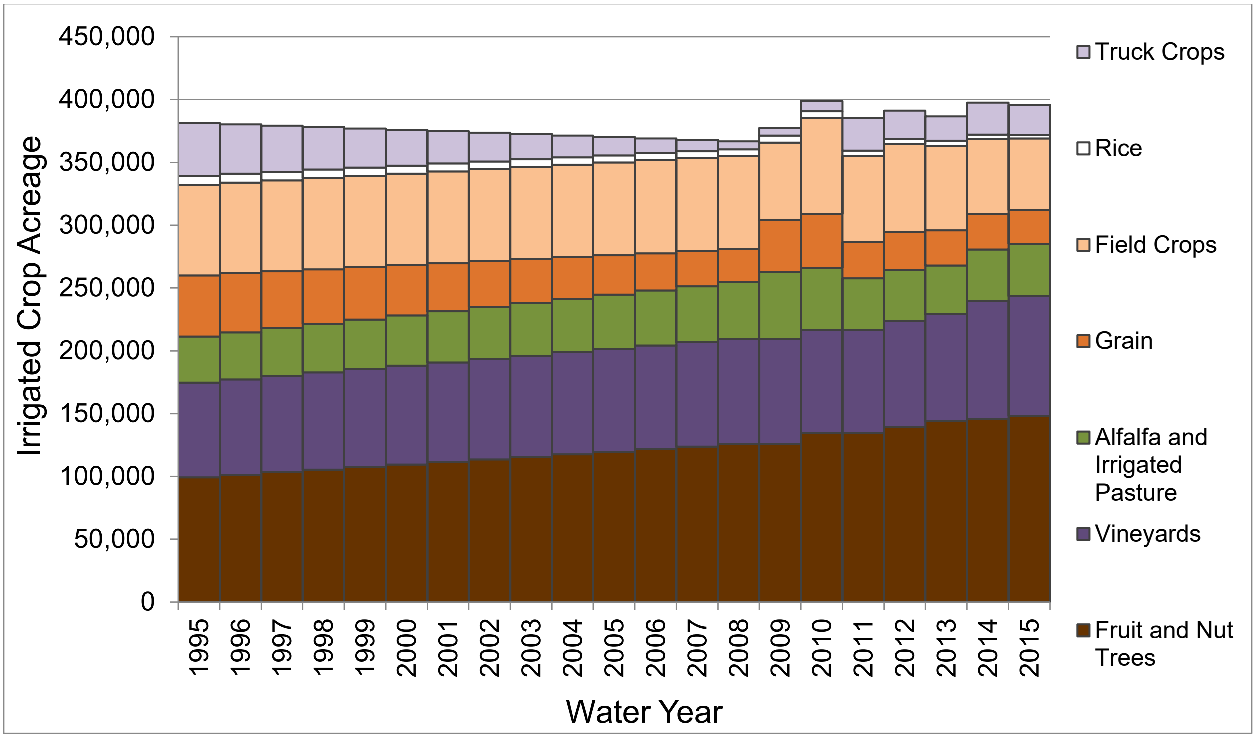


Figure 9b: Irrigated Crop Acreages- Subregion 1 (North Delta Subregion)

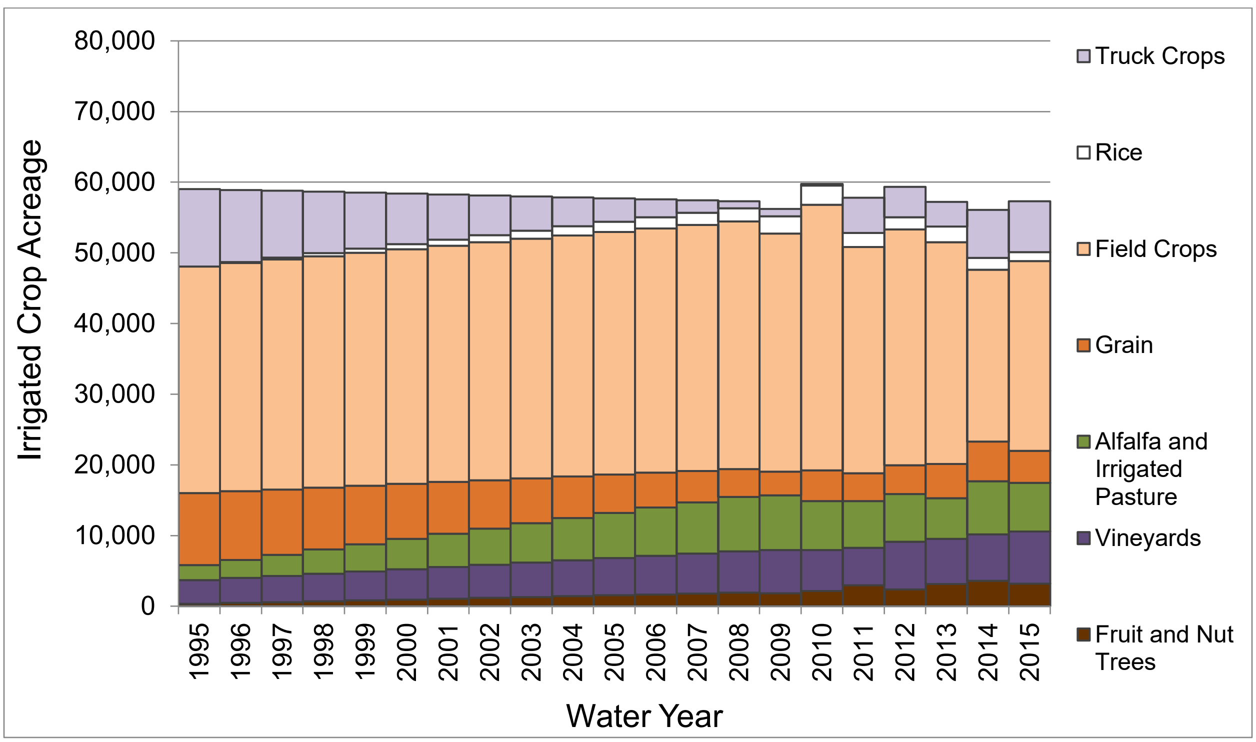


Figure 9c: Irrigated Crop Acreages- Subregion 2 (Woodbridge Subregion)

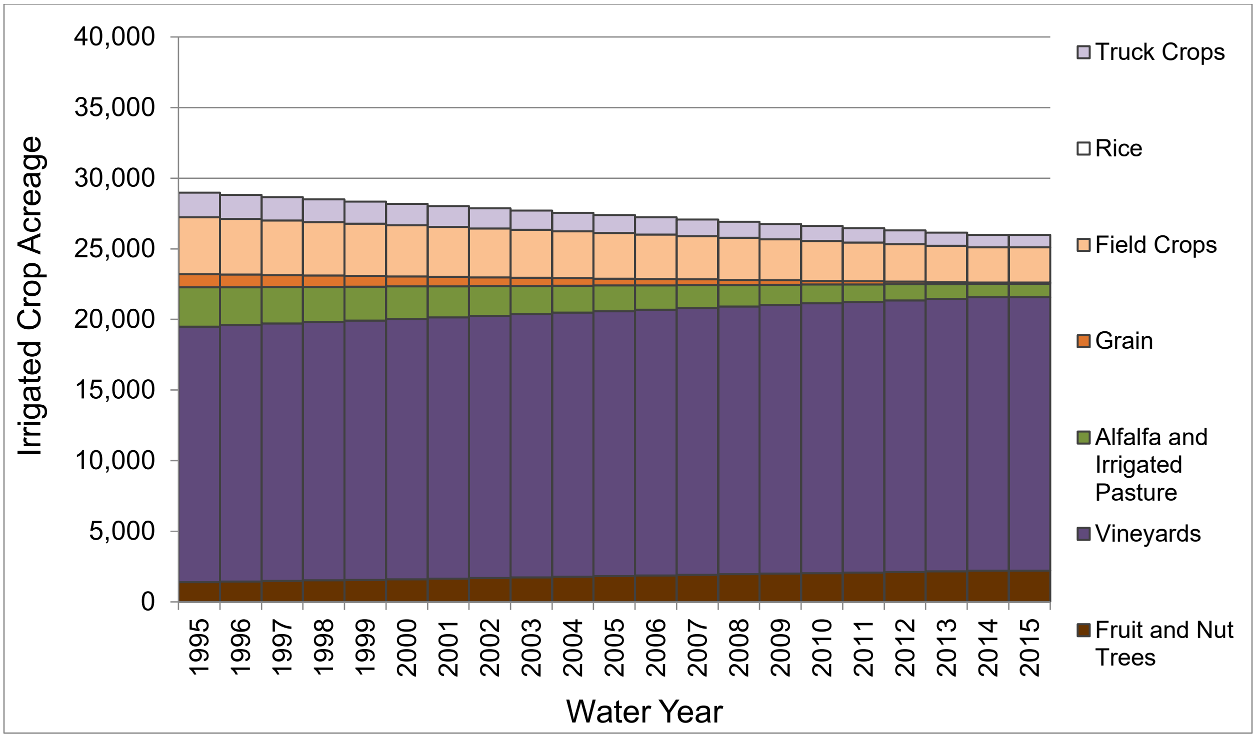


Figure 9d: Irrigated Crop Acreages- Subregion 4 (North San Joaquin Subregion)

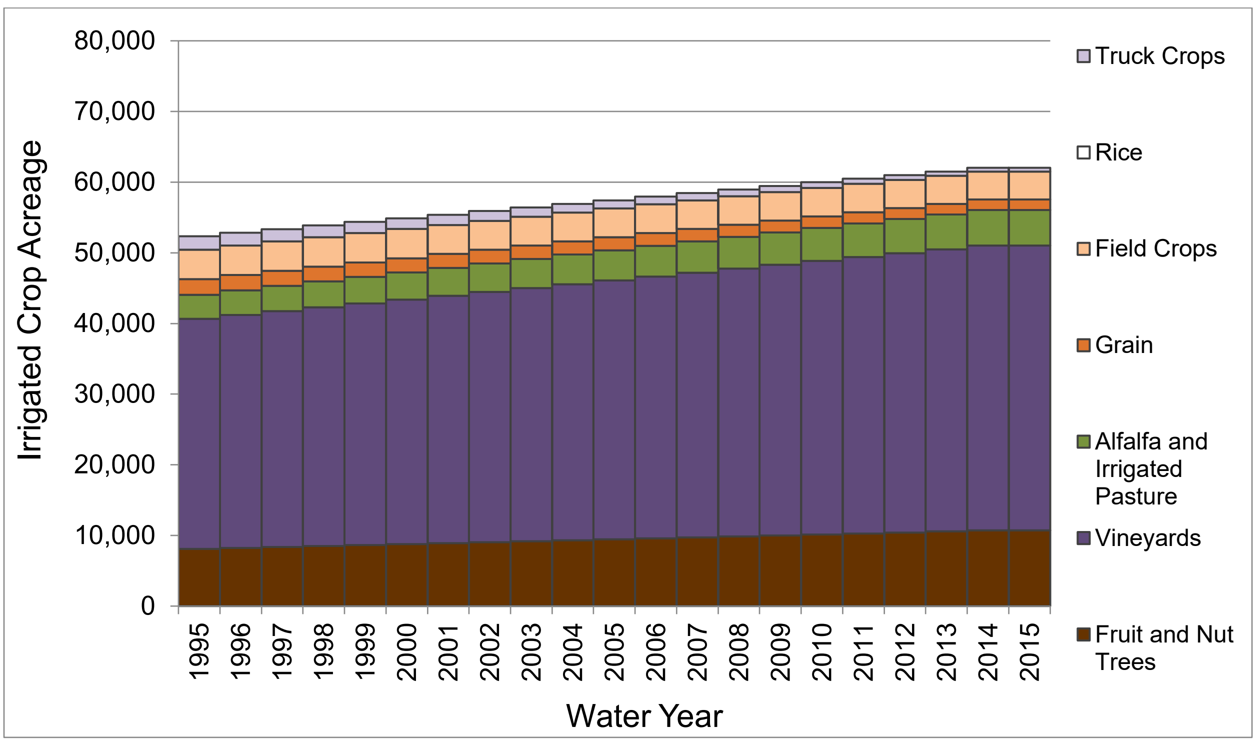


Figure 9e: Irrigated Crop Acreages- Subregion 5 (Calaveras Subregion)

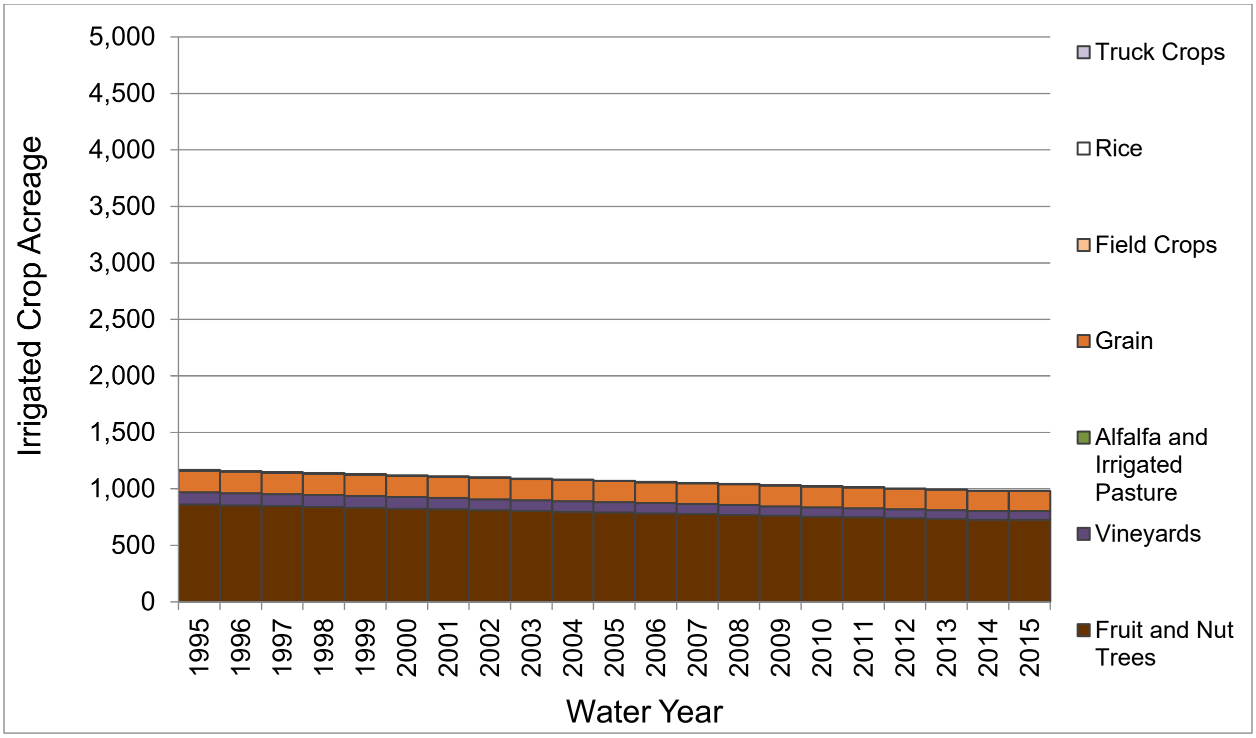


Figure 9f: Irrigated Crop Acreages- Subregion 7 (Stockton East Subregion)

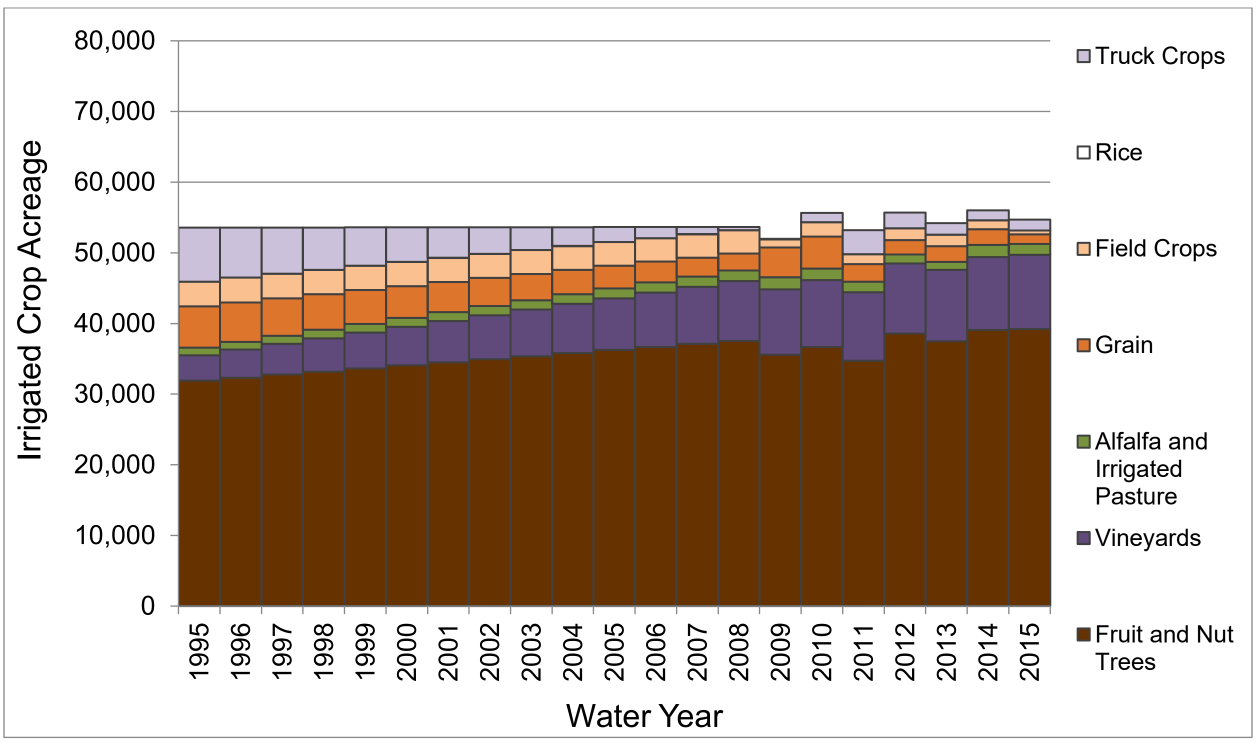


Figure 9g: Irrigated Crop Acreages- Subregion 8 (Central San Joaquin Subregion)

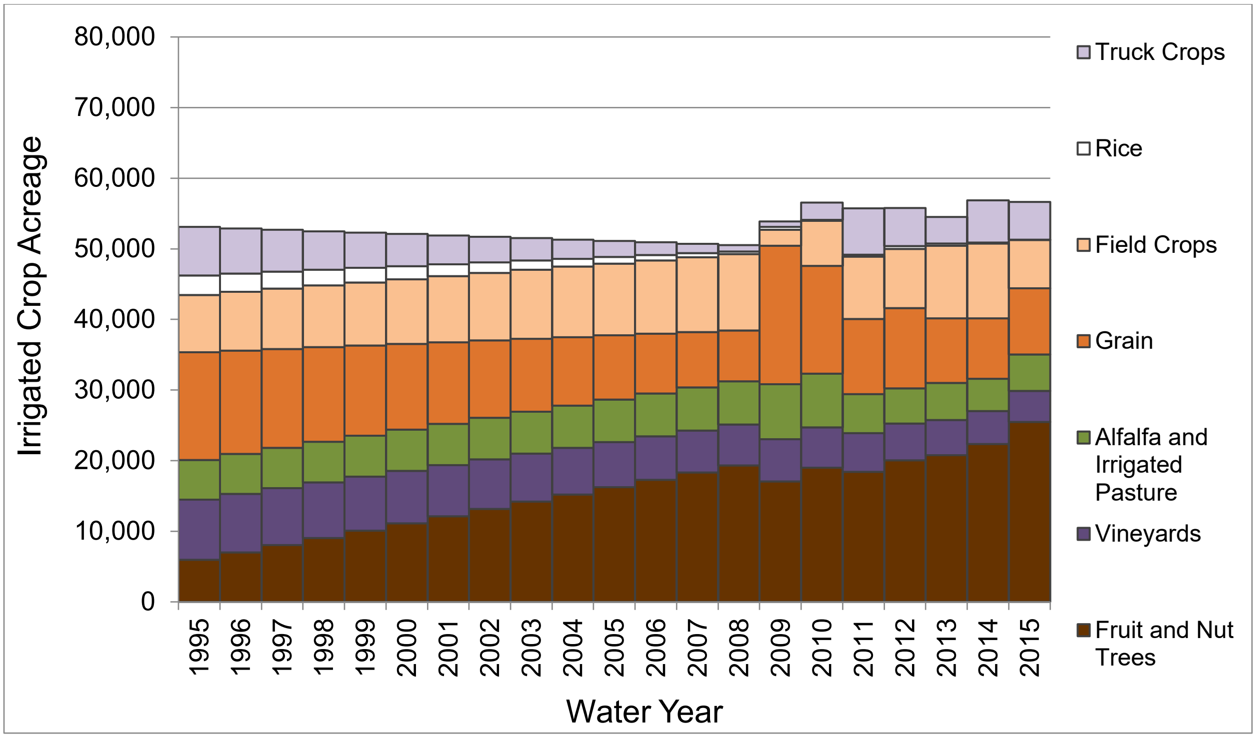


Figure 9h: Irrigated Crop Acreages- Subregion 11 (South San Joaquin East Subregion)

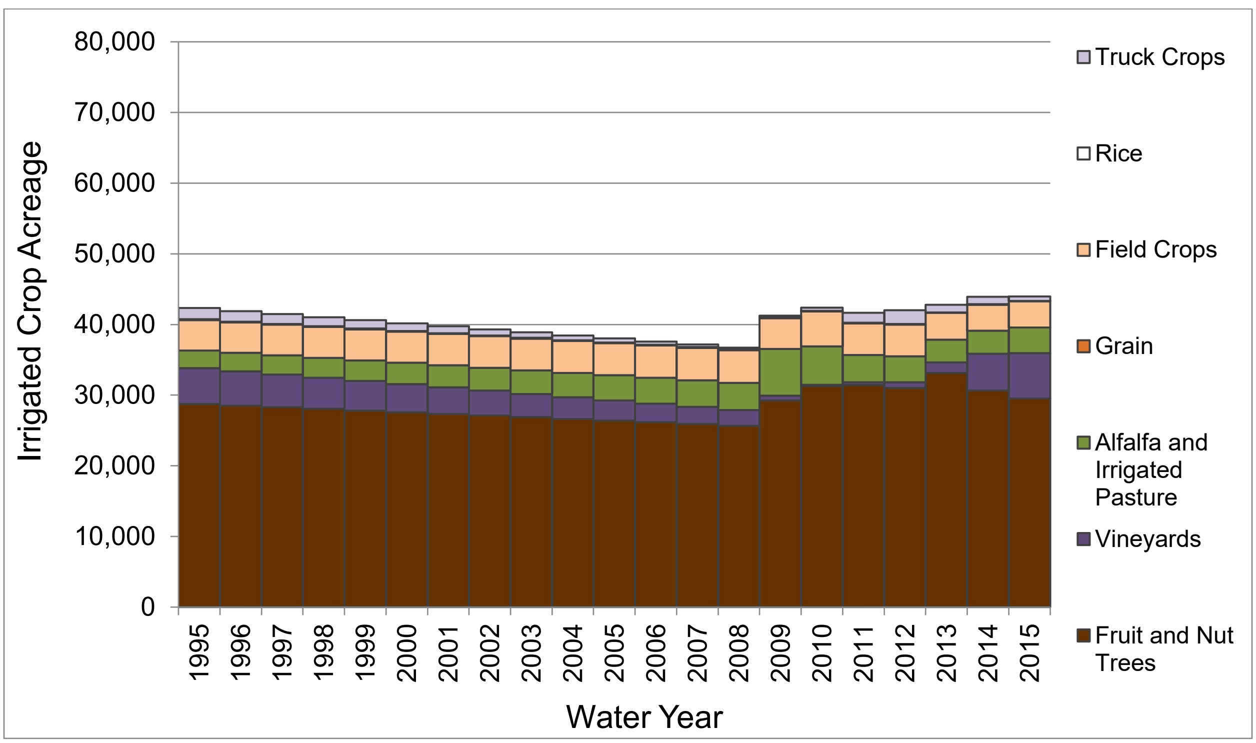


Figure 9i: Irrigated Crop Acreages- Subregion 13 (Oakdale West Subregion)

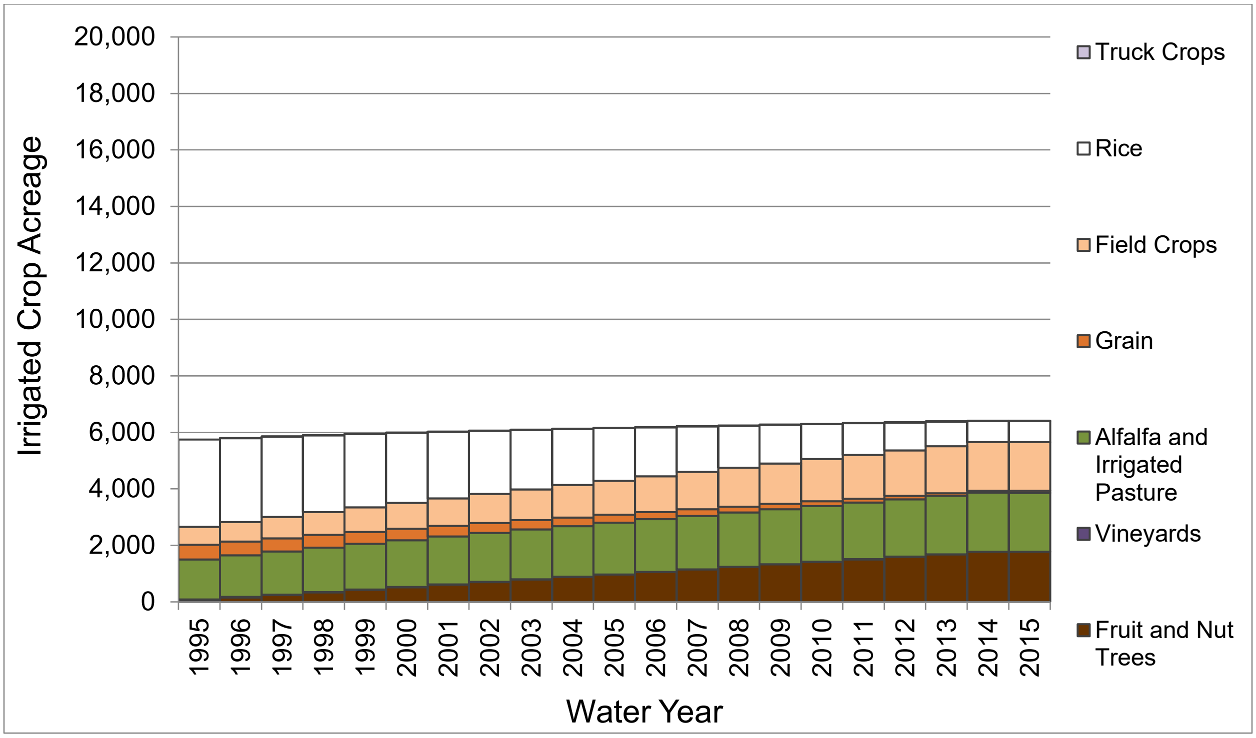


Figure 9j: Irrigated Crop Acreages- Subregion 14 (South Delta Subregion)

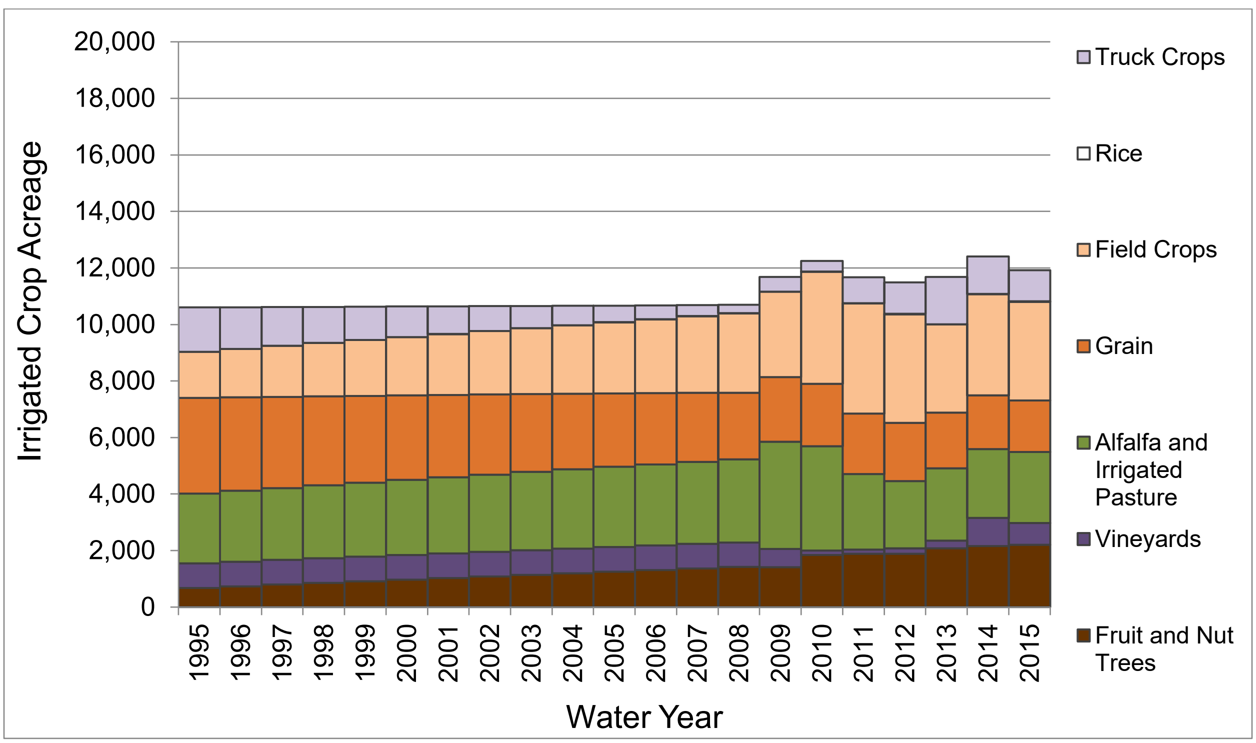


Figure 9k: Irrigated Crop Acreages- Subregion 15 (South San Joaquin West Subregion)

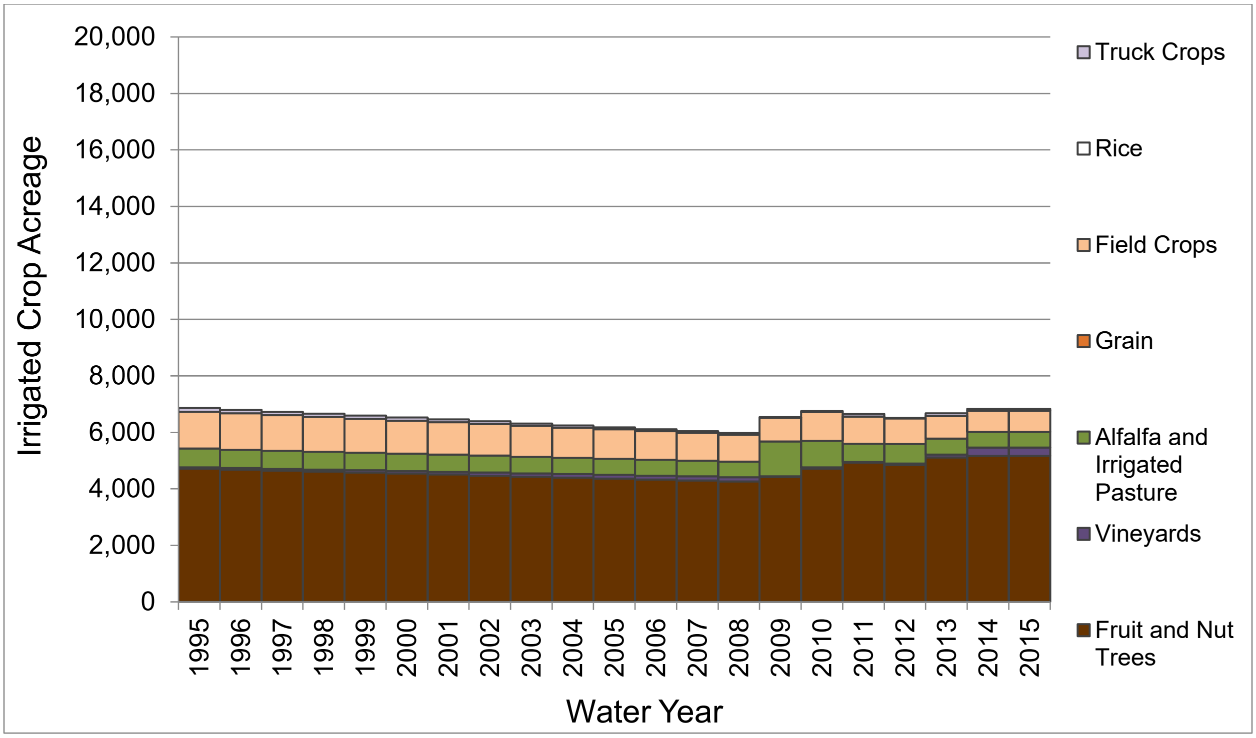


Figure 9l: Irrigated Crop Acreages- Subregion 17 (Stanislaus Subregion)

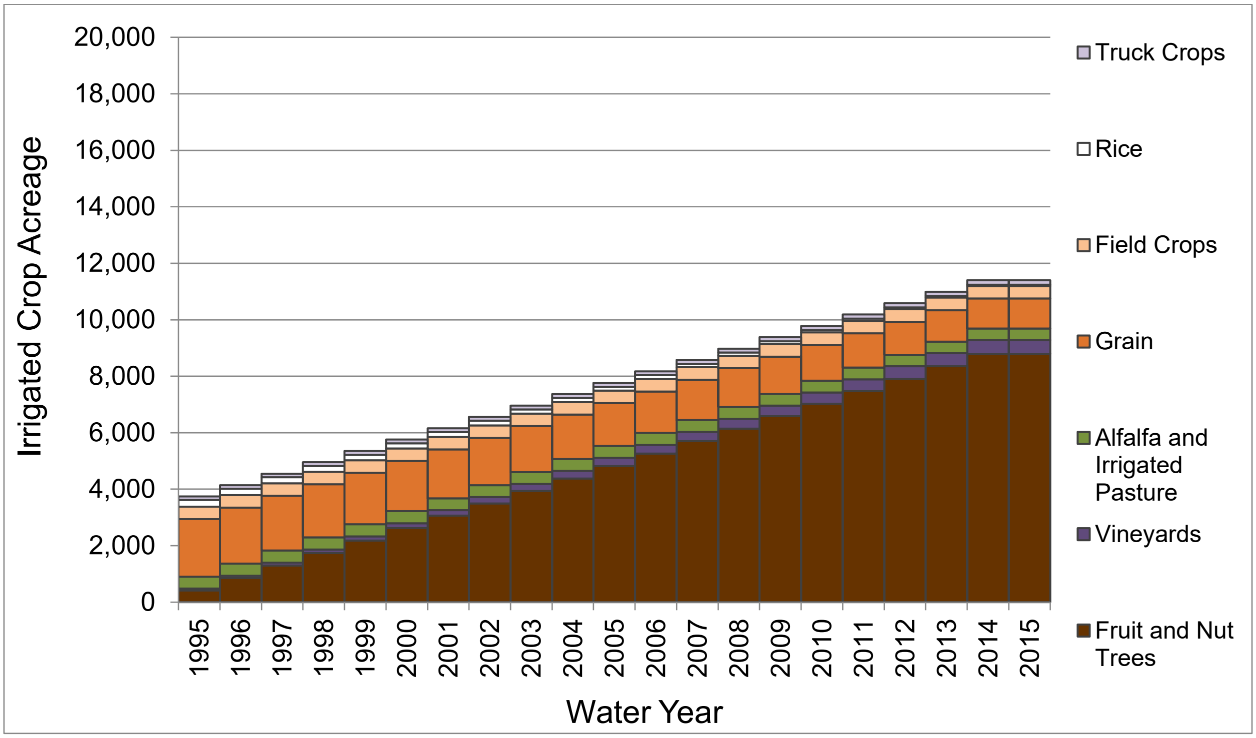


Figure 9m: Irrigated Crop Acreages- Subregion 18 (Oakdale East Subregion)

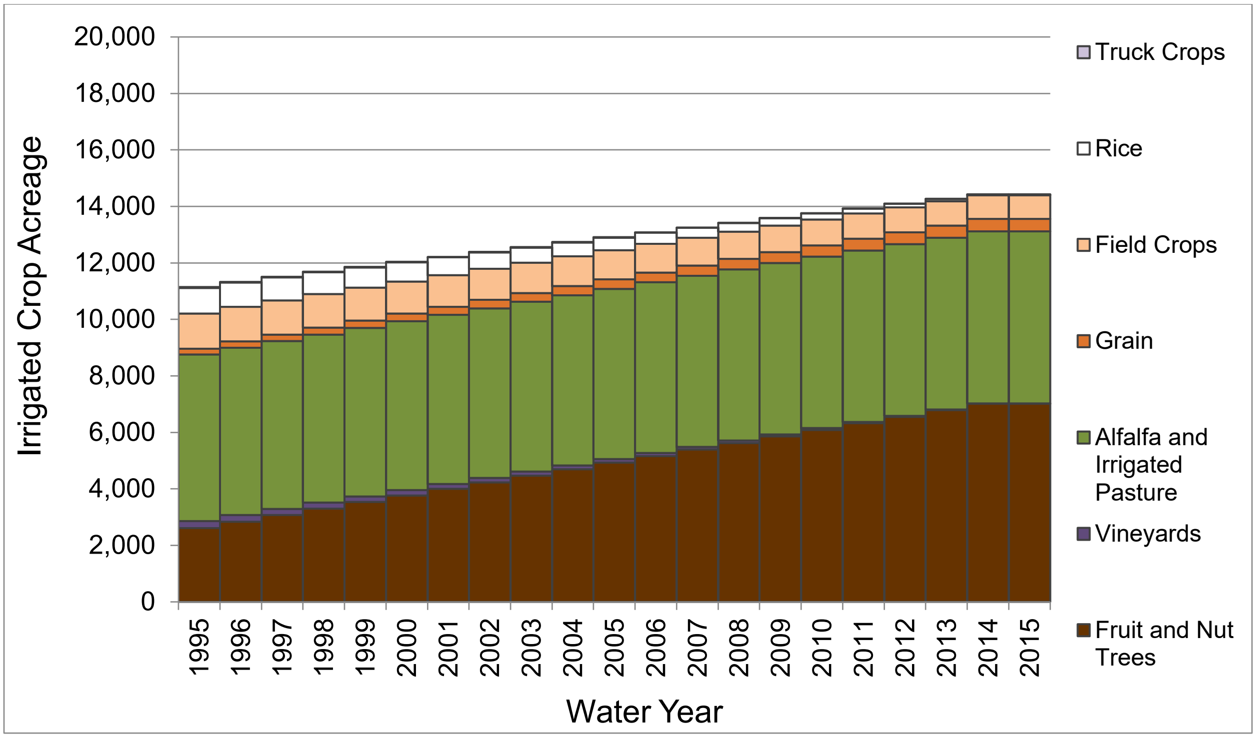


Figure 10: Urban Population Centers in Eastern San Joaquin Subbasin

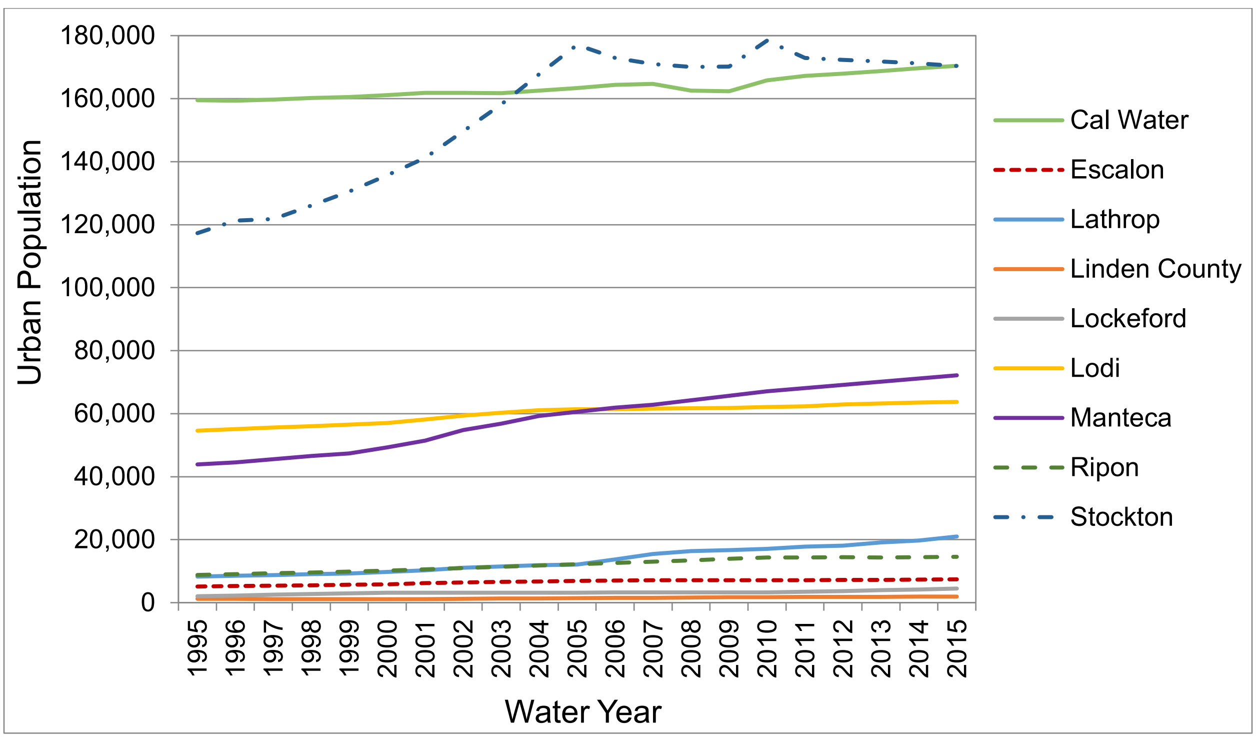


Figure 11: Urban Per Capita Water Use in Eastern San Joaquin Subbasin

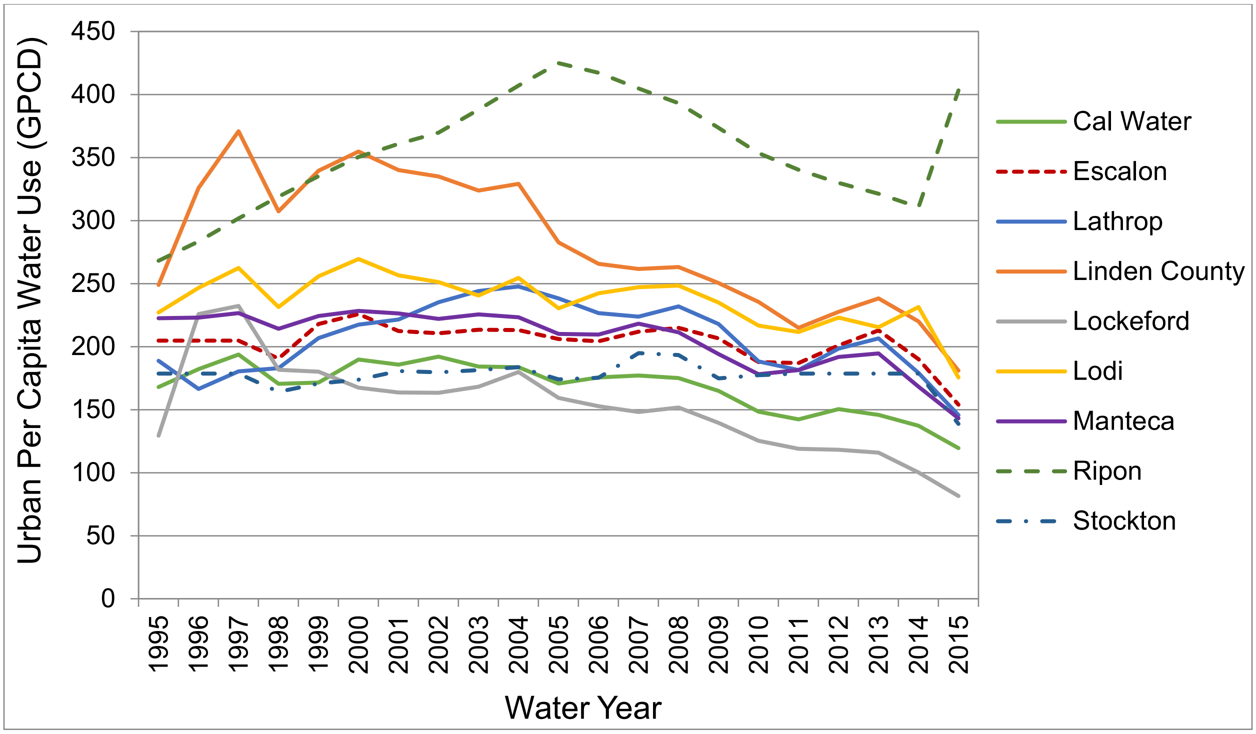


Figure 12a: Urban Demand- Eastern San Joaquin Subbasin

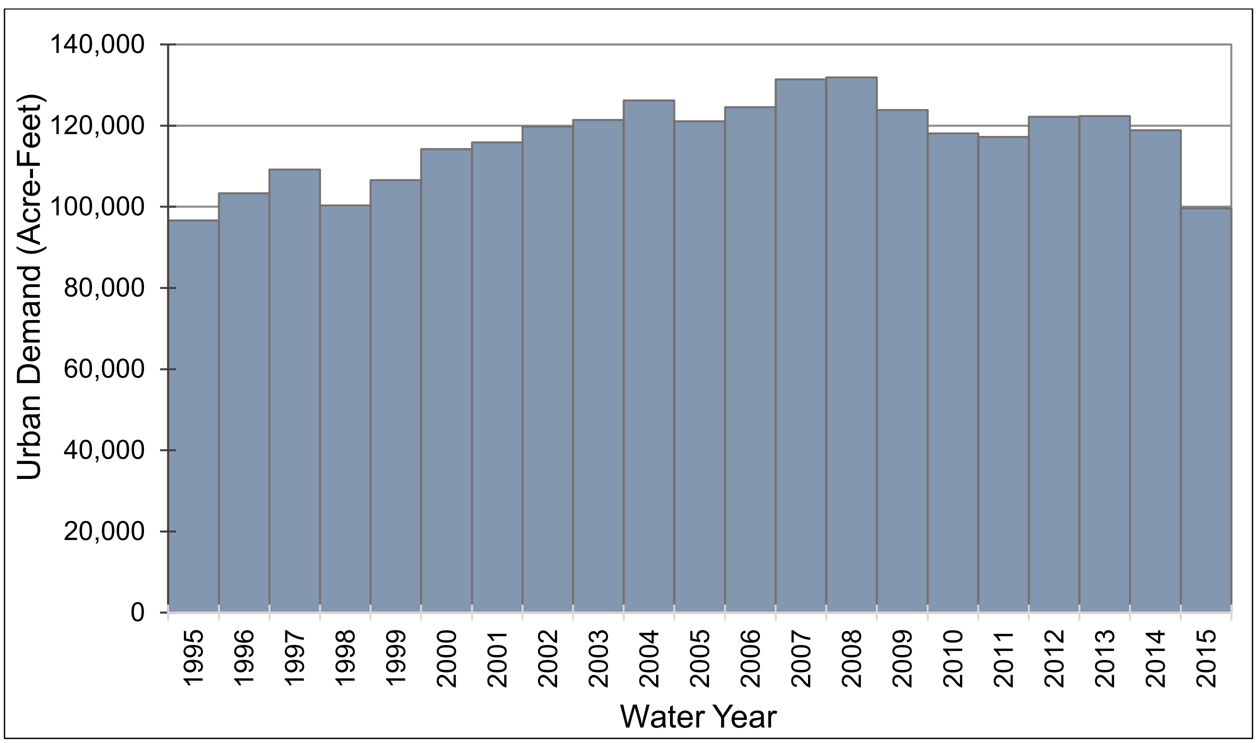


Figure 12b: Urban Demand- Subregion 3 (Lodi Subregion)

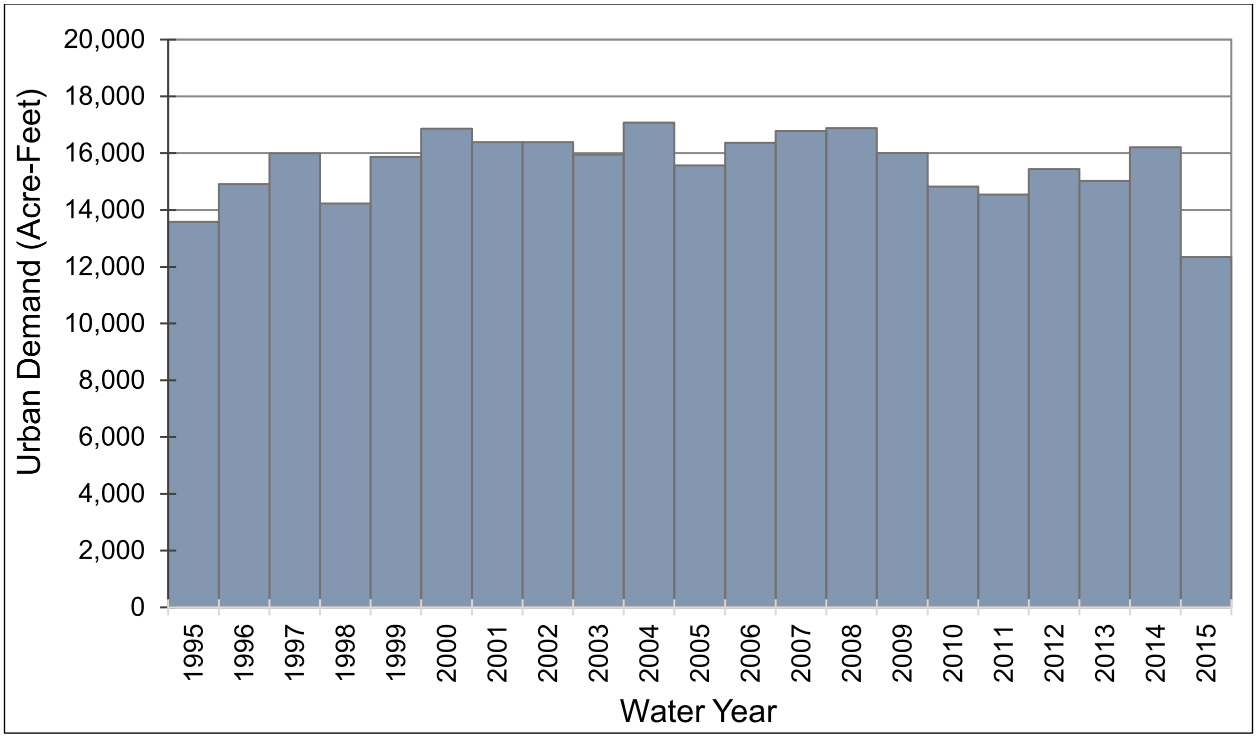


Figure 12c: Urban Demand- Subregion 6 (Stockton Subregion)

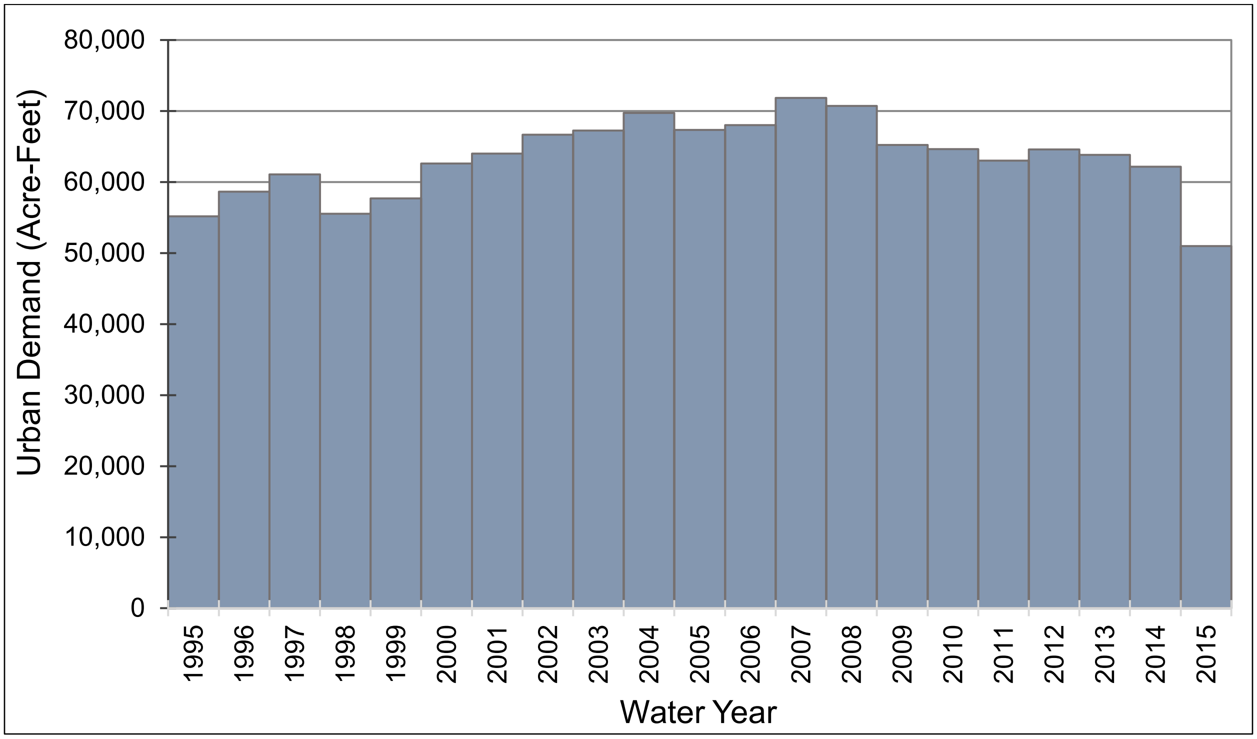


Figure 12d: Urban Demand- Subregion 9 (Lathrop Subregion)

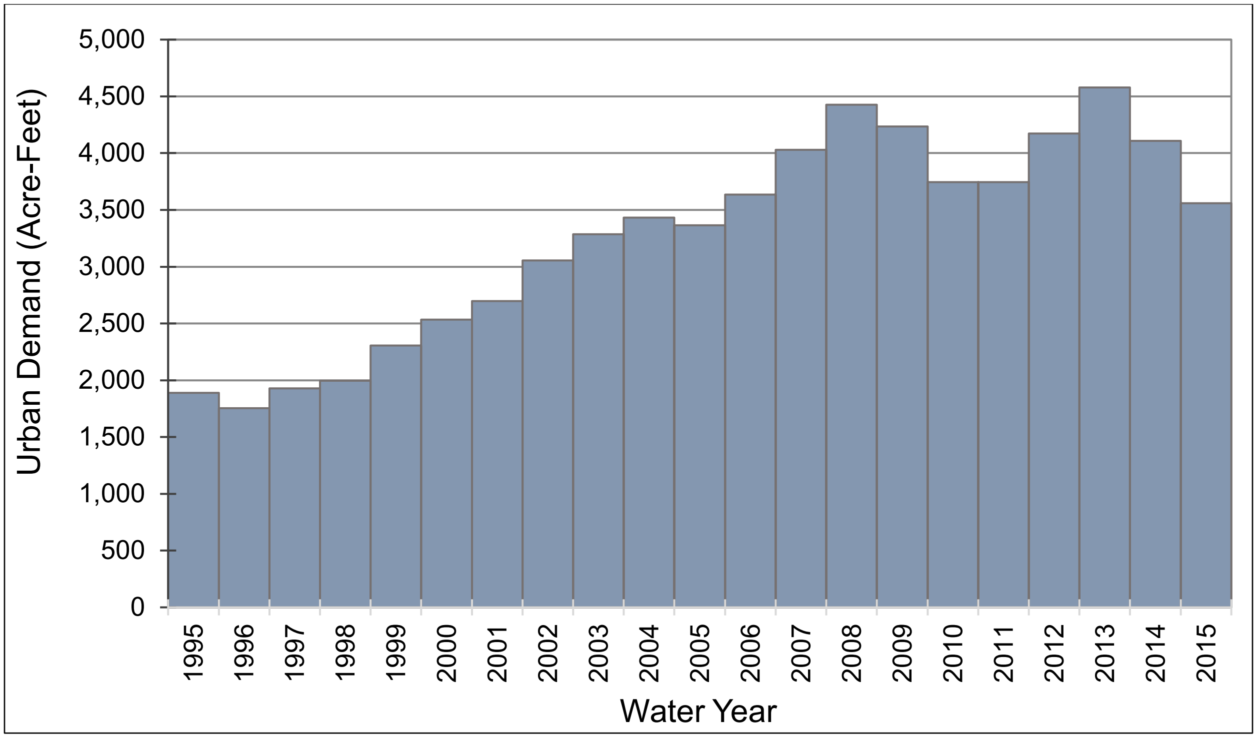


Figure 12e: Urban Demand- Subregion 10 (Manteca Subregion)

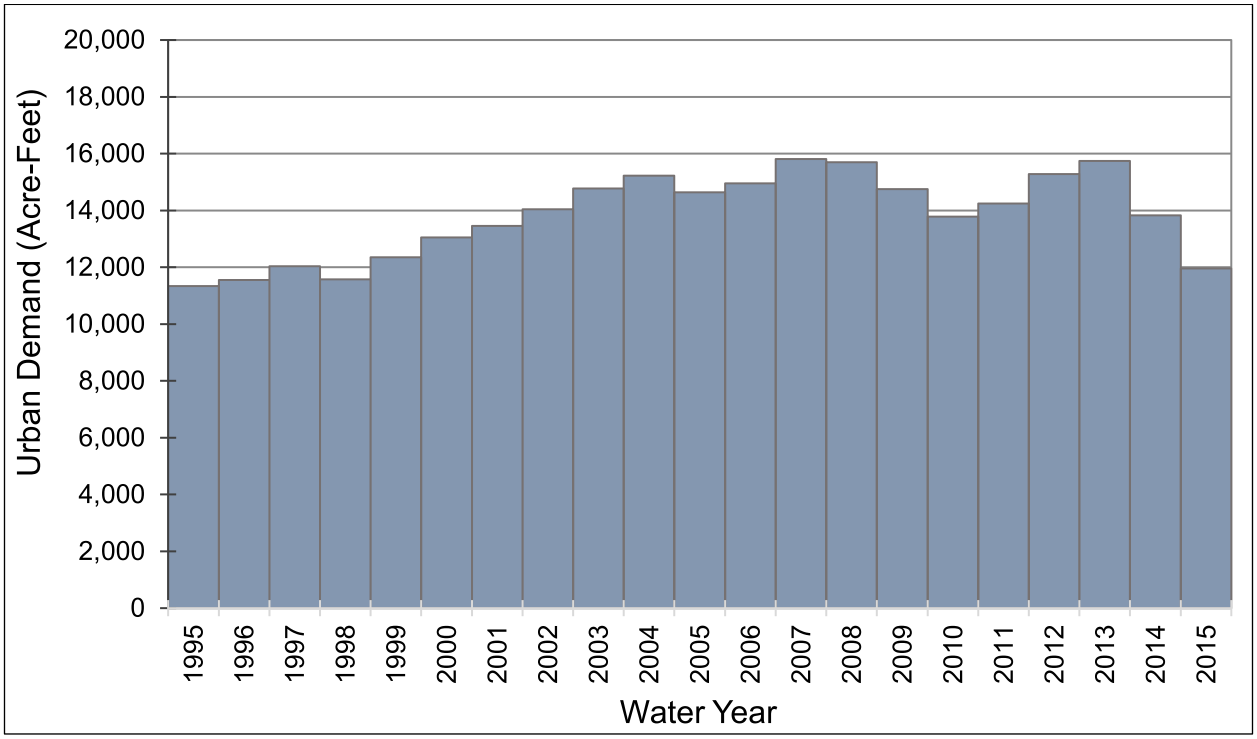


Figure 12f: Urban Demand- Subregion 12 (Escalon Subregion)

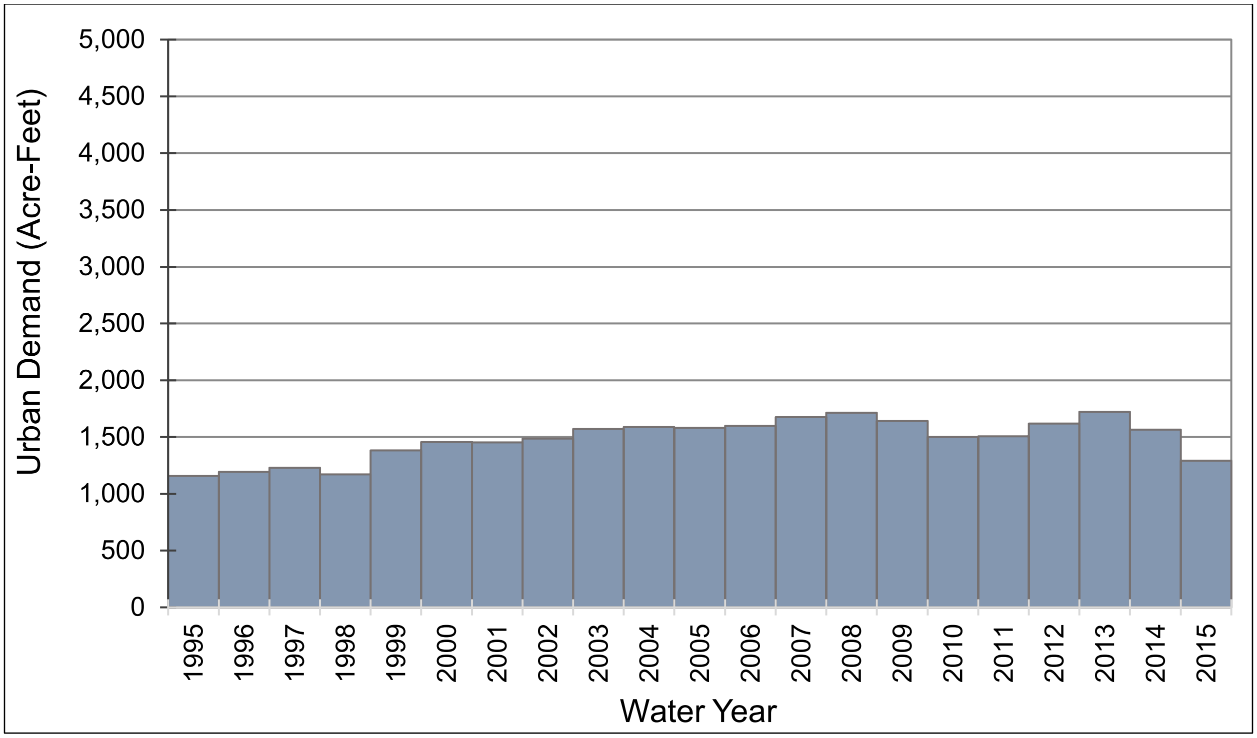


Figure 12g: Urban Demand- Subregion 16 (Ripon Subregion)

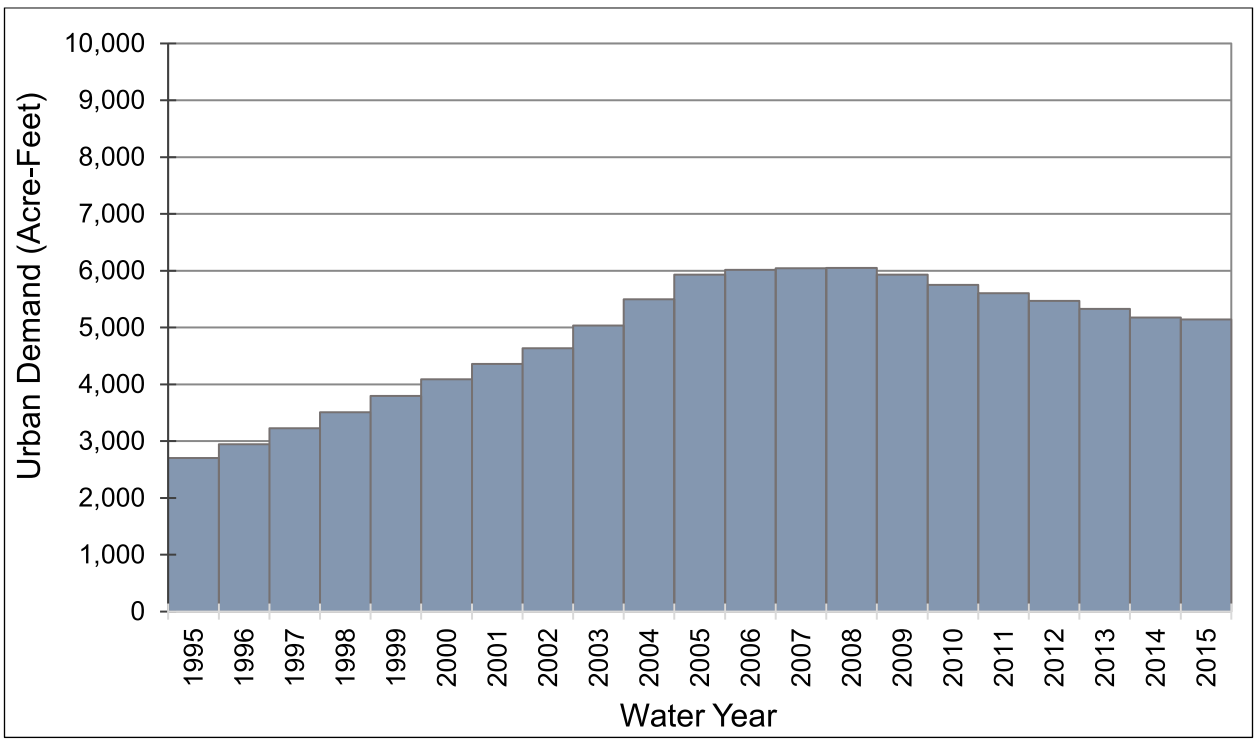


Figure 13: Annual Crop Evapotranspiration

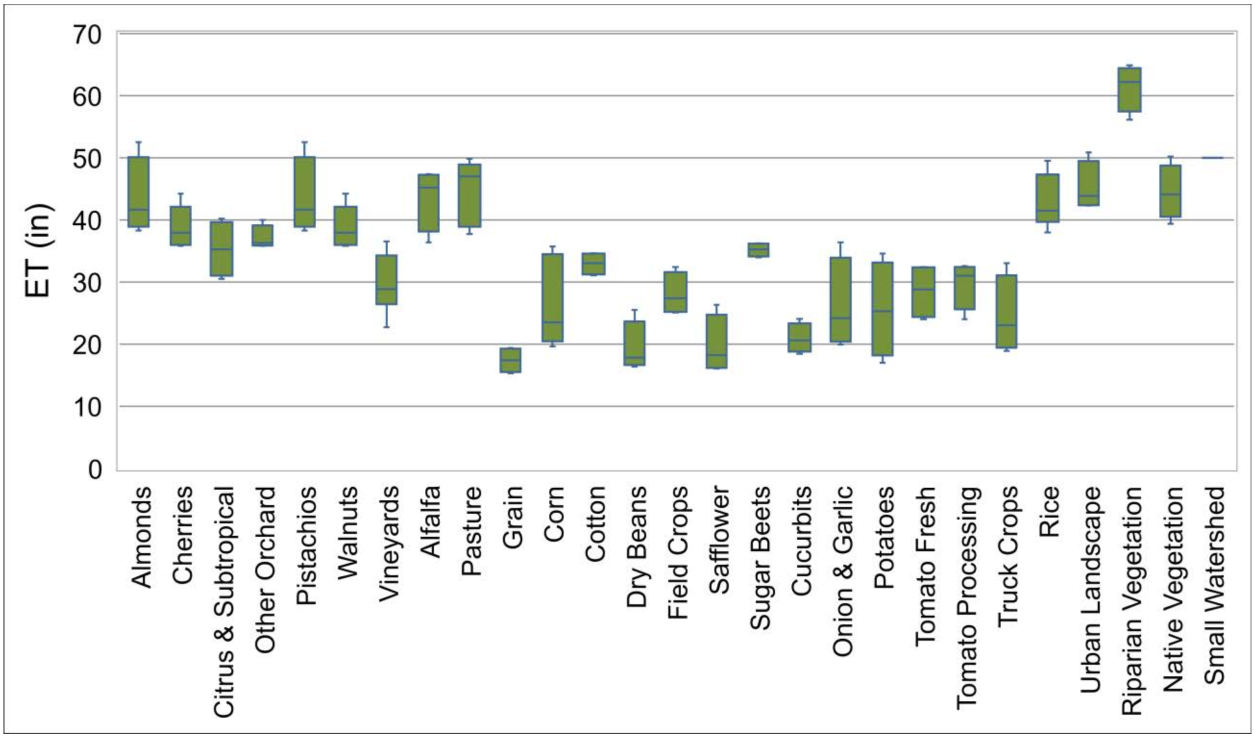


Figure 14: Annual Precipitation

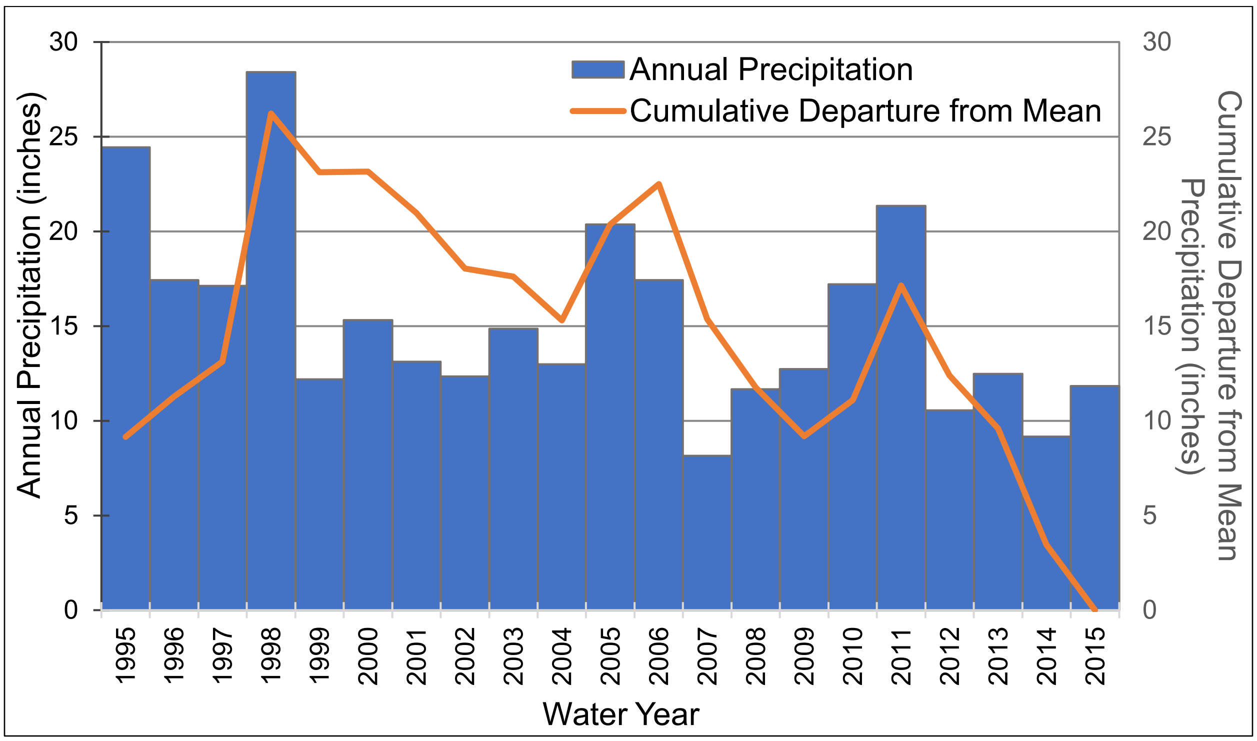


Figure 15a: Agricultural Demand- Eastern San Joaquin Subbasin

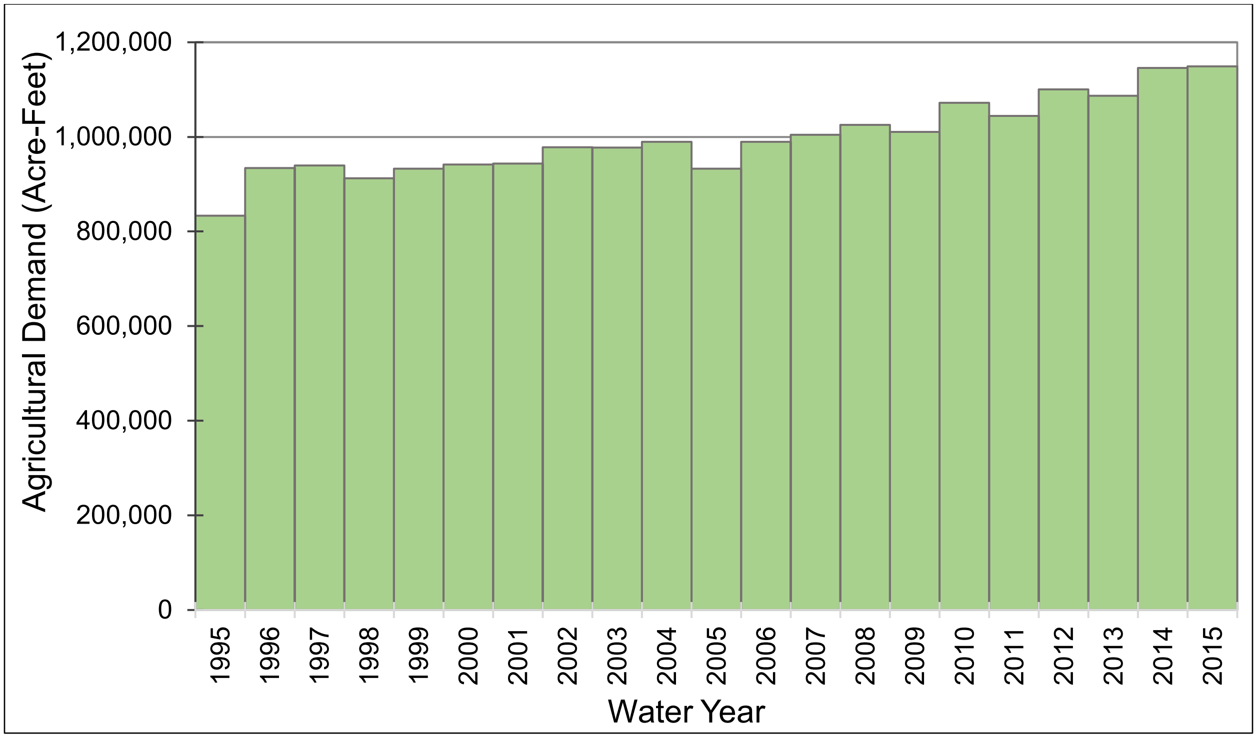


Figure 15b: Unit Agricultural Water Use and ETAW- Eastern San Joaquin Subbasin

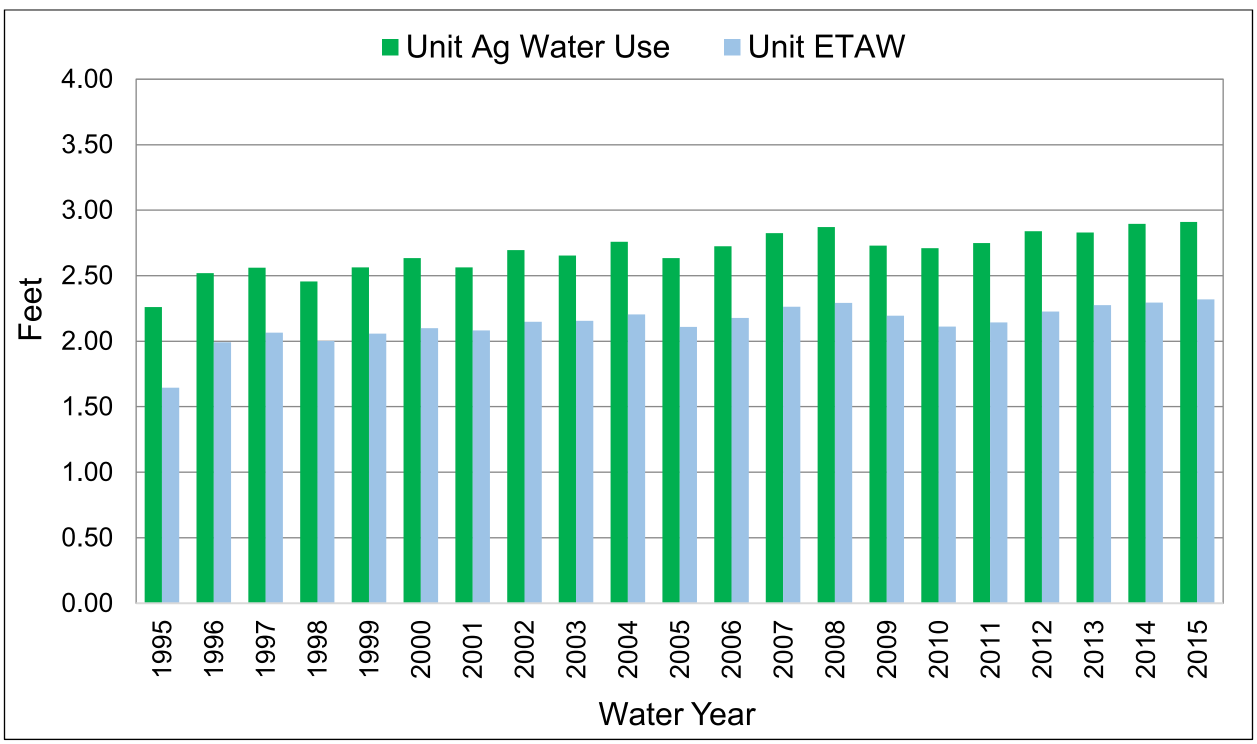


Figure 15c: Agricultural Demand- Subregion 2 (Woodbridge Subregion)

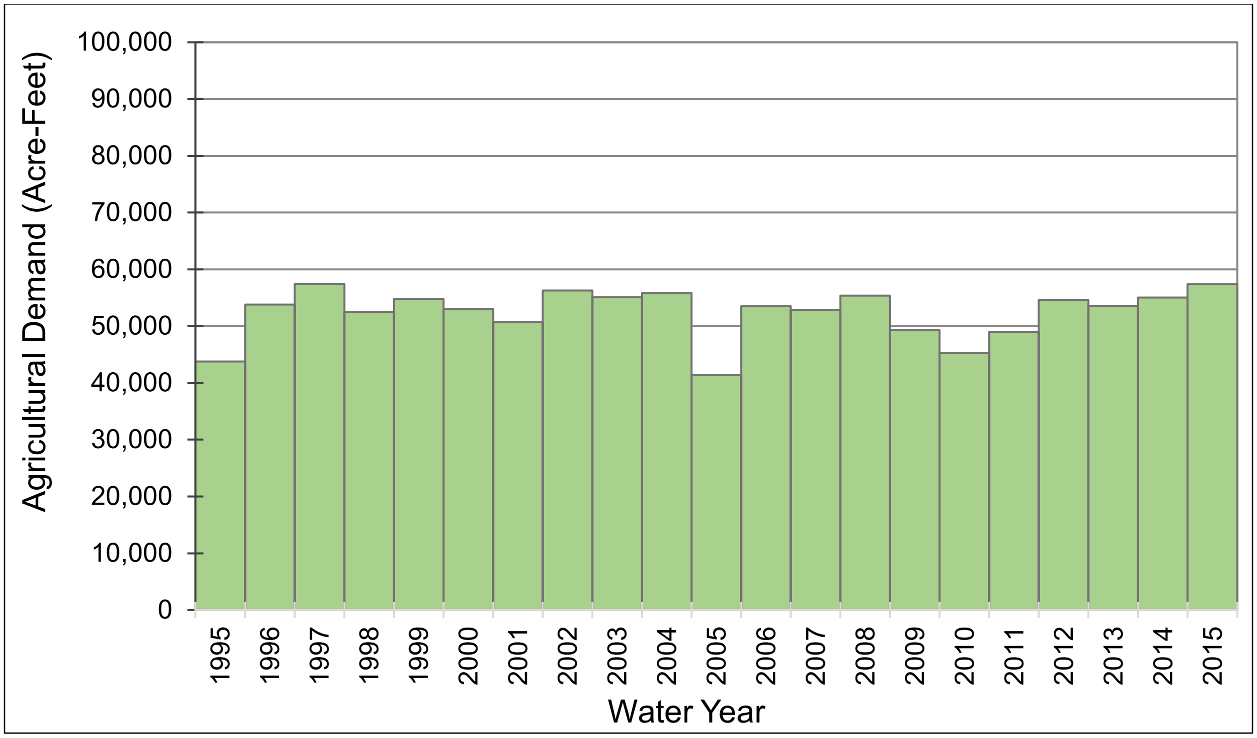


Figure 15d: Unit Agricultural Water Use and ETAW- Subregion 2 (Woodbridge Subregion)

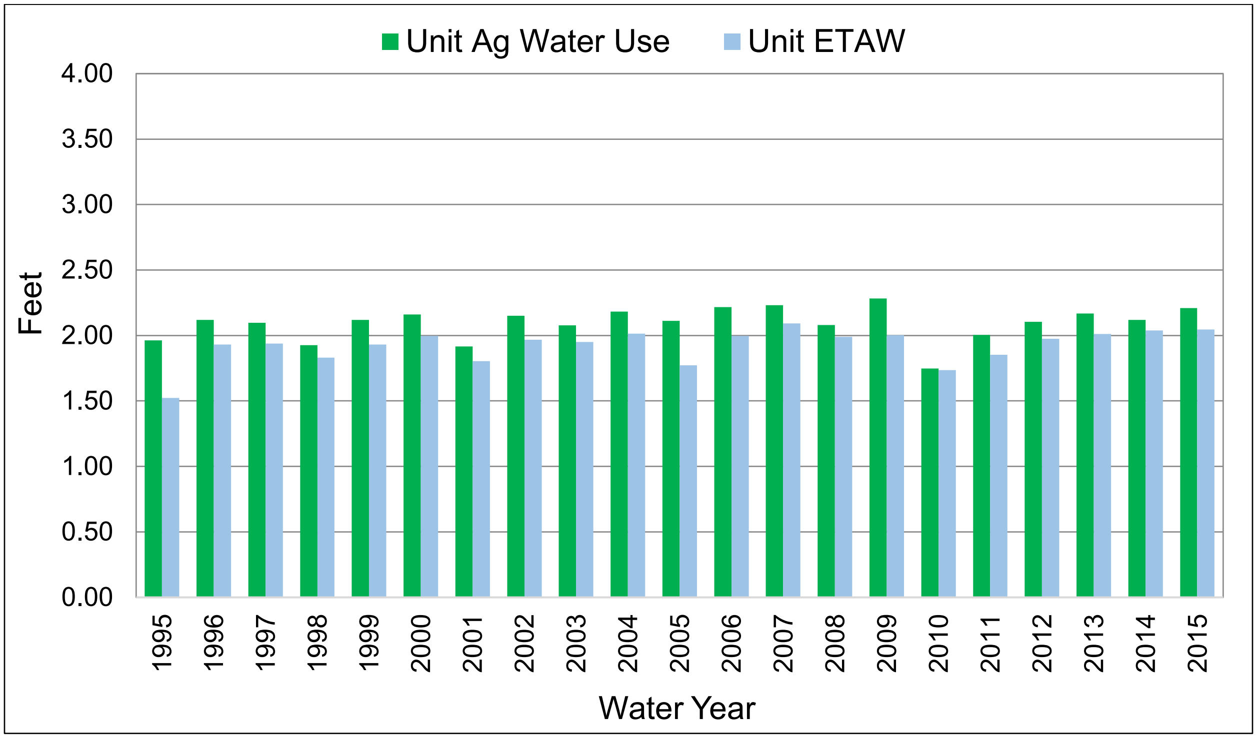


Figure 15e: Agricultural Demand- Subregion 4 (North San Joaquin Subregion)

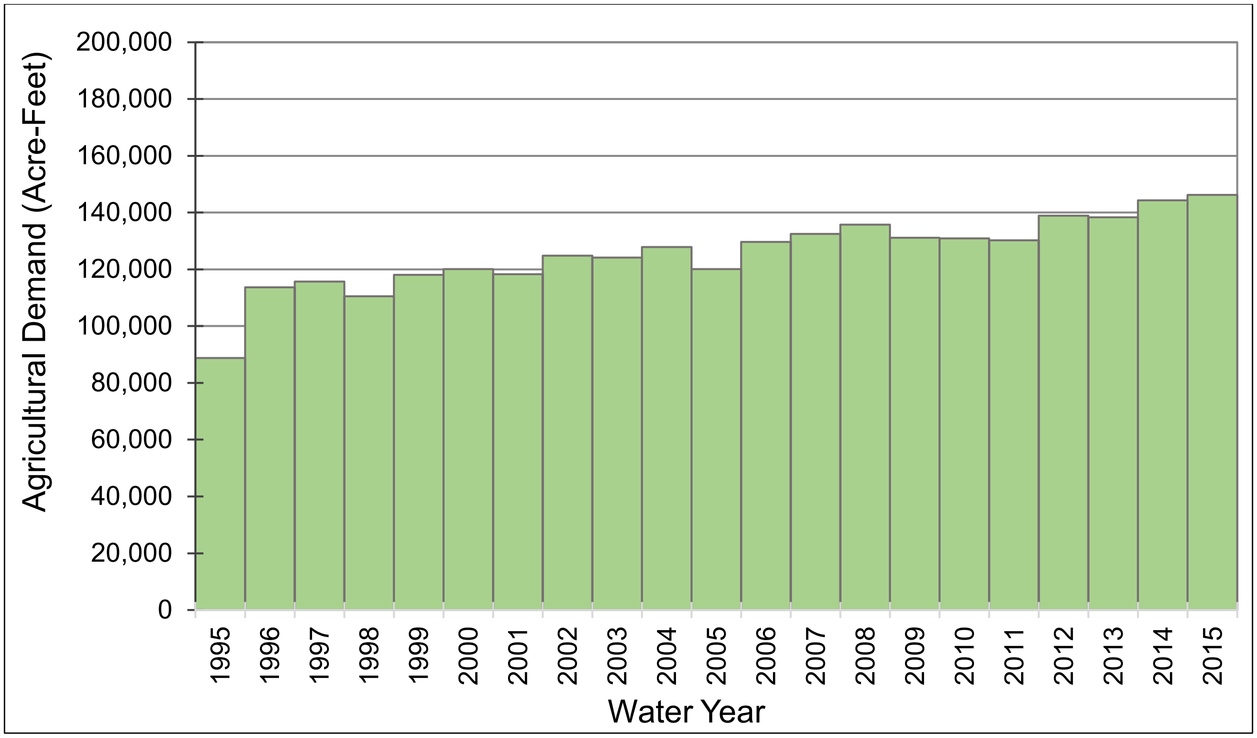


Figure 15f: Unit Agricultural Water Use and ETAW- Subregion 4 (North San Joaquin Subregion)

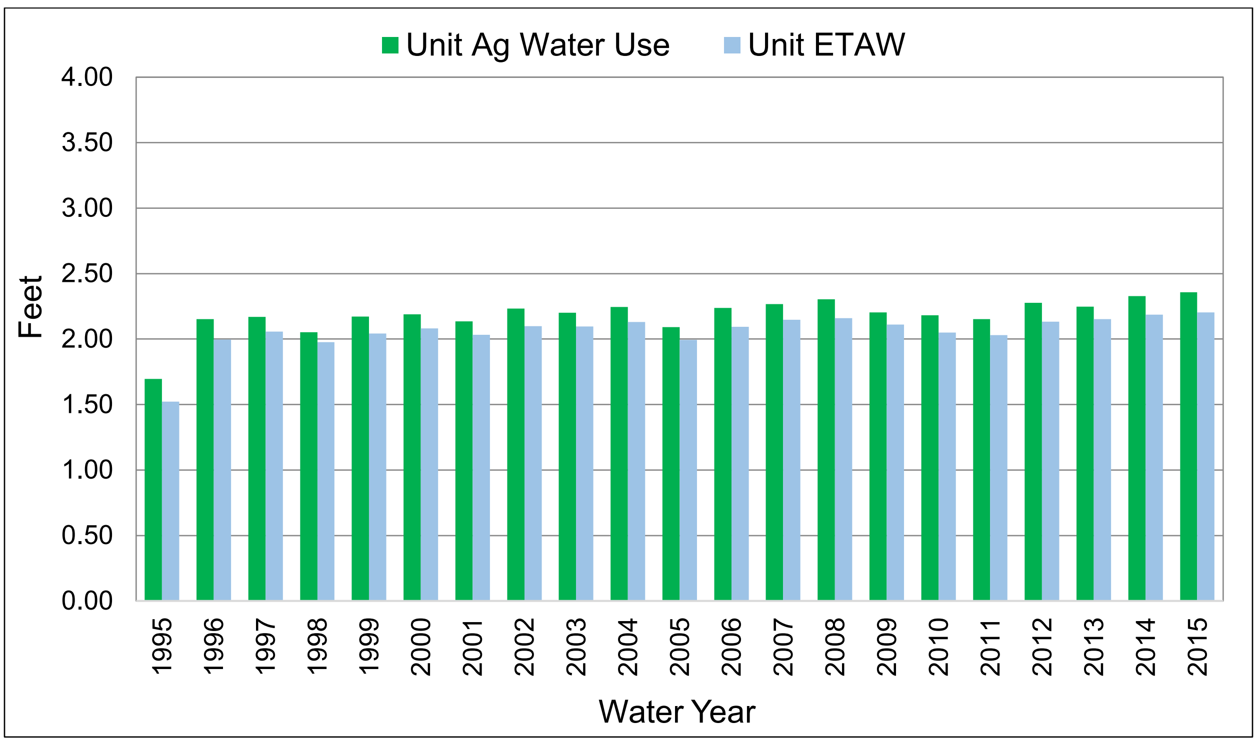


Figure 15g: Agricultural Demand- Subregion 7 (Stockton East Subregion)

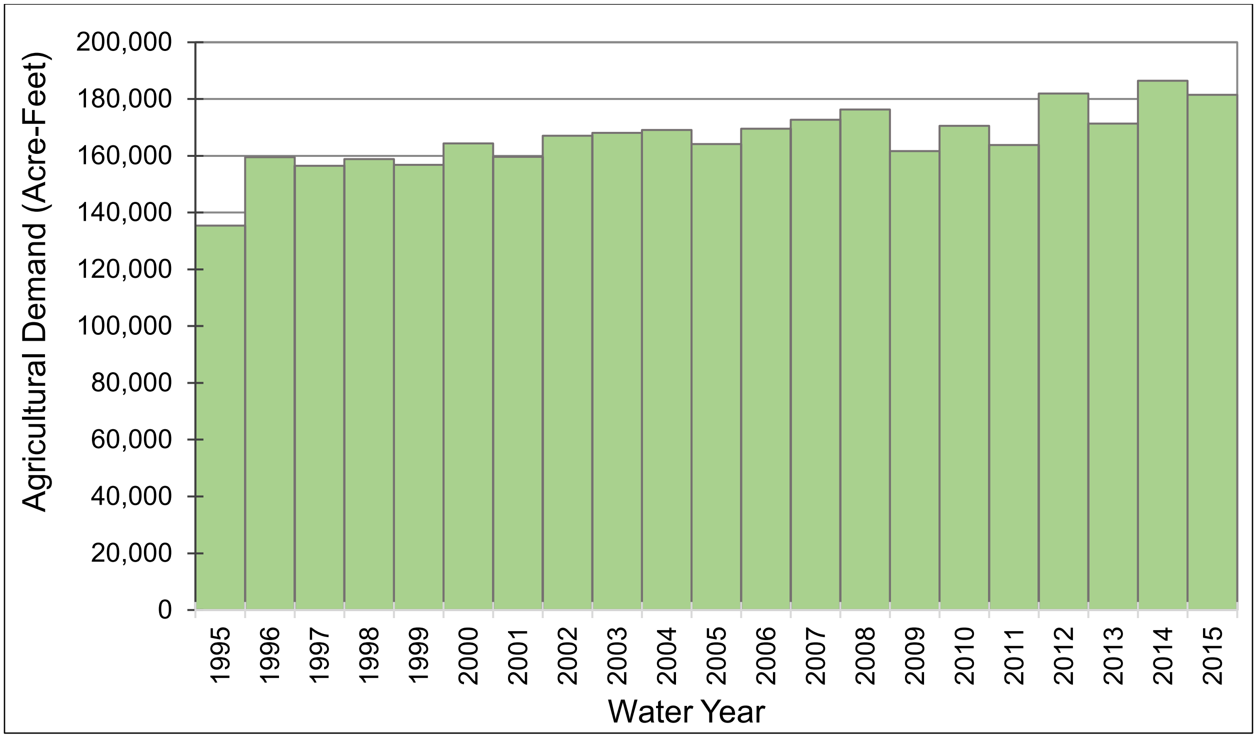


Figure 15h: Unit Agricultural Water Use and ETAW- Subregion 7 (Stockton East Subregion)

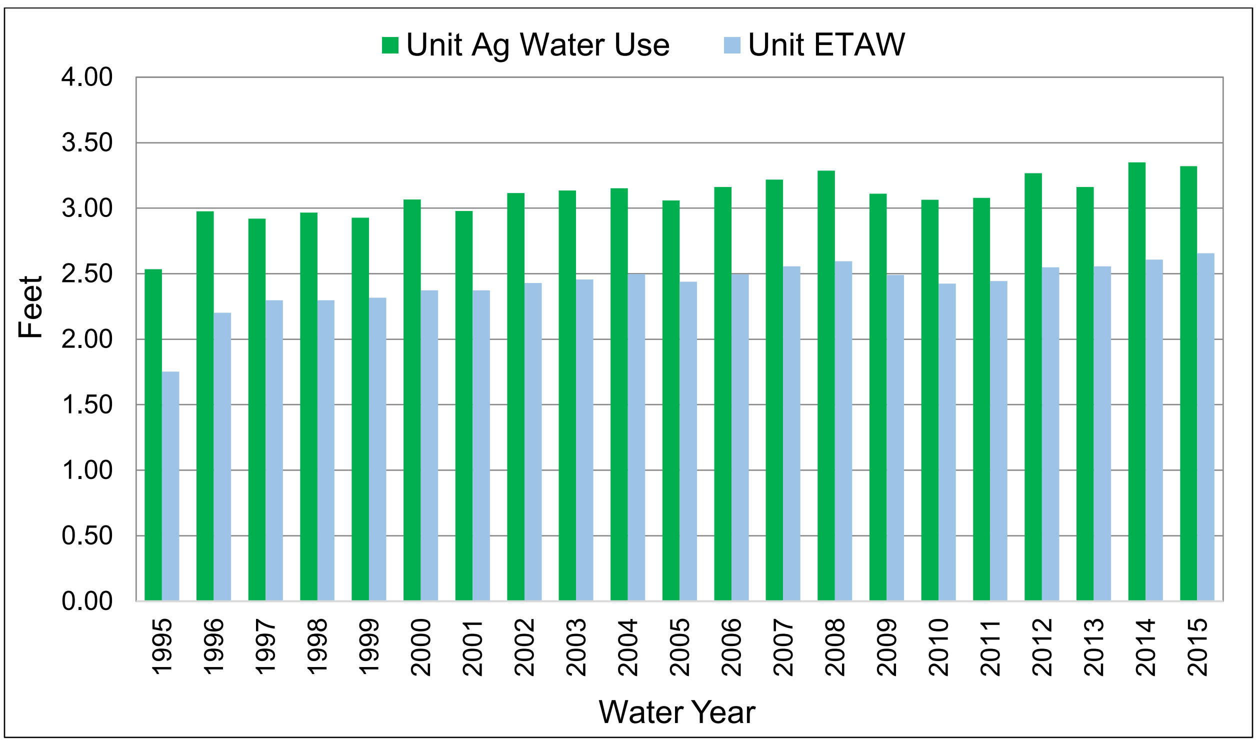


Figure 15i: Agricultural Demand- Subregion 11 (South San Joaquin East Subregion)

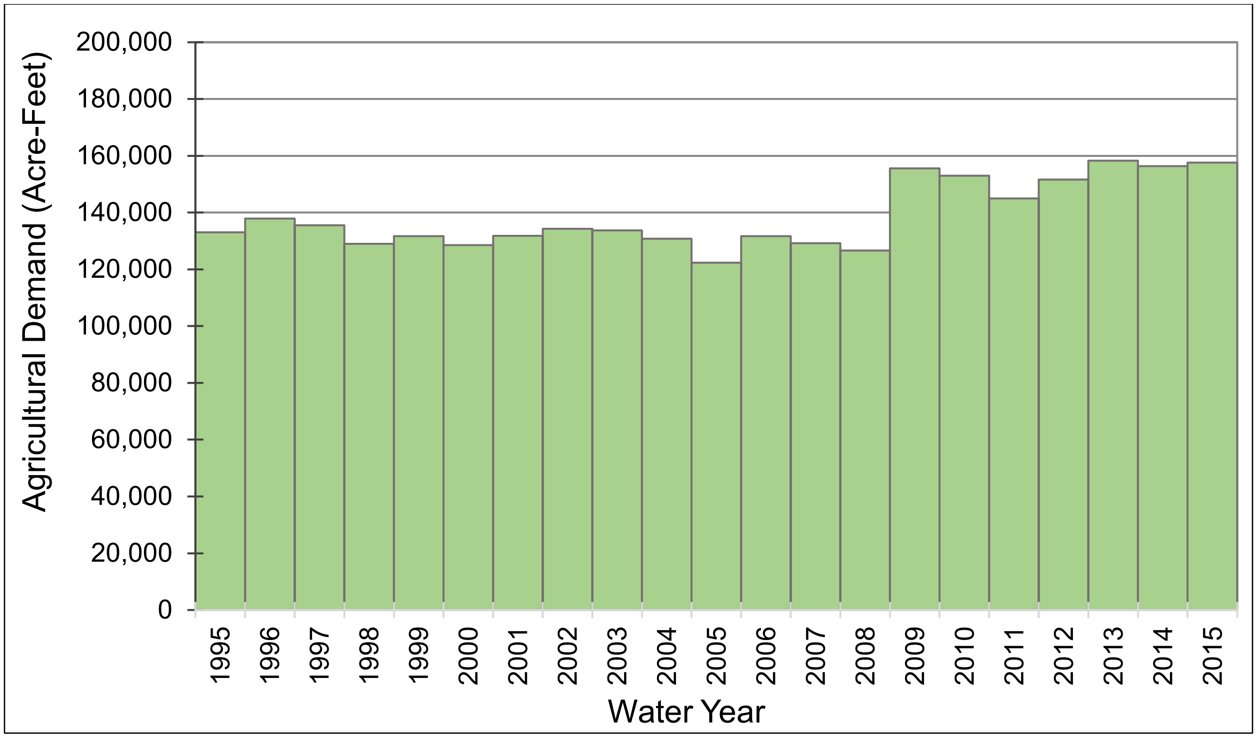


Figure 15j: Unit Agricultural Water Use and ETAW- Subregion 11 (South San Joaquin East Subregion)

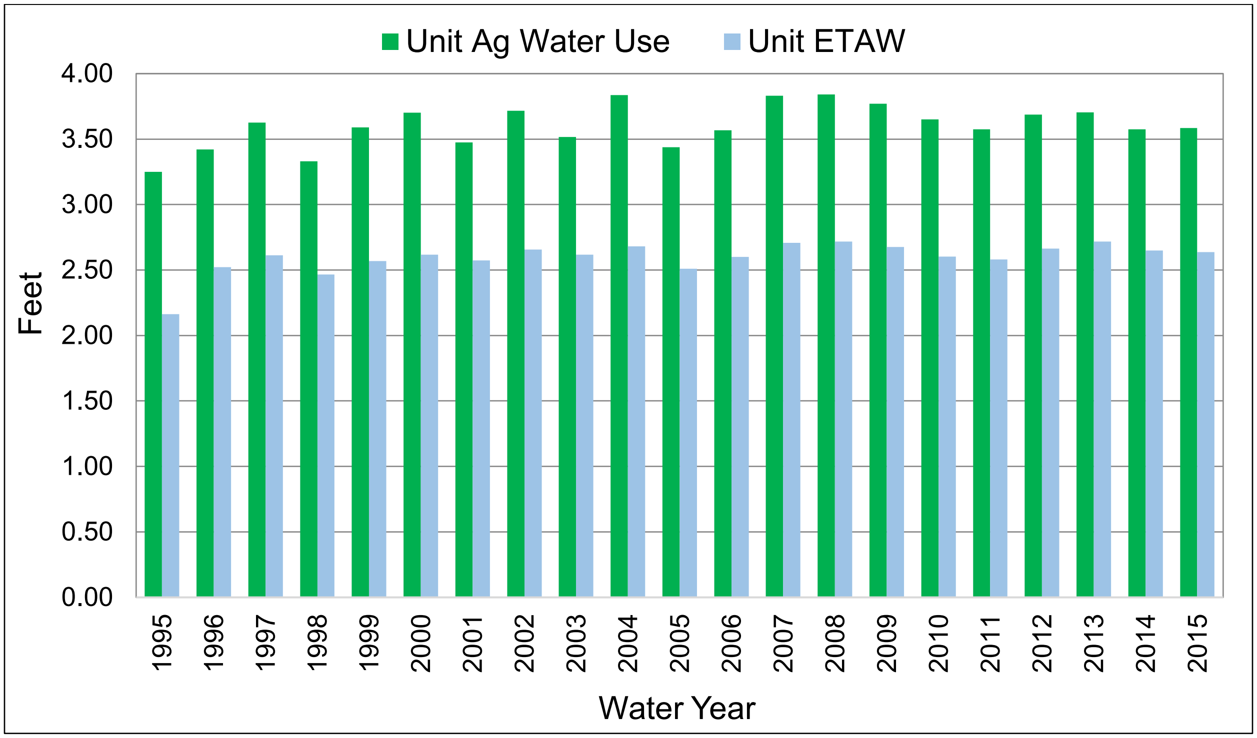


Figure 15k: Agricultural Demand- Subregion 13 (Oakdale West Subregion)

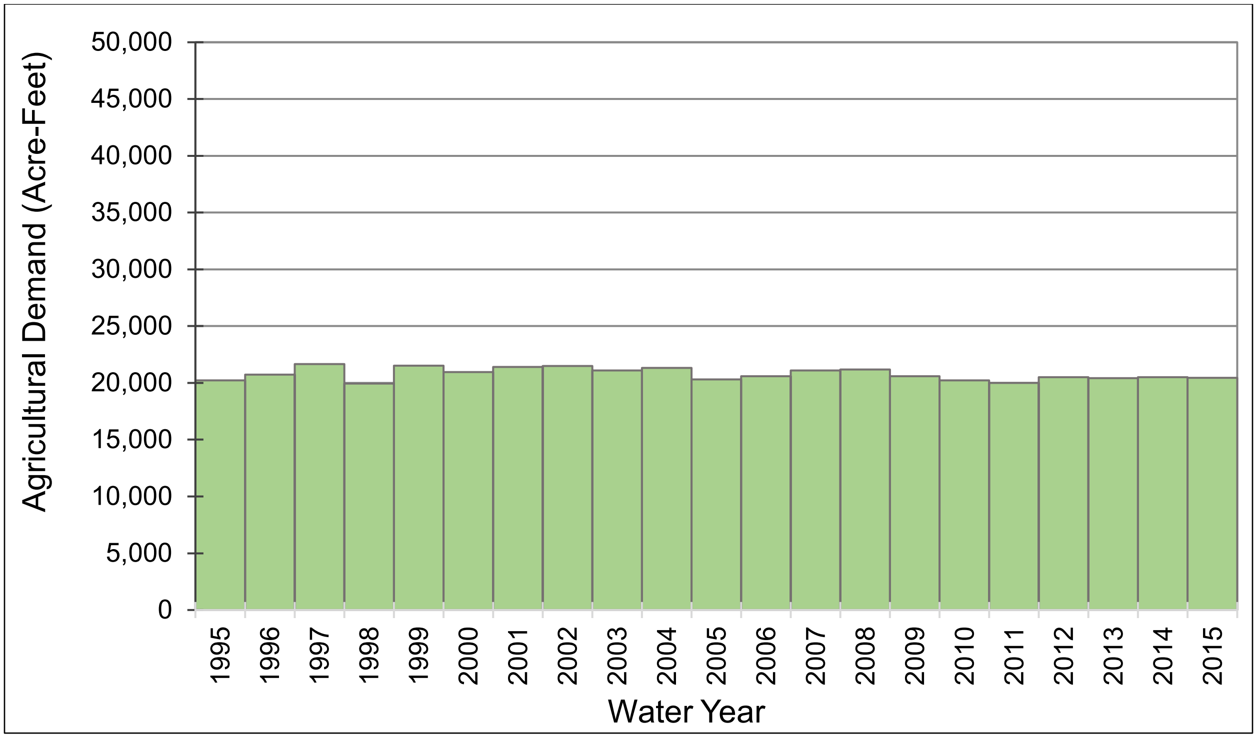


Figure 15l: Unit Agricultural Water Use and ETAW- Subregion 13 (Oakdale West Subregion)

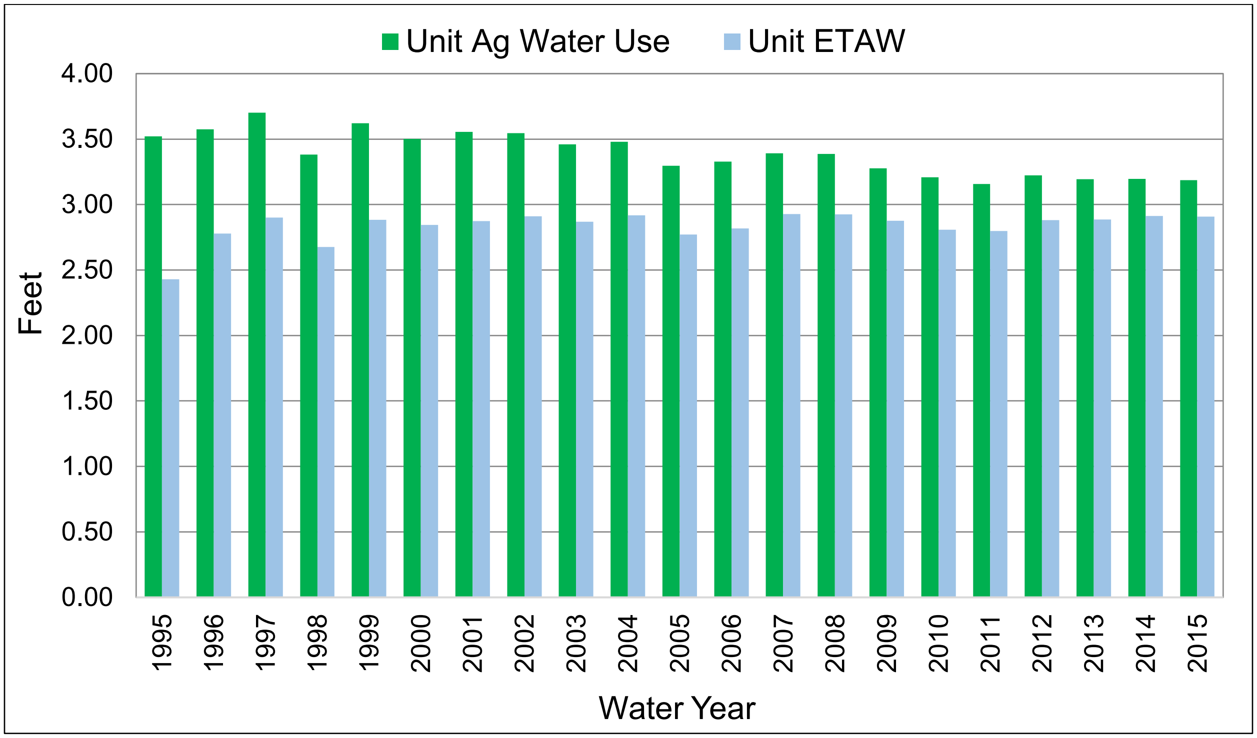


Figure 15m: Agricultural Demand- Subregion 18 (Oakdale East Subregion)

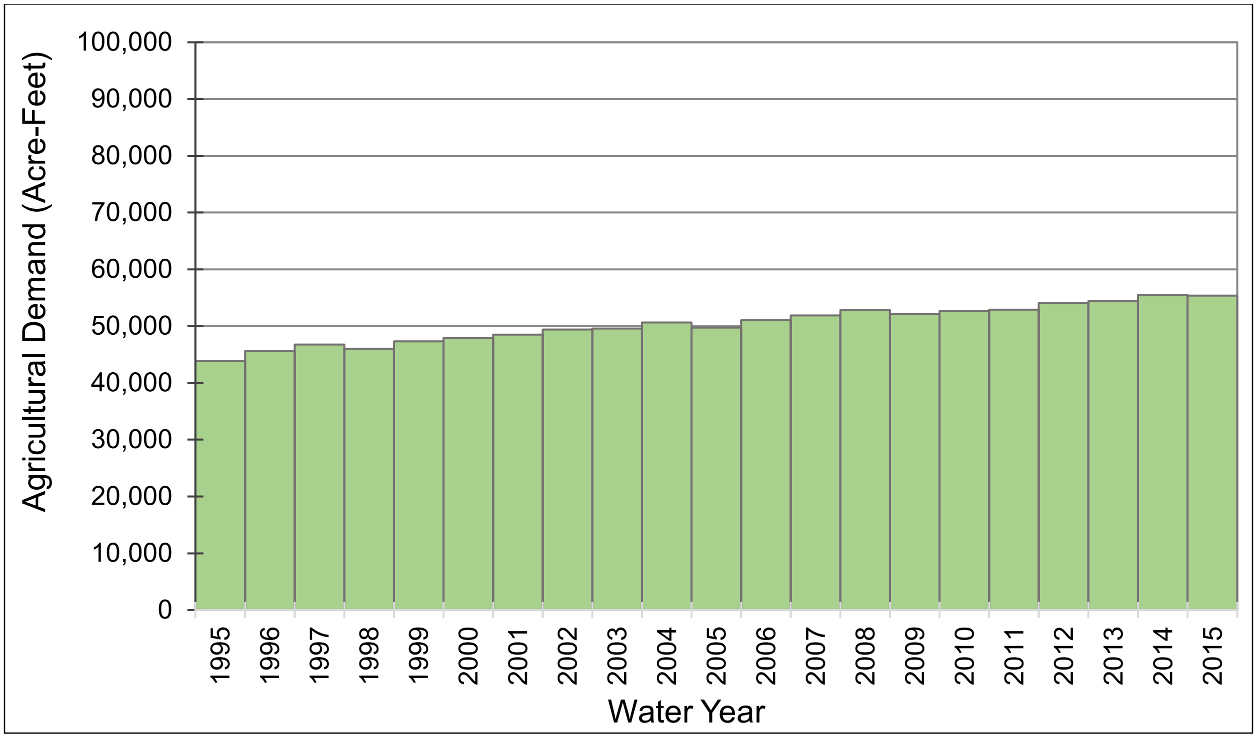
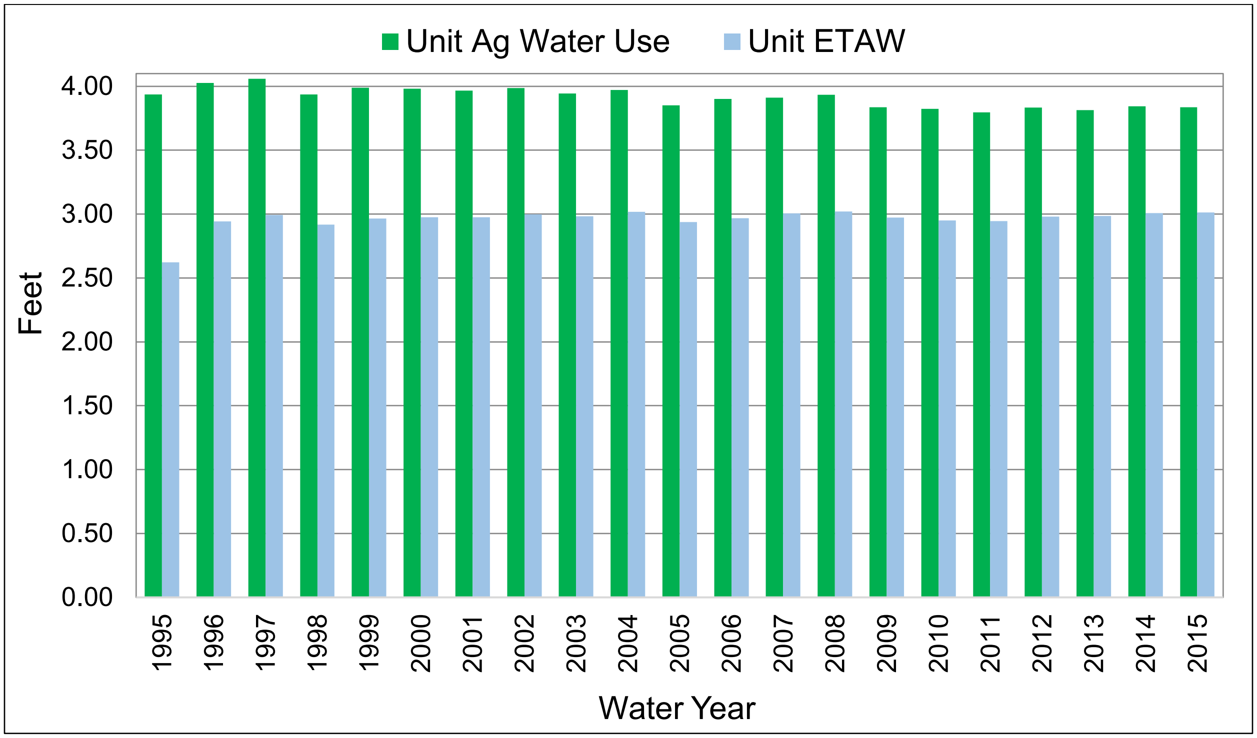


Figure 15n: Unit Agricultural Water Use and ETAW- Subregion 18 (Oakdale East Subregion)



APPENDIX C: ESJWRM CALIBRATION WELLS

Figure C-1: ESJWRM Groundwater Level Calibration Wells

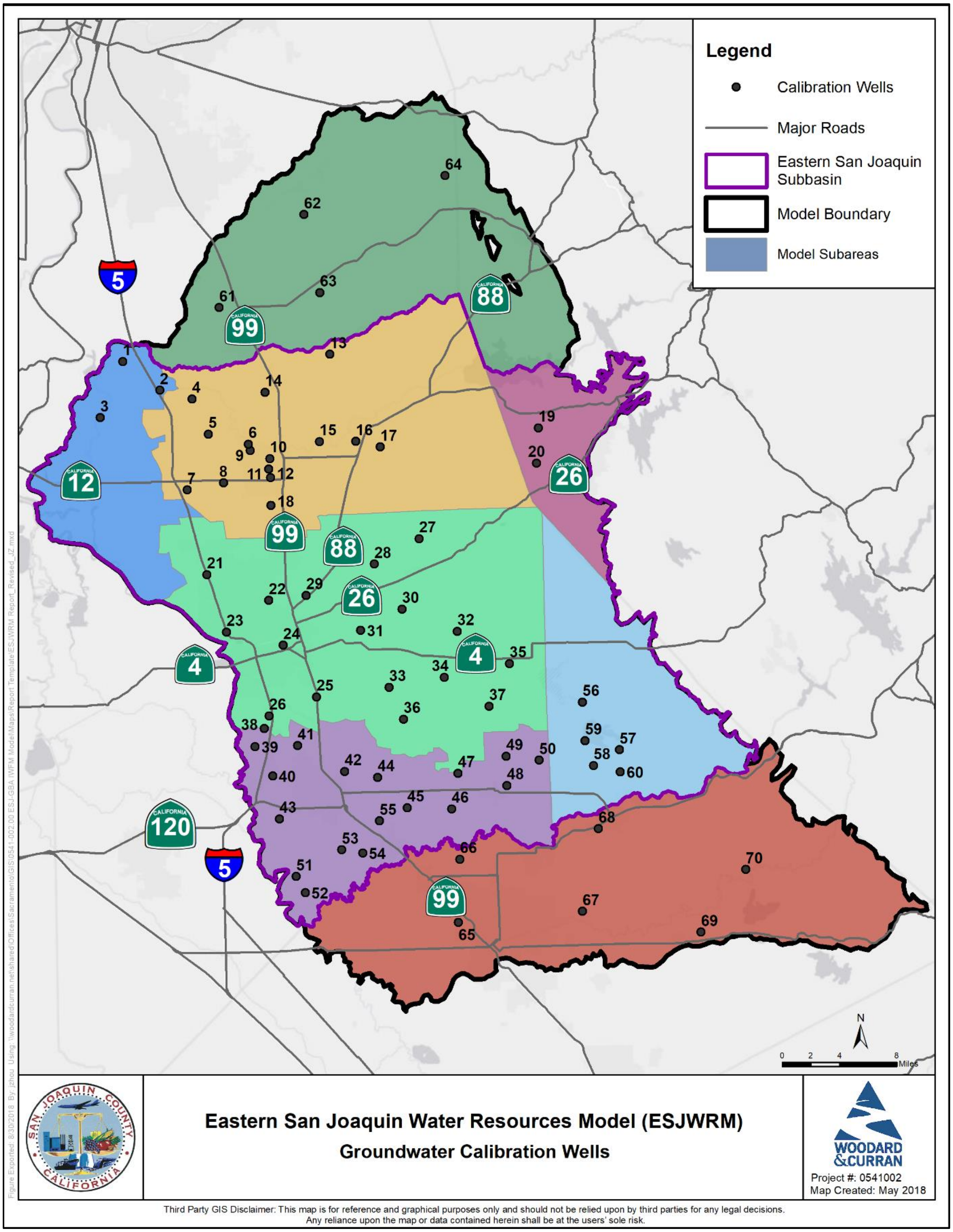


Table C-1: ESJWRM Groundwater Level Calibration Wells

Hydrograph ID	ID by Model Subregion	Well Name	Well Source	Agency*	Well Type	Depth	Screening Intervals
1	101	05N05E32M001	Voluntary	SJCFCWCD	Stockwatering	145	Unknown
2	102	04N05E10K001	CASGEM	SJCFCWCD	Residential	115	90/115
3	103	04N04E24F001M	Voluntary	DWR	Observation	20	Unknown
4	201	04N05E13H001	CASGEM	SJCFCWCD	Irrigation	190	50/190
5	202	04N06E29N002	Voluntary	SJCFCWCD	Irrigation	475	204/475
6	203	04N06E34J002	Voluntary	SJCFCWCD	Irrigation	466	94/167, 172/466
7	204	03N05E13L001	Voluntary	SJCFCWCD	Irrigation	65	Unknown
8	205	03N06E17A004	Voluntary	SJCFCWCD	Unknown	128	60/128
9	301	Lodi Well 7	Local Agency	City of Lodi	Production	422	142/422
10	302	Lodi Well 2	Local Agency	City of Lodi	Production	315	109/310
11	303	Lodi G-25B	Local Agency	City of Lodi	Observation	150	140/150
12	304	Lodi MW-19	CASGEM	SJCFCWCD	Observation	73	58/73
13	401	05N07E34G001M	Voluntary	DWR	Irrigation	590	Unknown
14	402	04N06E12N002	CASGEM	SJCFCWCD	Irrigation	320	104/320
15	403	04N07E33H001	Voluntary	SJCFCWCD	Irrigation	104	Unknown
16	404	04N07E36L001	Voluntary	DWR	Irrigation	565	Unknown
17	405	04N08E32N001	Voluntary	SJCFCWCD	Irrigation	Unknown	Unknown
18	406	03N06E24M003M	Voluntary	DWR	Irrigation	237	156/237
19	501	CCWD 010	CASGEM	CCWD	Observation	390	Unknown
20	502	CCWD 006	CASGEM	CCWD	Observation	230	Unknown
21	601	02N06E18K001M	Voluntary	DWR	Unknown	650	Unknown
22	602	02N06E26H001	Voluntary	SJCFCWCD	Irrigation	Unknown	Unknown
23	603	01N06E05H001	Voluntary	DWR	Irrigation	315	235/277
24	604	01N06E12G001	Voluntary	DWR	Irrigation	230	210/230
25	605	01N07E32A001	Voluntary	DWR	Irrigation	232	178/232
26	606	01S06E02G002	Voluntary	DWR	Irrigation	135	101/135
27	701	02N08E03G002	Voluntary	SJCFCWCD	Residential	125	Unknown
28	702	02N08E18C001	Voluntary	SJCFCWCD	Irrigation	544	Unknown
29	703	02N07E29B001	CASGEM	SJCFCWCD	Irrigation	202	130/202
30	704	02N08E33E001	Voluntary	SJCFCWCD	Irrigation	168	Unknown
31	705	01N07E01M002	Voluntary	SJCFCWCD	Irrigation	364	104/108
32	801	01N09E06N001	Voluntary	SJCFCWCD	Irrigation	300	92/300
33	802	01N08E29M002	Voluntary	SJCFCWCD	Irrigation	460	Unknown
34	803	01N08E26A002	Voluntary	SJCFCWCD	Irrigation	216	176/216
35	804	01N09E22G002	Voluntary	SJCFCWCD	Irrigation	340	Unknown
36	805	01S08E05R001	Voluntary	SJCFCWCD	Unknown	125	Unknown

Hydrograph ID	ID by Model Subregion	Well Name	Well Source	Agency*	Well Type	Depth	Screening Intervals
37	806	01S09E05H002	CASGEM	SJCFCWCD	Irrigation	256	148/256
38	901	01S06E11E001M	Voluntary	DWR	Irrigation	185	Unknown
39	902	01S06E15F001M	Voluntary	DWR	Residential	188	160/184
40	903	01S06E26K001M	Voluntary	DWR	Irrigation	248	191/195
41	1001	01S07E18L001M	Voluntary	DWR	Residential	248	144/154
42	1002	01S07E27K001	Voluntary	SJCFCWCD	Irrigation	300	120/300
43	1003	02S06E11J001	Voluntary	DWR	Irrigation	165	Unknown
44	1101	01S07E25R001M	Voluntary	DWR	Irrigation	130	Unknown
45	1102	02S08E08A001	CASGEM	SJCFCWCD	Irrigation	180	50/180
46	1103	02S08E12D001	Voluntary	DWR	Residential	82	72/82
47	1104	01S08E25Q001	Voluntary	SJCFCWCD	Irrigation	450	Unknown
48	1105	01S09E33J002	Voluntary	DWR	Residential	95	88/95
49	1301	01S09E21J002	CASGEM	SJCFCWCD	Irrigation	223	195/223
50	1302	01S09E24R001	Voluntary	SJCFCWCD	Irrigation	264	176/264
51	1401	02S07E31N001	Voluntary	SJCFCWCD	Irrigation	226	130/226
52	1402	03S07E06Q001	Voluntary	DWR	Stockwatering	71	Unknown
53	1501	02S07E22N002	Voluntary	DWR	Irrigation	162	52/162
54	1502	02S07E26B001	Voluntary	SJCFCWCD	Irrigation	386	56/386
55	1601	02S07E12R001	Voluntary	SJCFCWCD	Residential	310	Unknown
56	1701	01S10E04C001	Voluntary	DWR	Unknown	Unknown	Unknown
57	1702	01S10E23H001M	Voluntary	DWR	Irrigation	300	Unknown
58	1703	01S10E28J001	Voluntary	DWR	Unknown	Unknown	Unknown
59	1801	1S10E16Q1-18	Voluntary	DWR	Irrigation	299	Unknown
60	1802	01S10E26J001M	CASGEM	Stanislaus County	Unknown	Unknown	Unknown
61	1901	05N06E08R001M	Voluntary	DWR	Irrigation	Unknown	Unknown
62	1902	06N07E08R001M	Voluntary	DWR	Residential	332	Unknown
63	1903	05N07E10D001M	Voluntary	DWR	Residential	260	180/260
64	1904	07N08E36B001M	CASGEM	SSCAWA	Observation	15	Unknown
65	2001	03S08E23H001M	CASGEM	MID	Irrigation	467	Unknown
66	2002	American 208	CASGEM	MID	Irrigation	320	Unknown
67	2003	03S10E17K001M	CASGEM	MID	Irrigation	476	116/400
68	2004	Birnbaum OID-03	CASGEM	STRGBA GSA	Irrigation	293	55/110, 147/154, 170/175, 185/200, 238/250, 265/270, 285/293

Hydrograph ID	ID by Model Subregion	Well Name	Well Source	Agency*	Well Type	Depth	Screening Intervals
69	2005	03S11E27G003M	CASGEM	STRGBA GSA	Irrigation	248	Unknown
70	2006	Paulsell 2 OID-12	CASGEM	STRGBA GSA	Irrigation	815	132/159, 160/815

* CCWD = Calaveras County Water District
DWR = Department of Water Resources
MID = Modesto Irrigation District
SJCFCWCD = San Joaquin County Flood Control and Water Conservation District
SSCAWA = Southeast Sacramento County Agricultural Water Authority
STRGBA GSA = Stanislaus & Tuolumne Rivers Groundwater Basin Association GSA

Figure C-2: ESJWRM Groundwater Level Hydrograph – Calibration Well #1

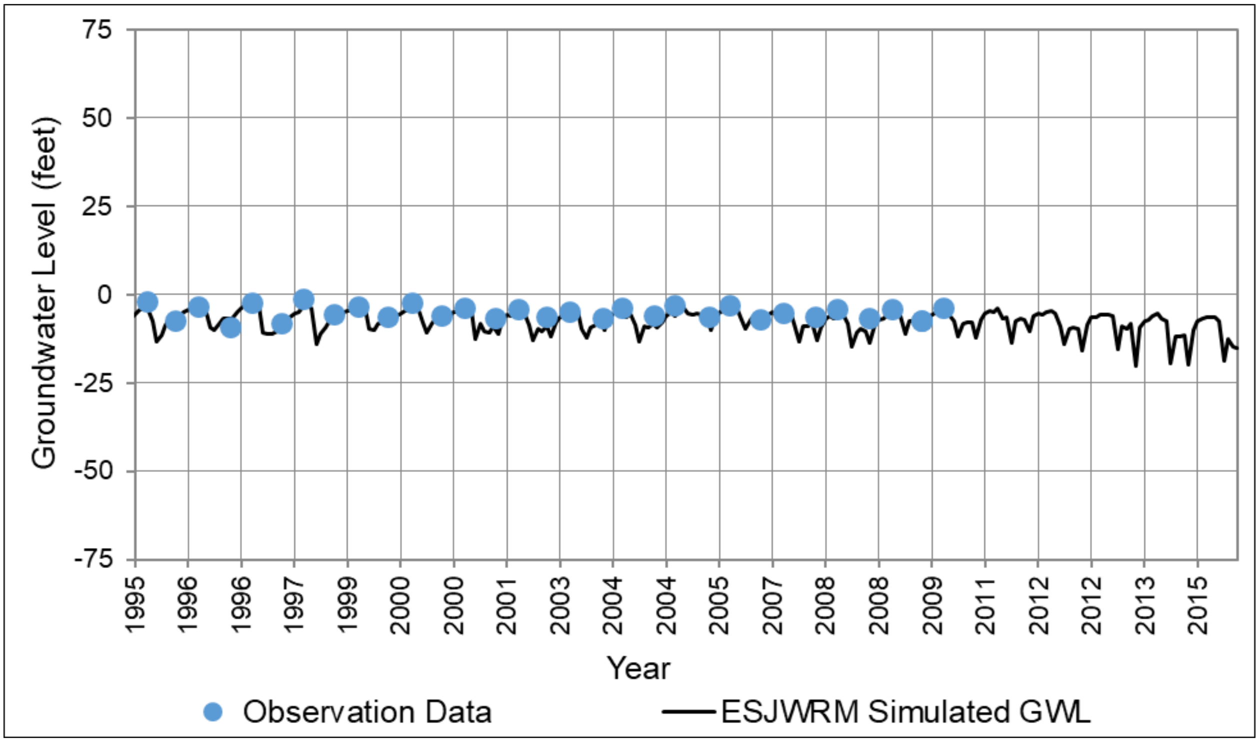


Figure C-3: ESJWRM Groundwater Level Hydrograph – Calibration Well #2

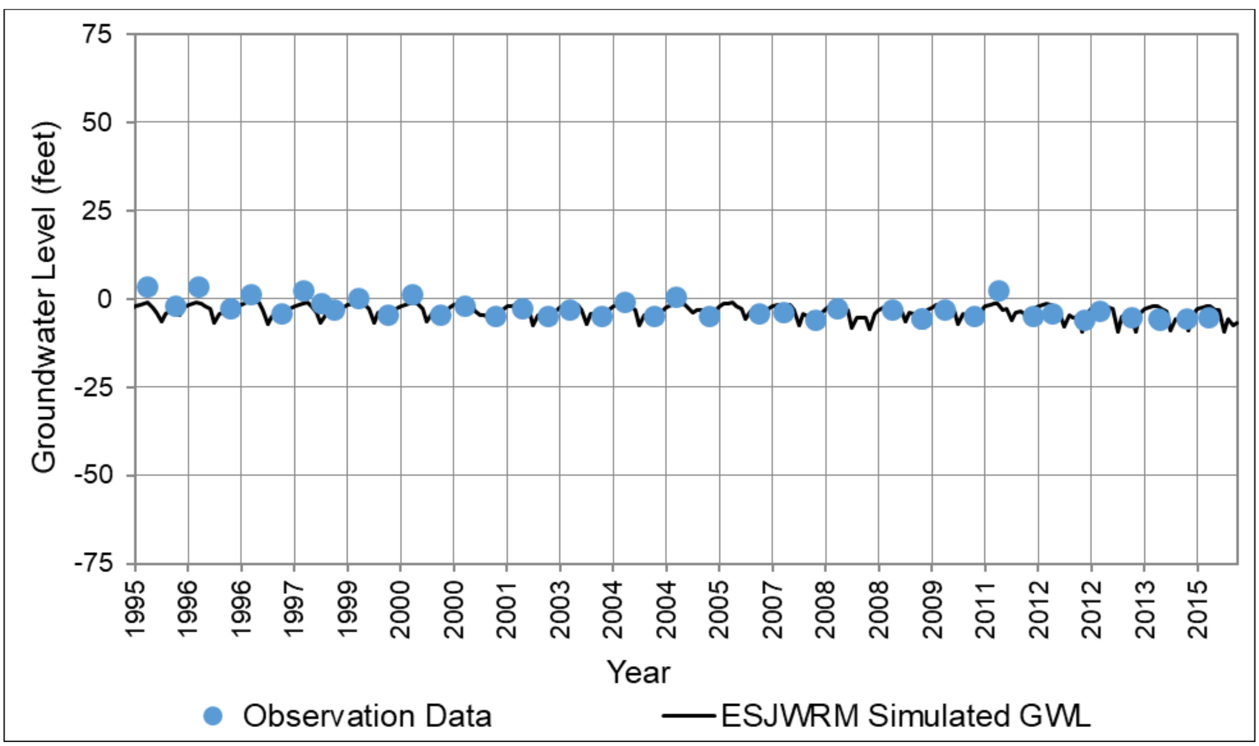


Figure C-4: ESJWRM Groundwater Level Hydrograph – Calibration Well #3

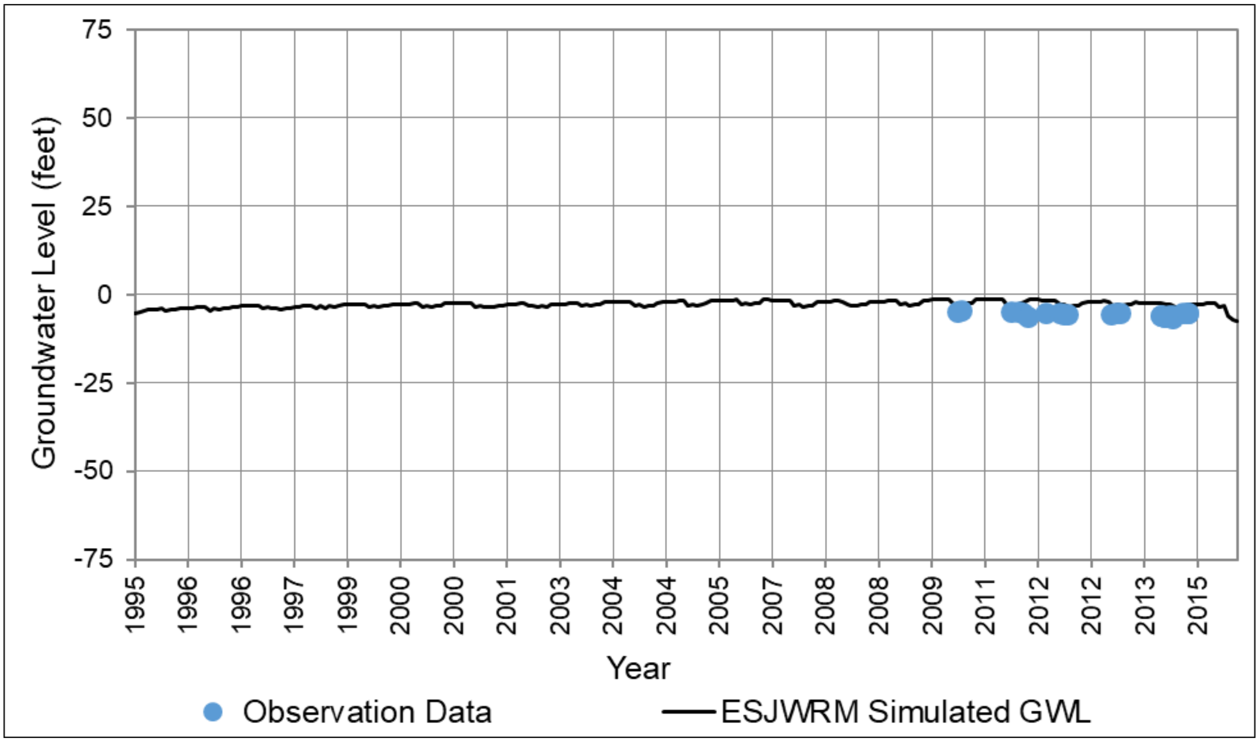


Figure C-5: ESJWRM Groundwater Level Hydrograph – Calibration Well #4

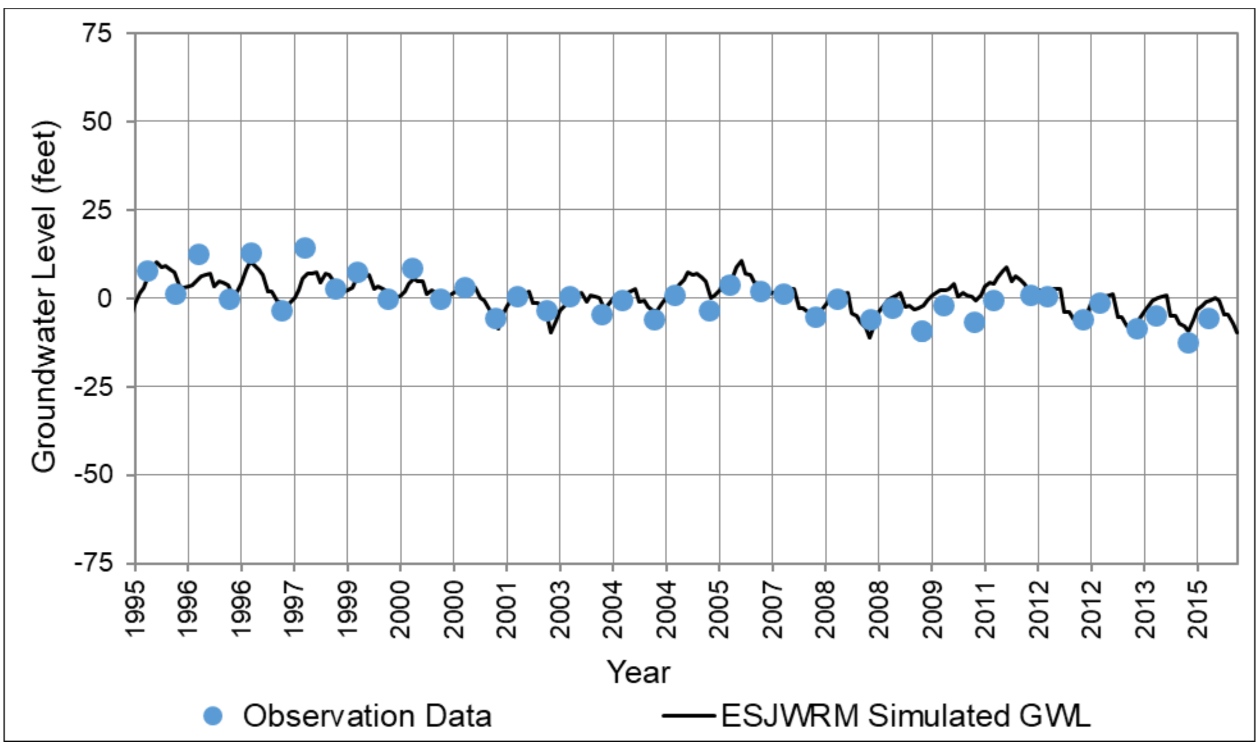


Figure C-6: ESJWRM Groundwater Level Hydrograph – Calibration Well #5

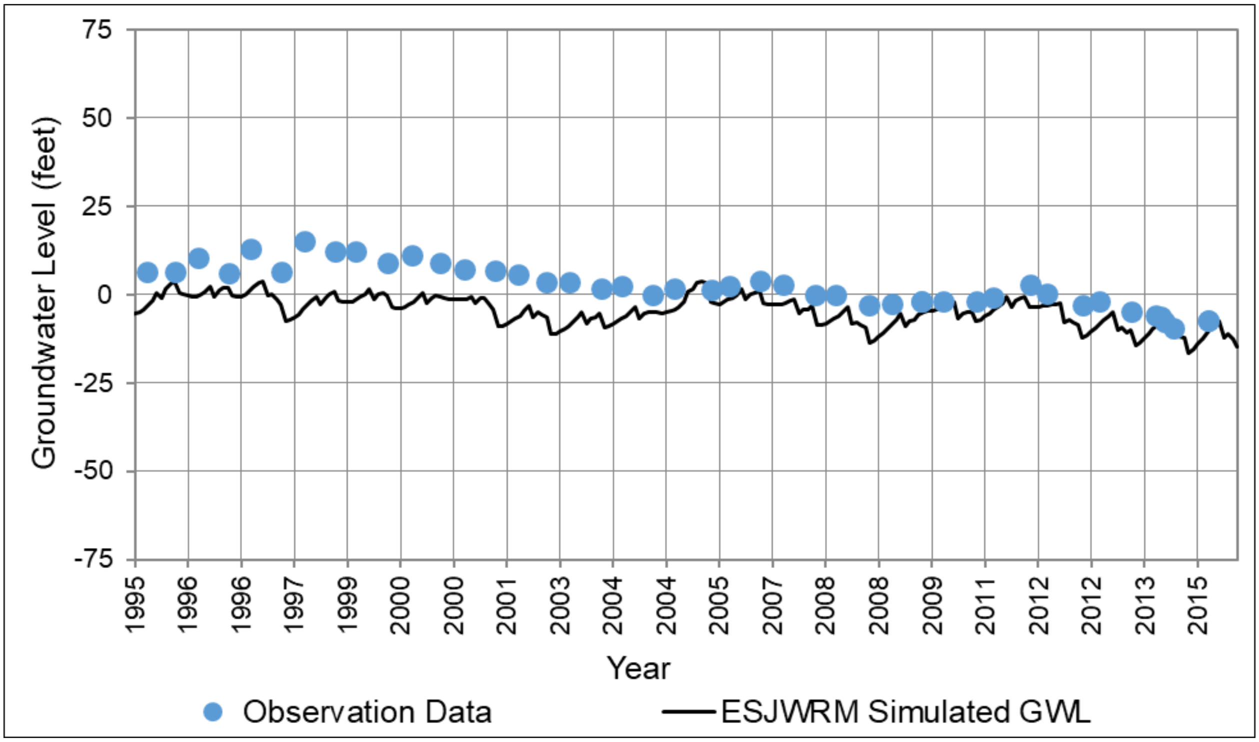


Figure C-7: ESJWRM Groundwater Level Hydrograph – Calibration Well #6

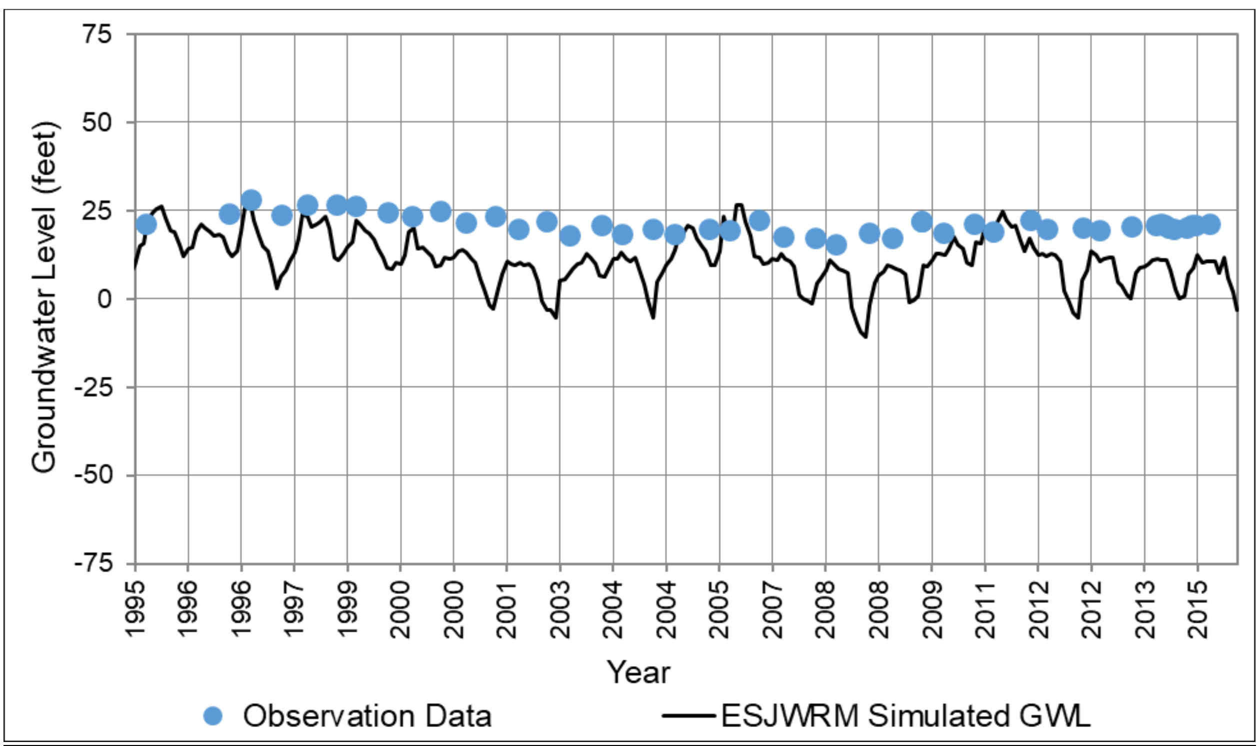


Figure C-8: ESJWRM Groundwater Level Hydrograph – Calibration Well #7

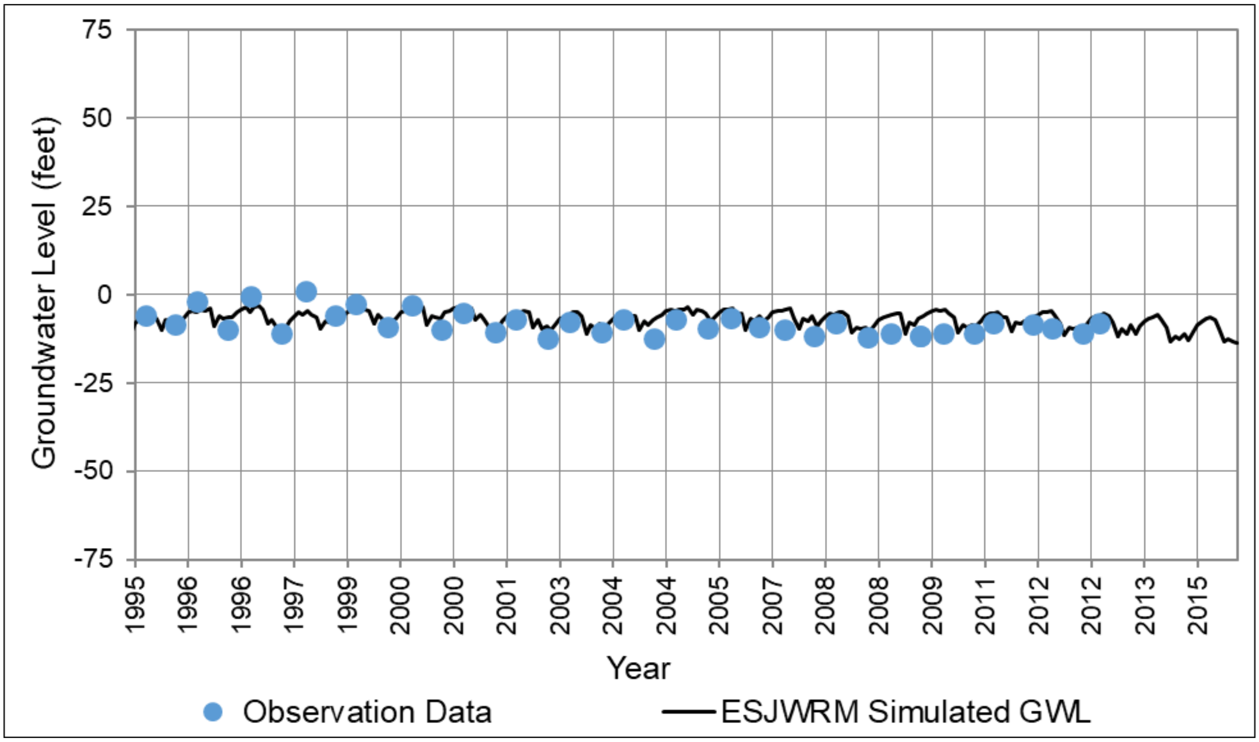


Figure C-9: ESJWRM Groundwater Level Hydrograph – Calibration Well #8

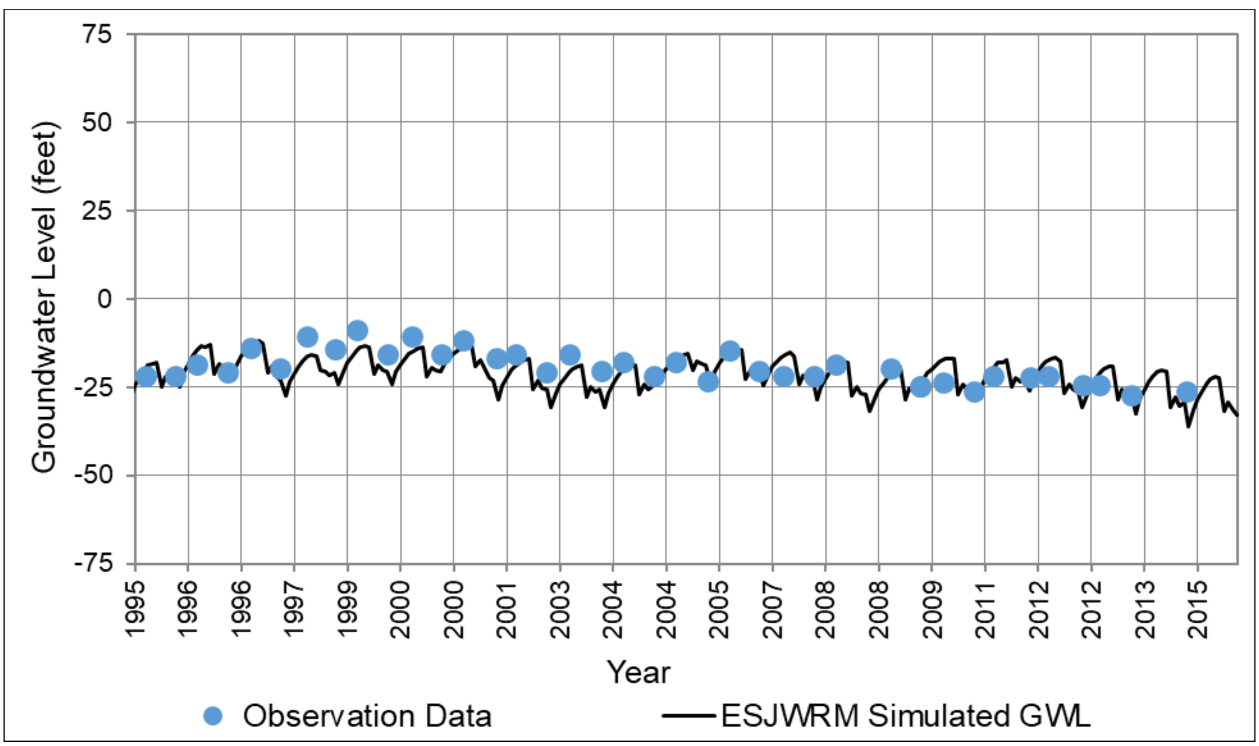


Figure C-10: ESJWRM Groundwater Level Hydrograph – Calibration Well #9

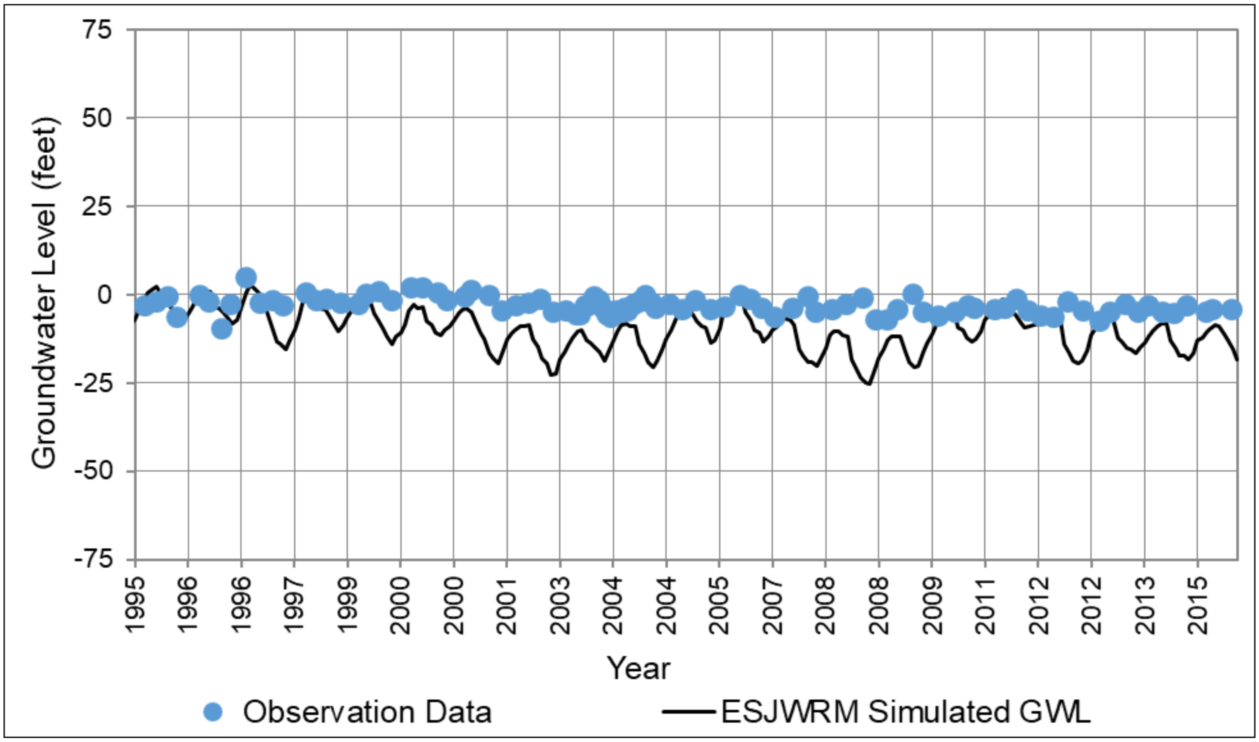


Figure C-11: ESJWRM Groundwater Level Hydrograph – Calibration Well #10

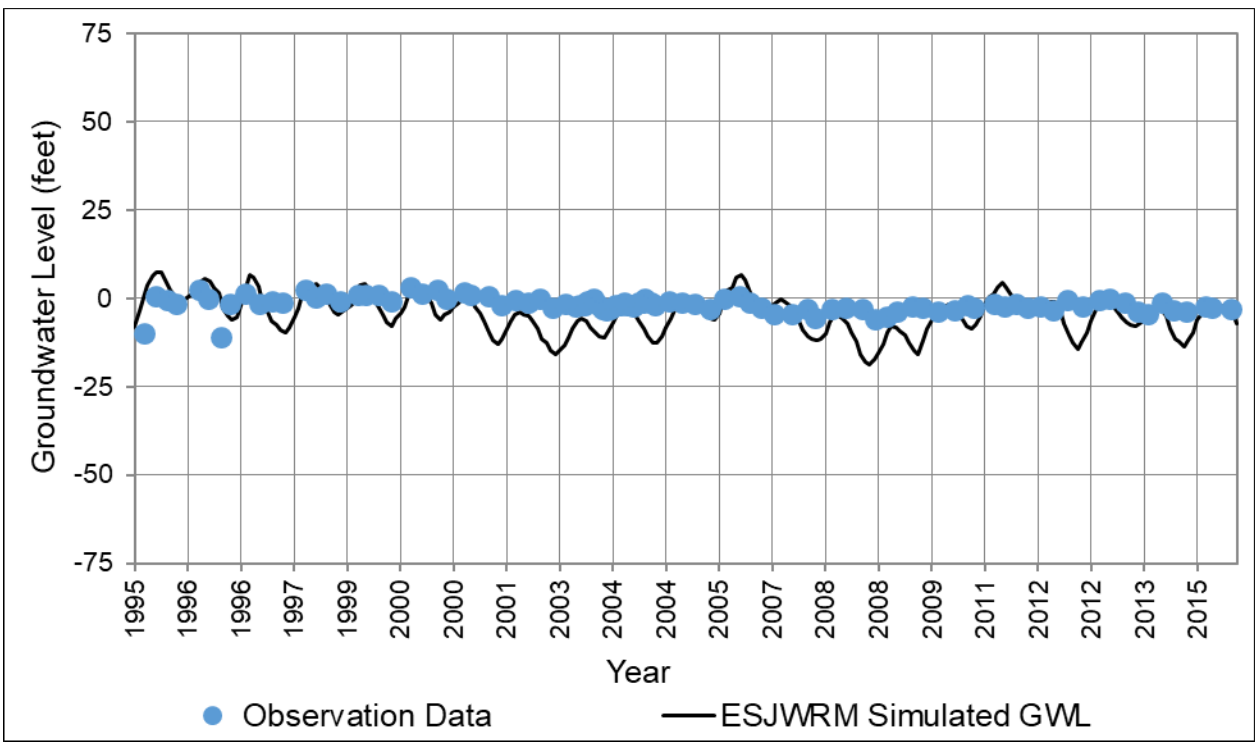


Figure C-12: ESJWRM Groundwater Level Hydrograph – Calibration Well #11

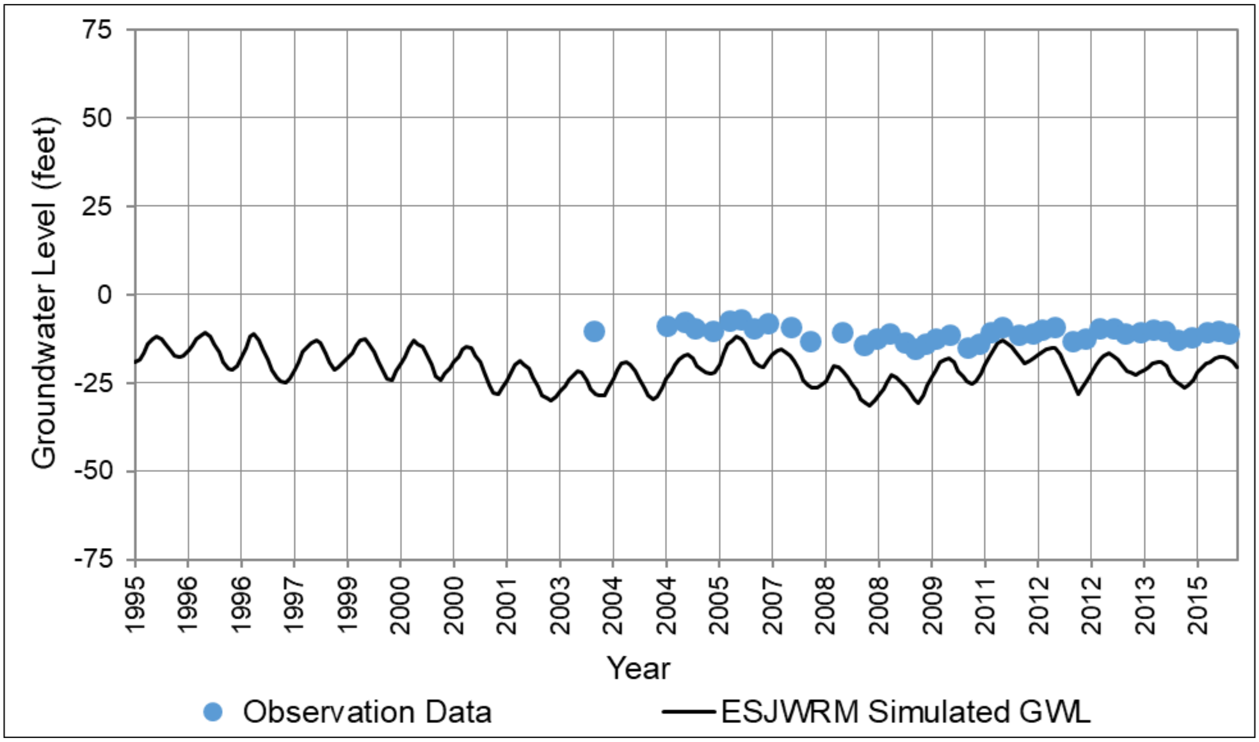


Figure C-13: ESJWRM Groundwater Level Hydrograph – Calibration Well #12

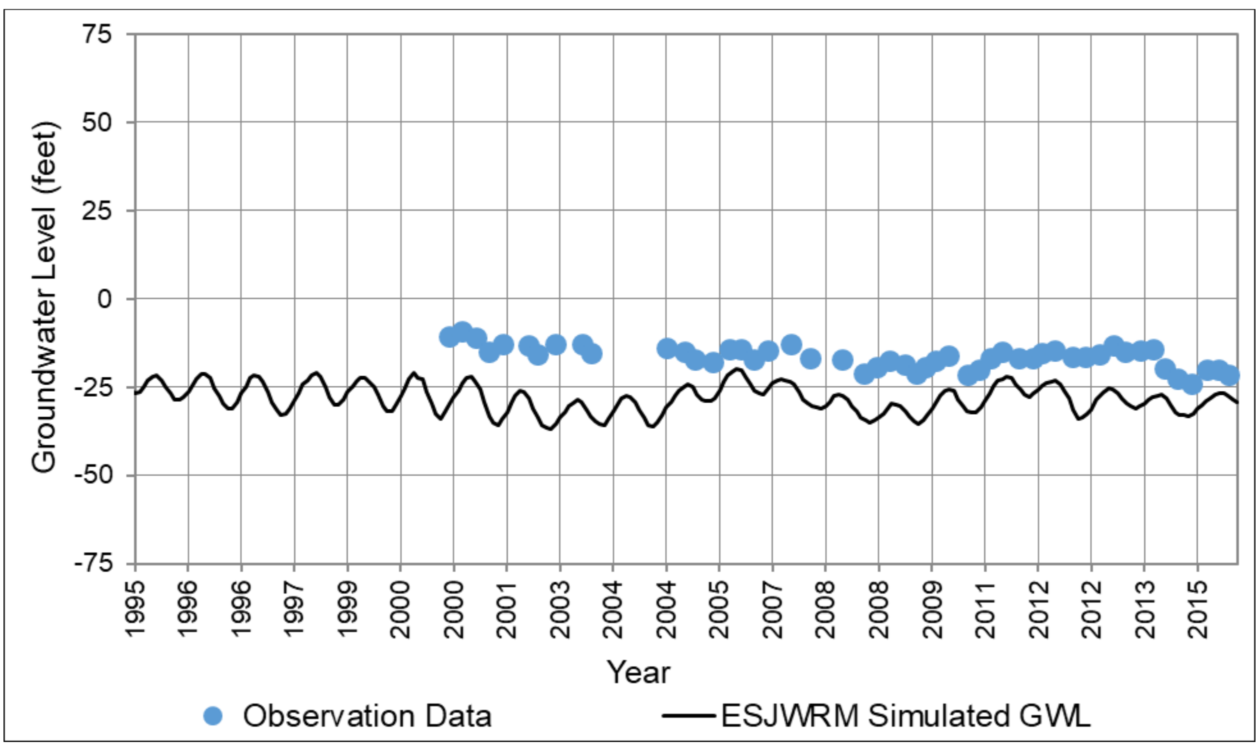


Figure C-14: ESJWRM Groundwater Level Hydrograph – Calibration Well #13

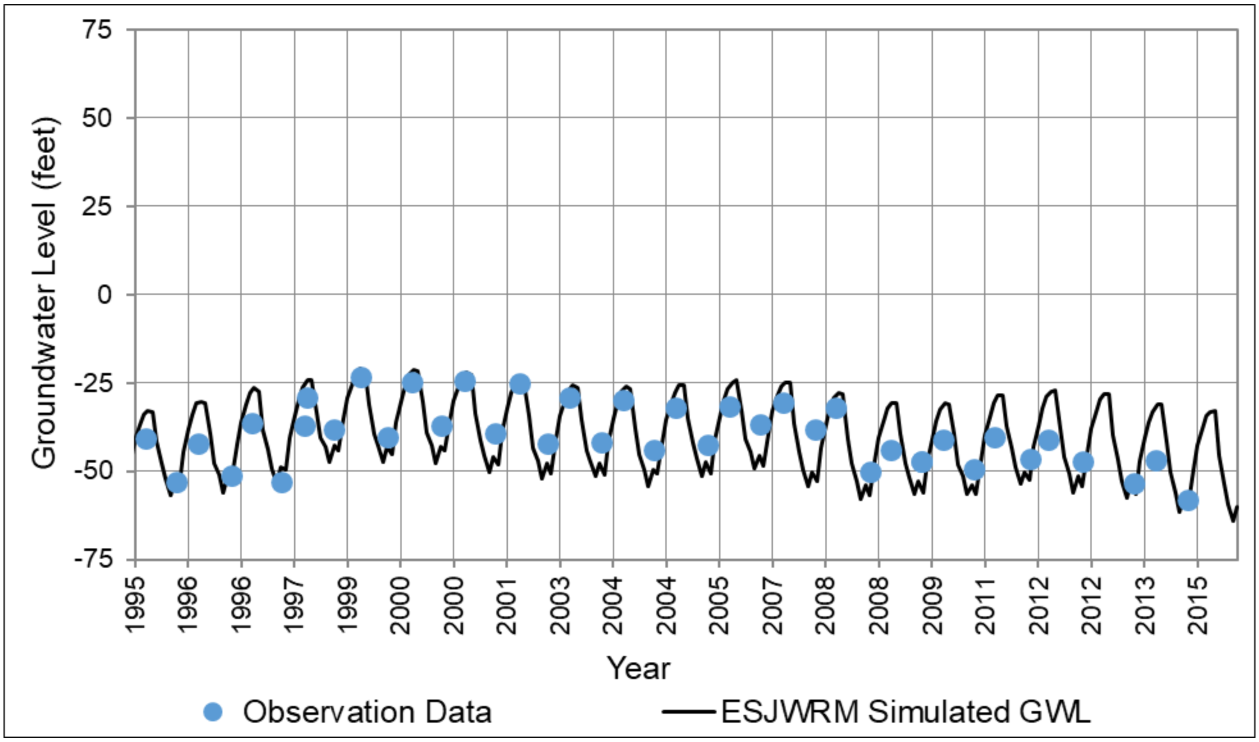


Figure C-15: ESJWRM Groundwater Level Hydrograph – Calibration Well #14

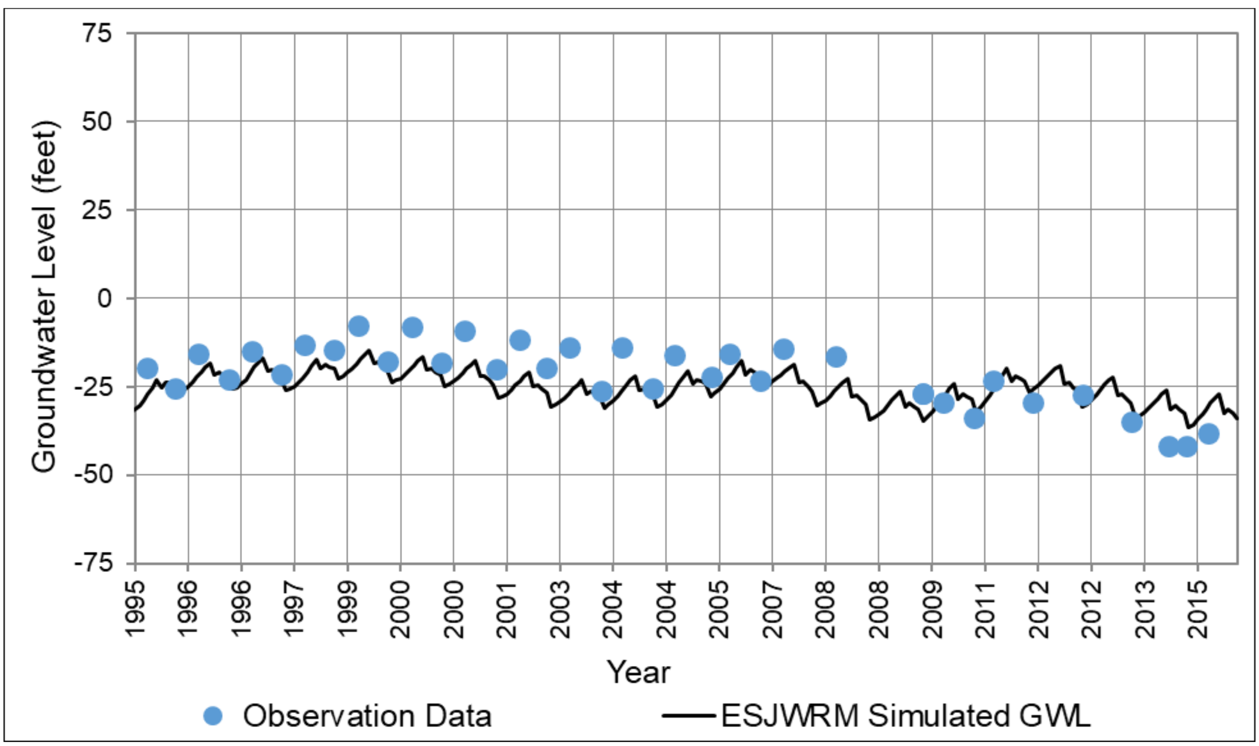


Figure C-16: ESJWRM Groundwater Level Hydrograph – Calibration Well #15

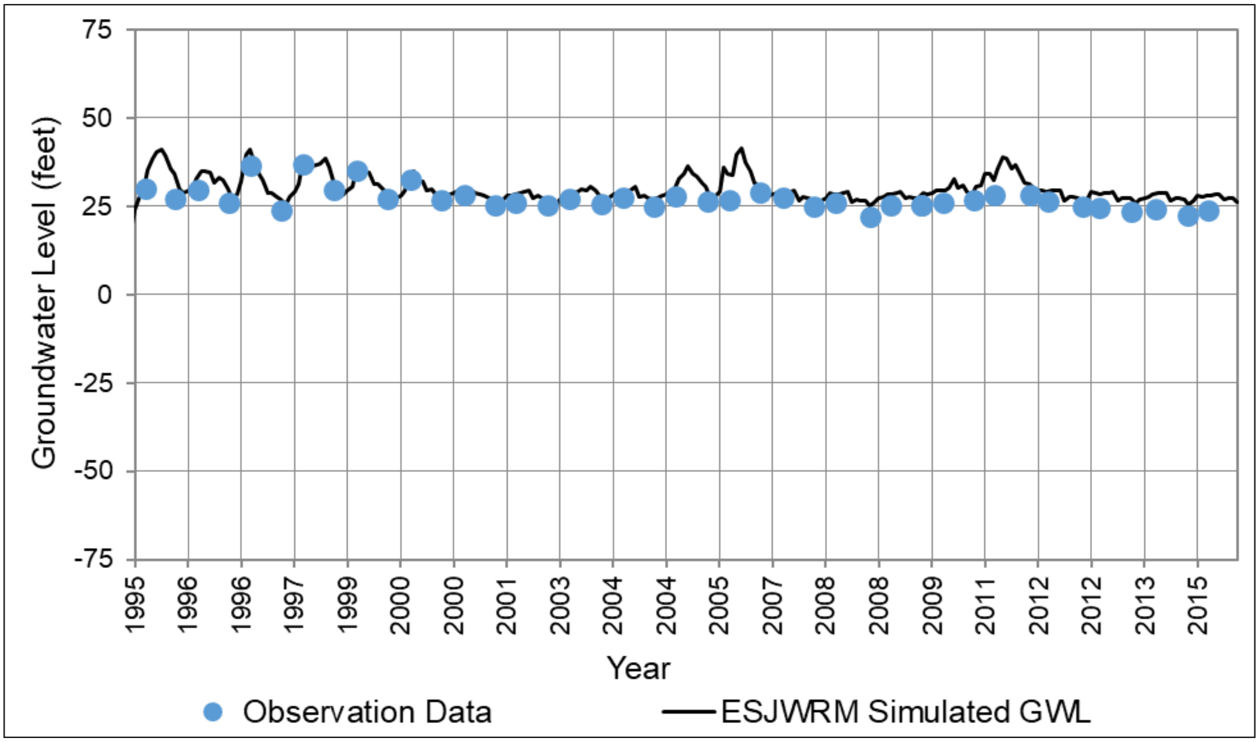


Figure C-17: ESJWRM Groundwater Level Hydrograph – Calibration Well #16

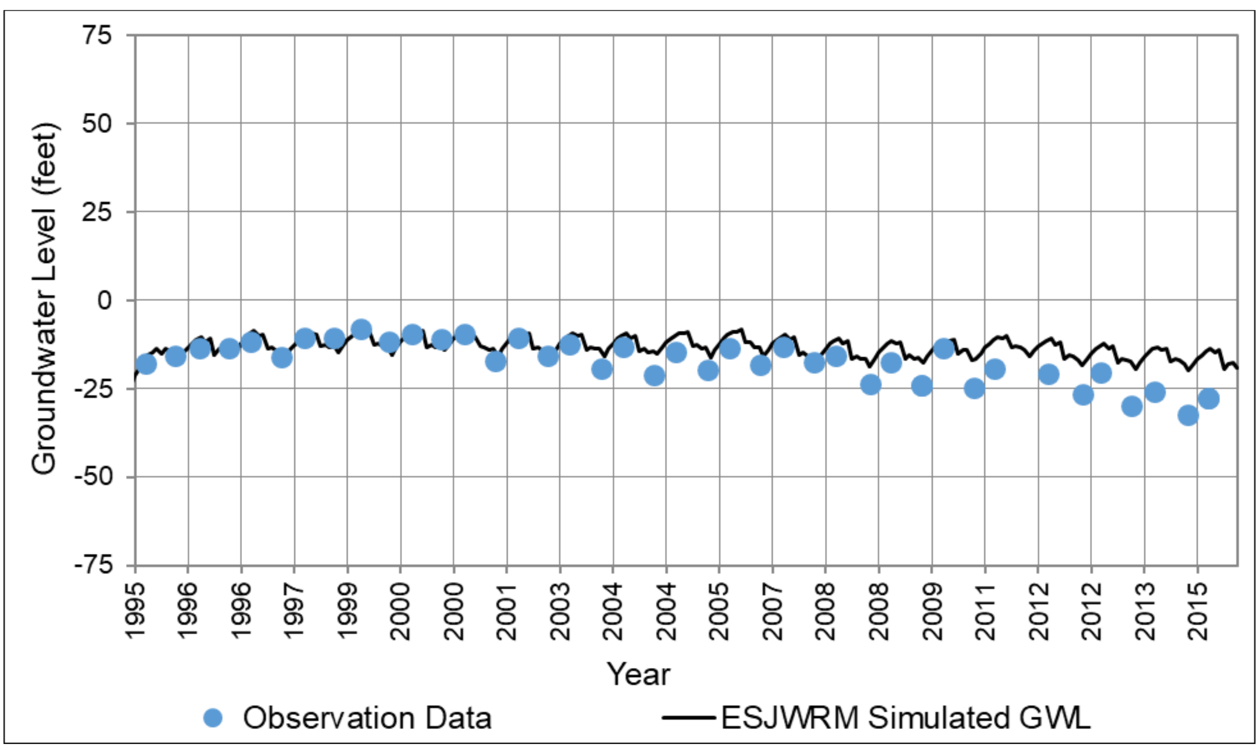


Figure C-18: ESJWRM Groundwater Level Hydrograph – Calibration Well #17

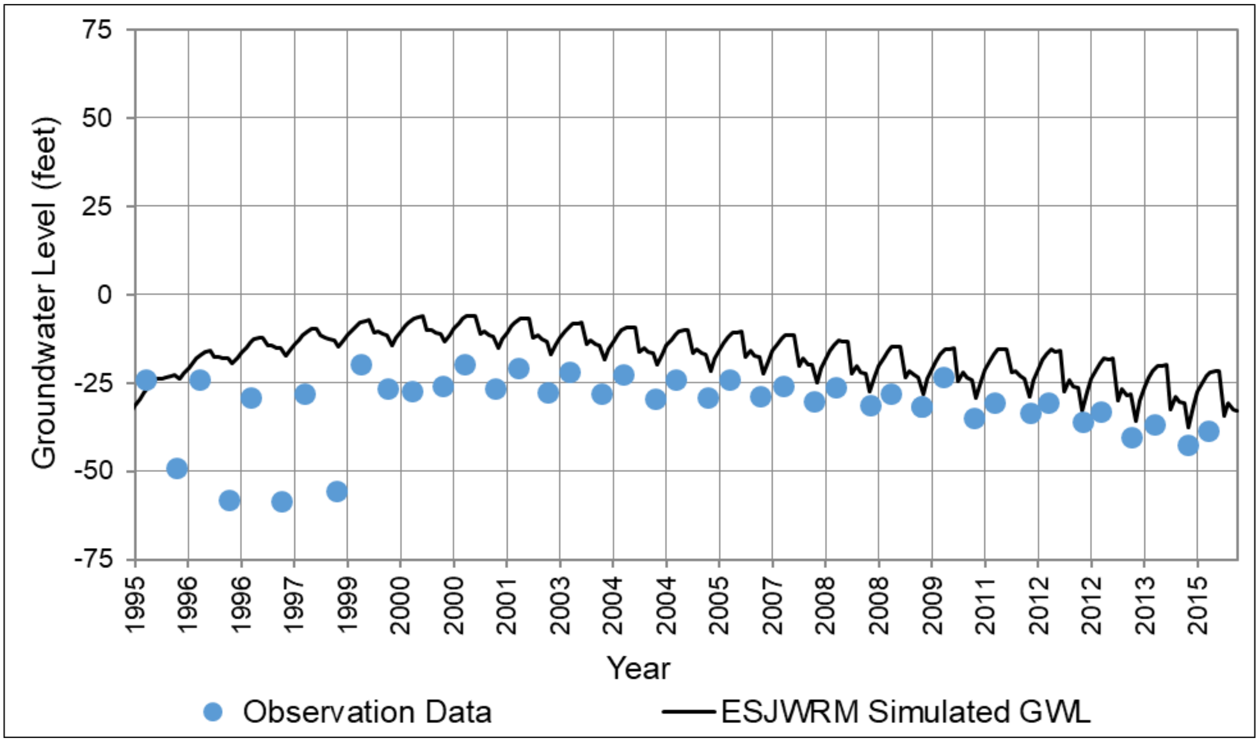


Figure C-19: ESJWRM Groundwater Level Hydrograph – Calibration Well #18

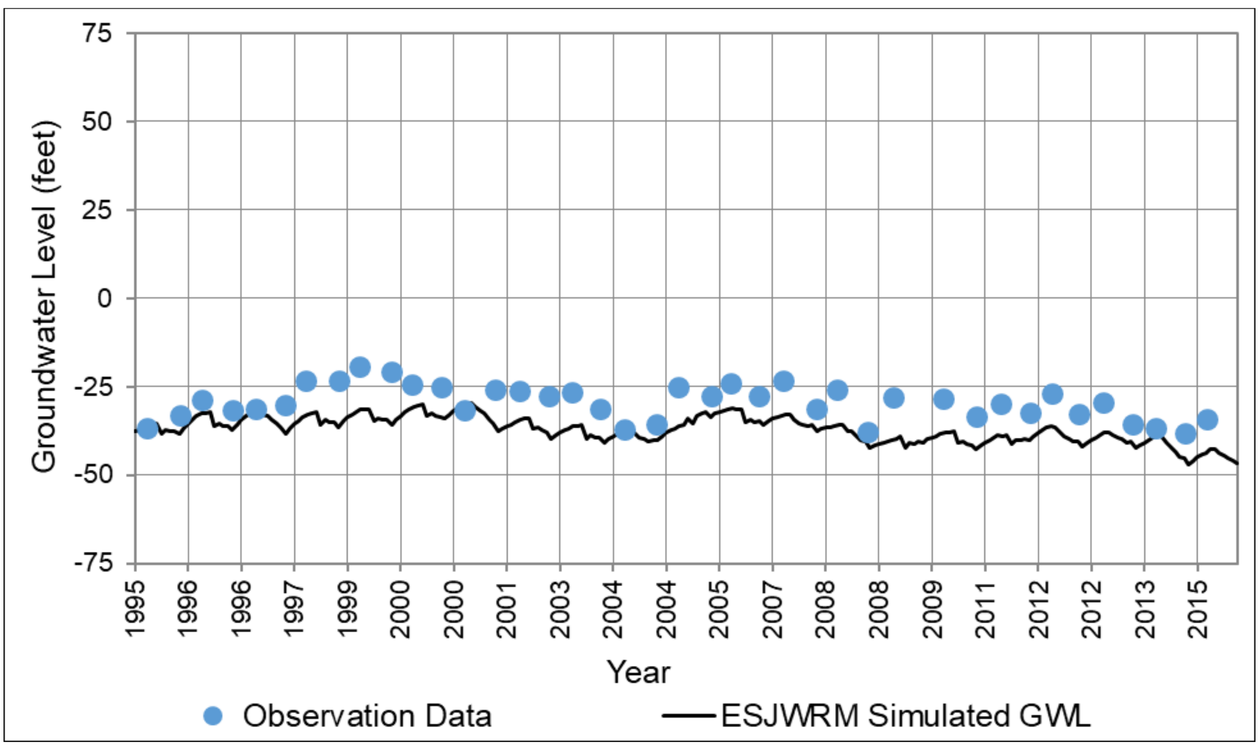


Figure C-20: ESJWRM Groundwater Level Hydrograph – Calibration Well #19

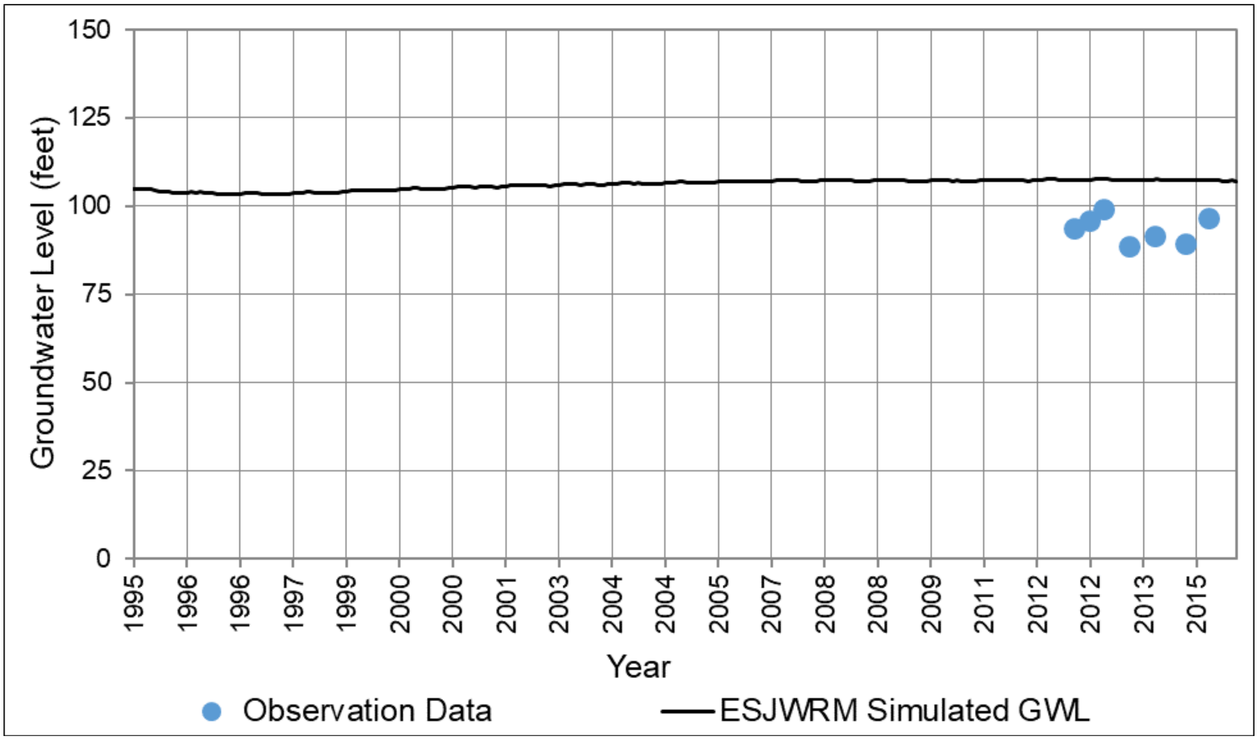


Figure C-21: ESJWRM Groundwater Level Hydrograph – Calibration Well #20

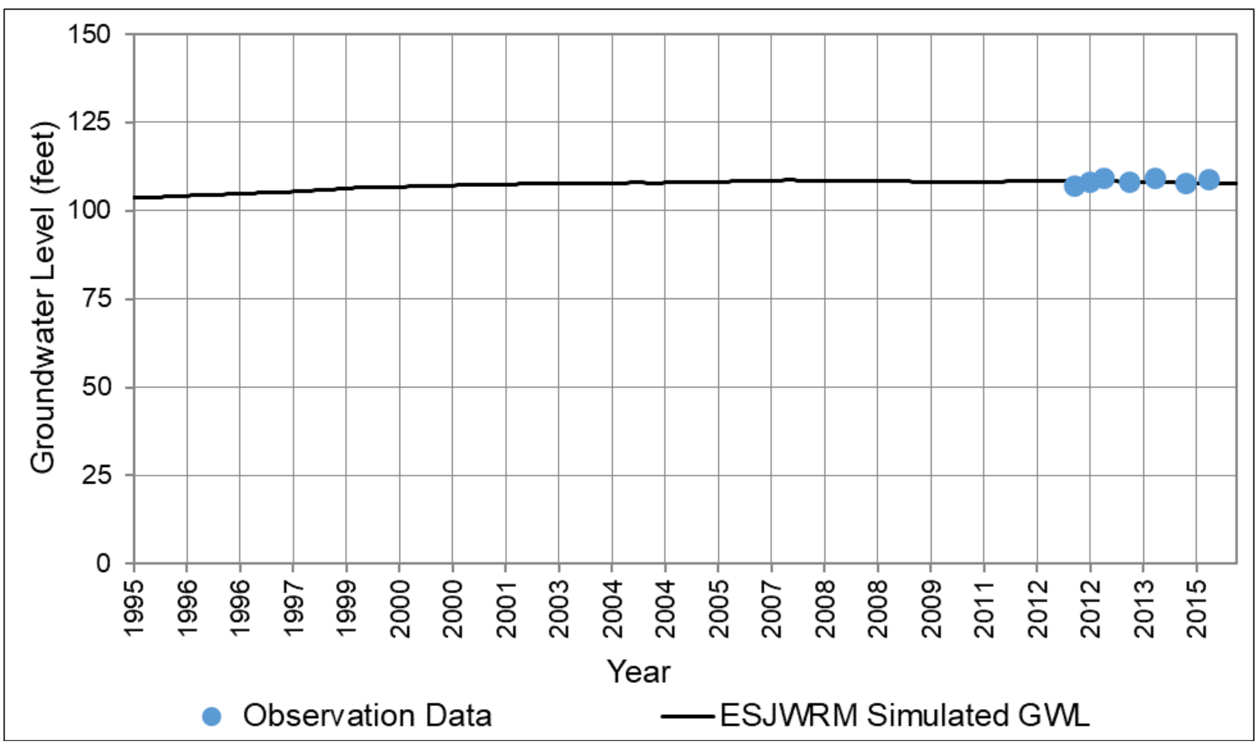


Figure C-22: ESJWRM Groundwater Level Hydrograph – Calibration Well #21

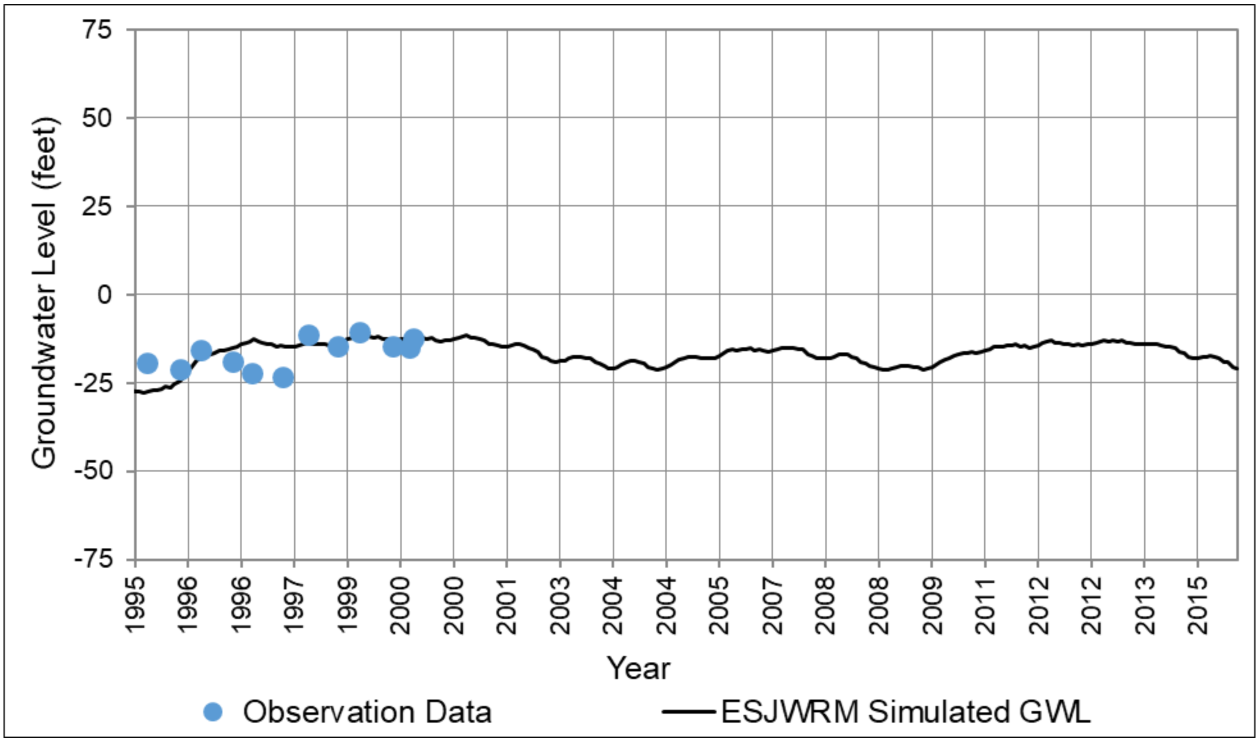


Figure C-23: ESJWRM Groundwater Level Hydrograph – Calibration Well #22

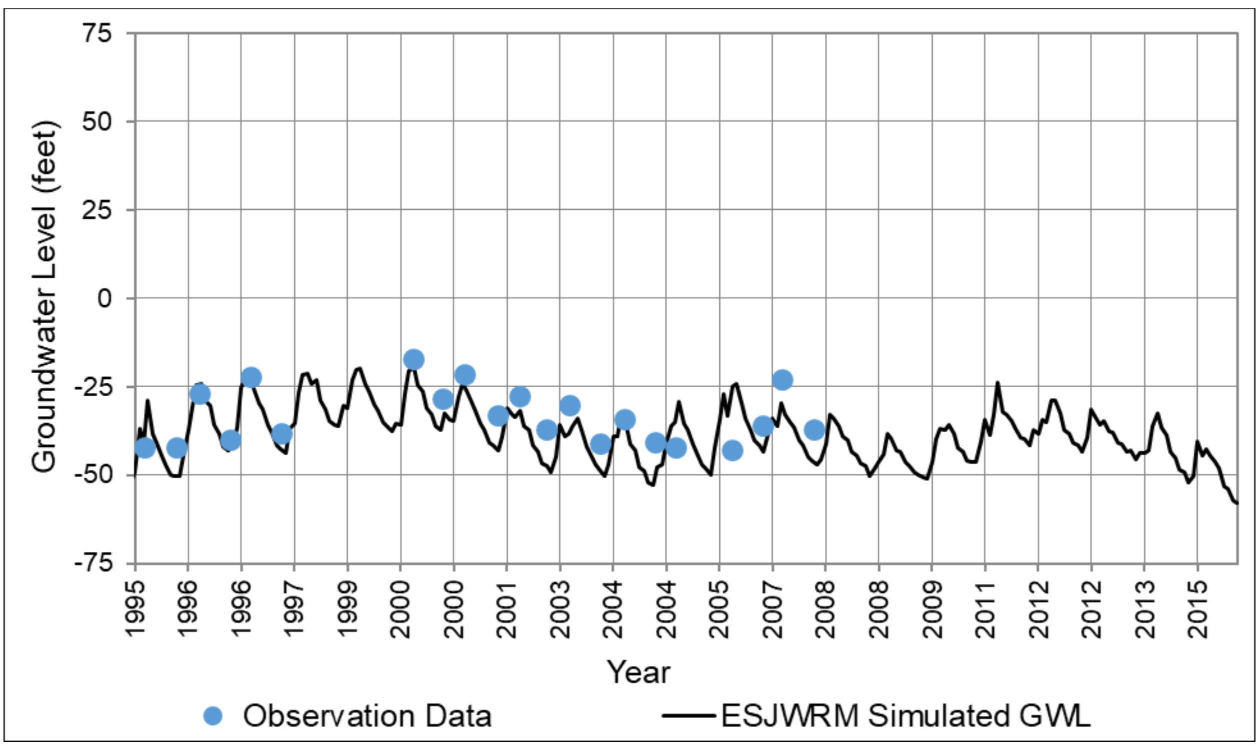


Figure C-24: ESJWRM Groundwater Level Hydrograph – Calibration Well #23

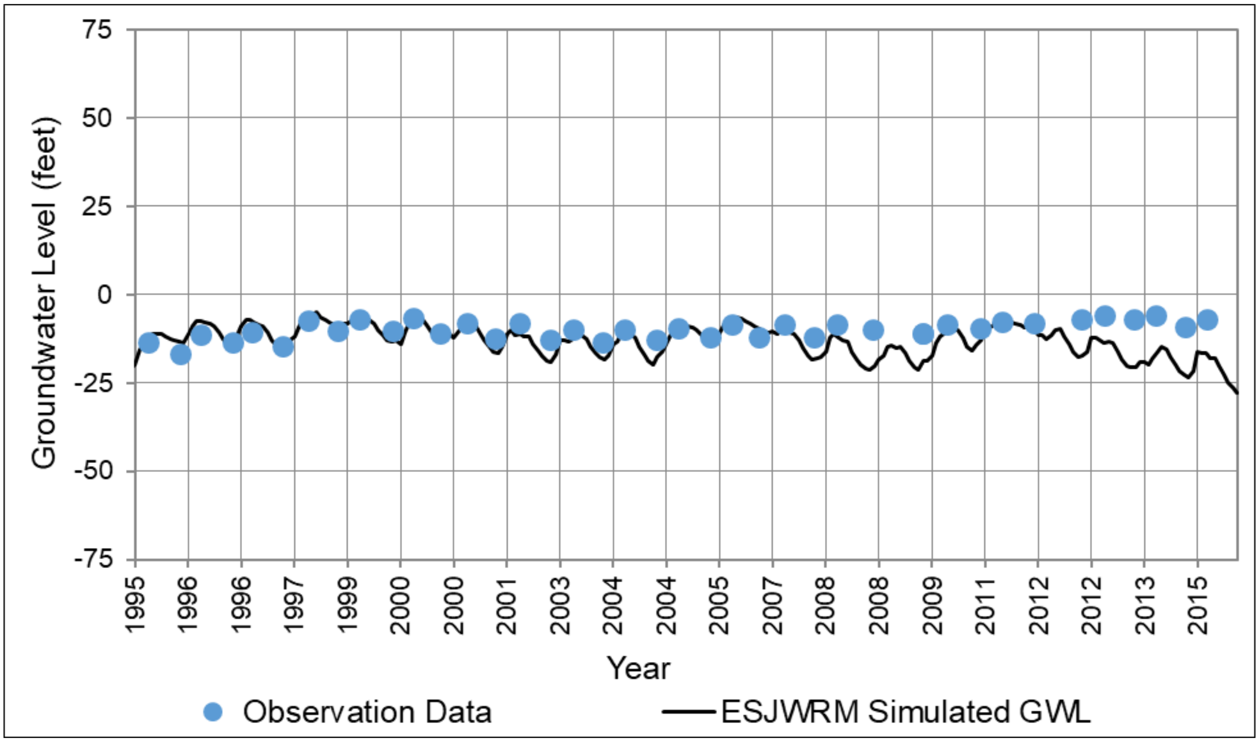


Figure C-25: ESJWRM Groundwater Level Hydrograph – Calibration Well #24

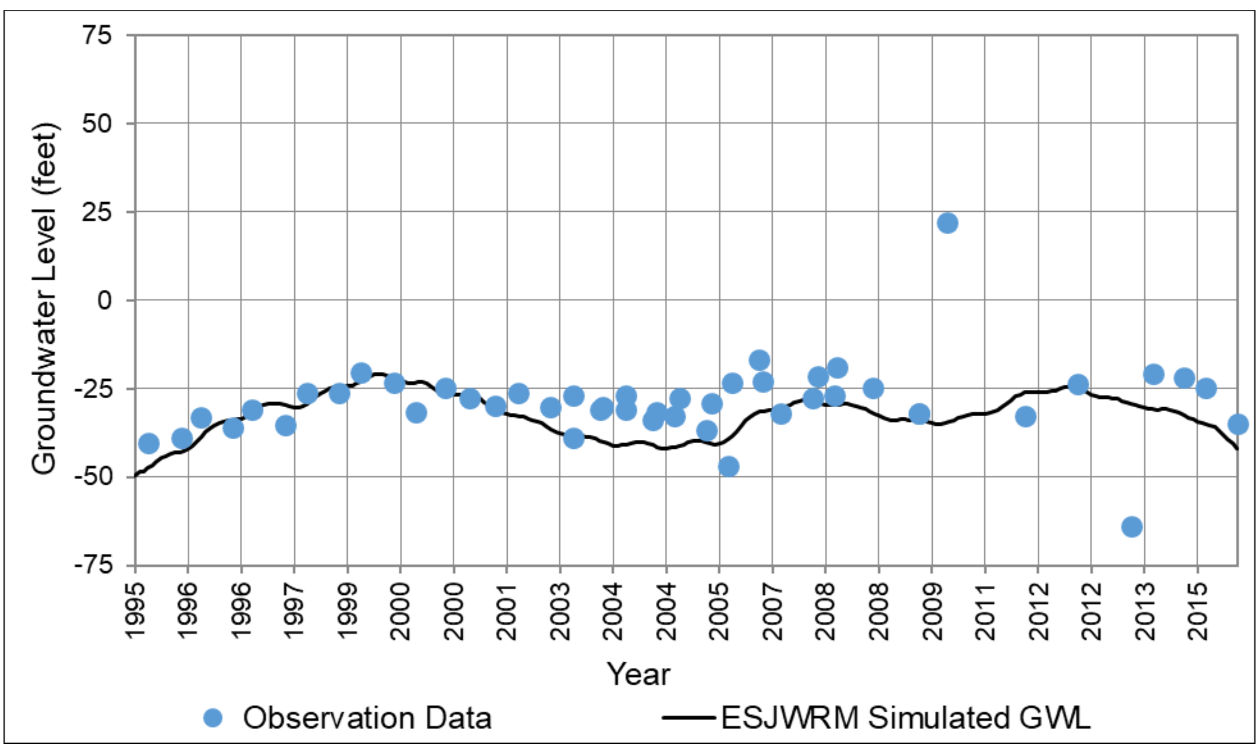


Figure C-26: ESJWRM Groundwater Level Hydrograph – Calibration Well #25

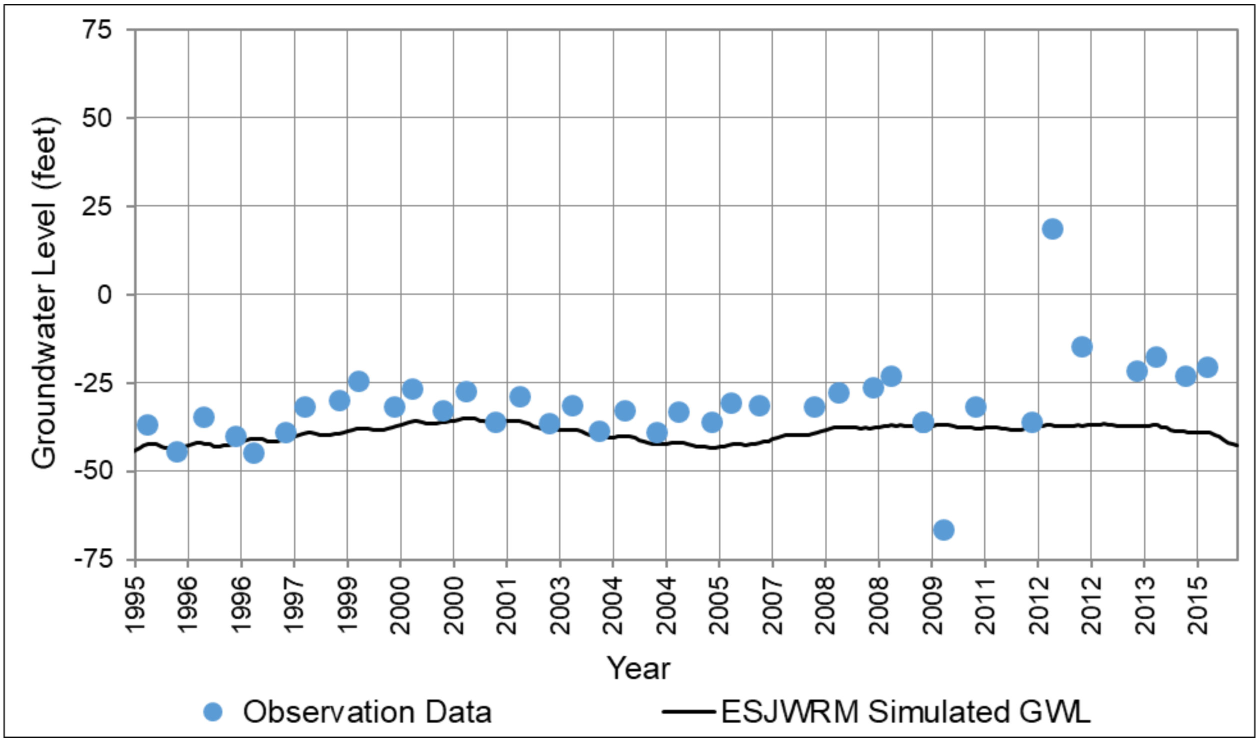


Figure C-27: ESJWRM Groundwater Level Hydrograph – Calibration Well #26

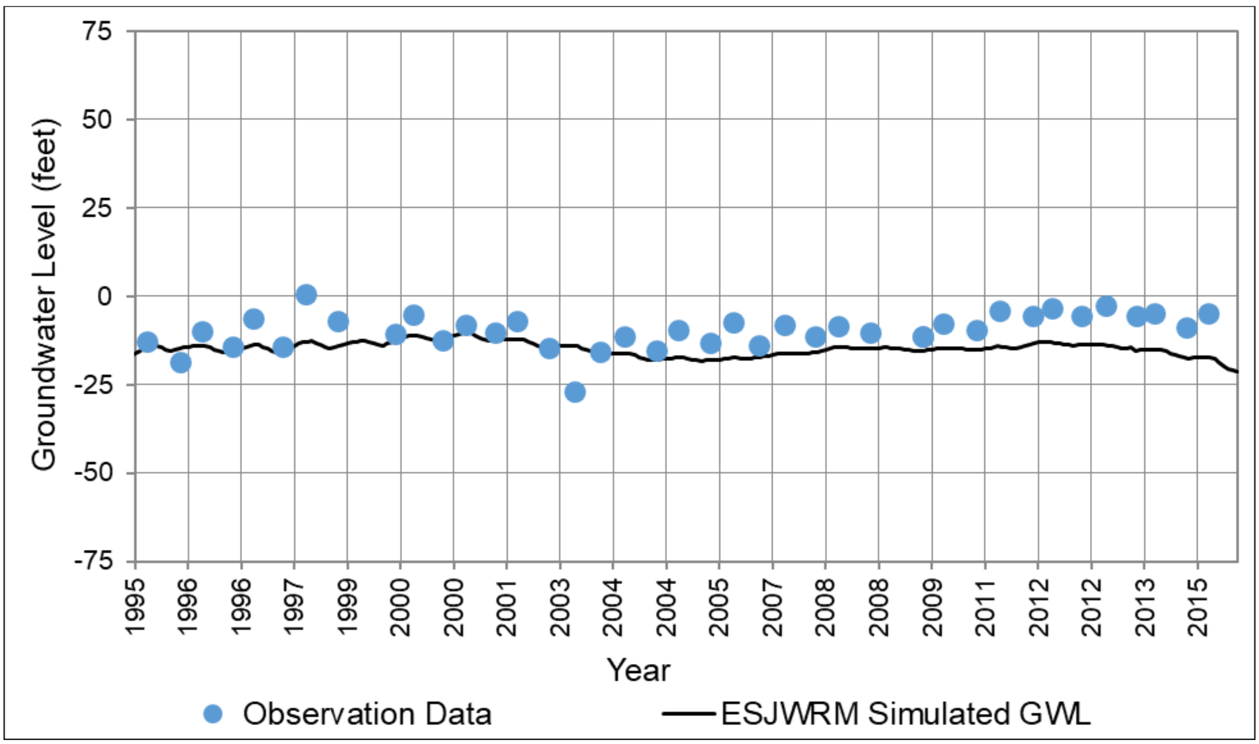


Figure C-28: ESJWRM Groundwater Level Hydrograph – Calibration Well #27

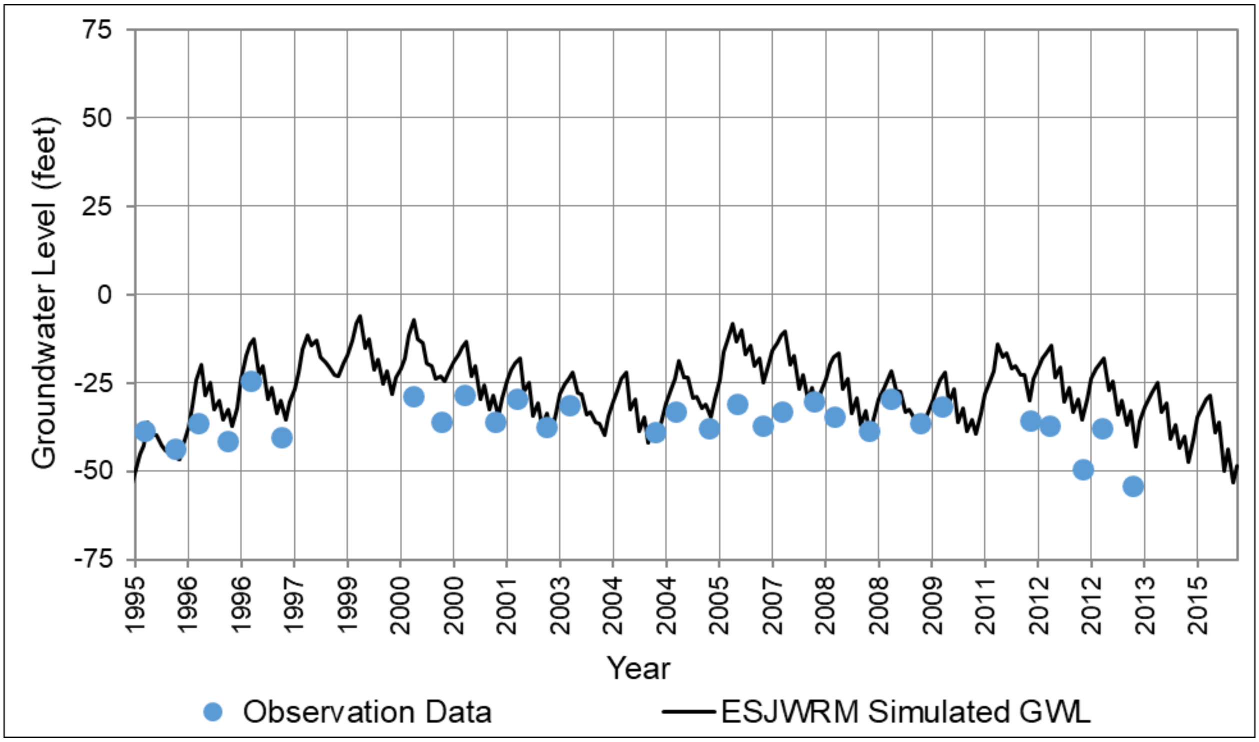


Figure C-29: ESJWRM Groundwater Level Hydrograph – Calibration Well #28

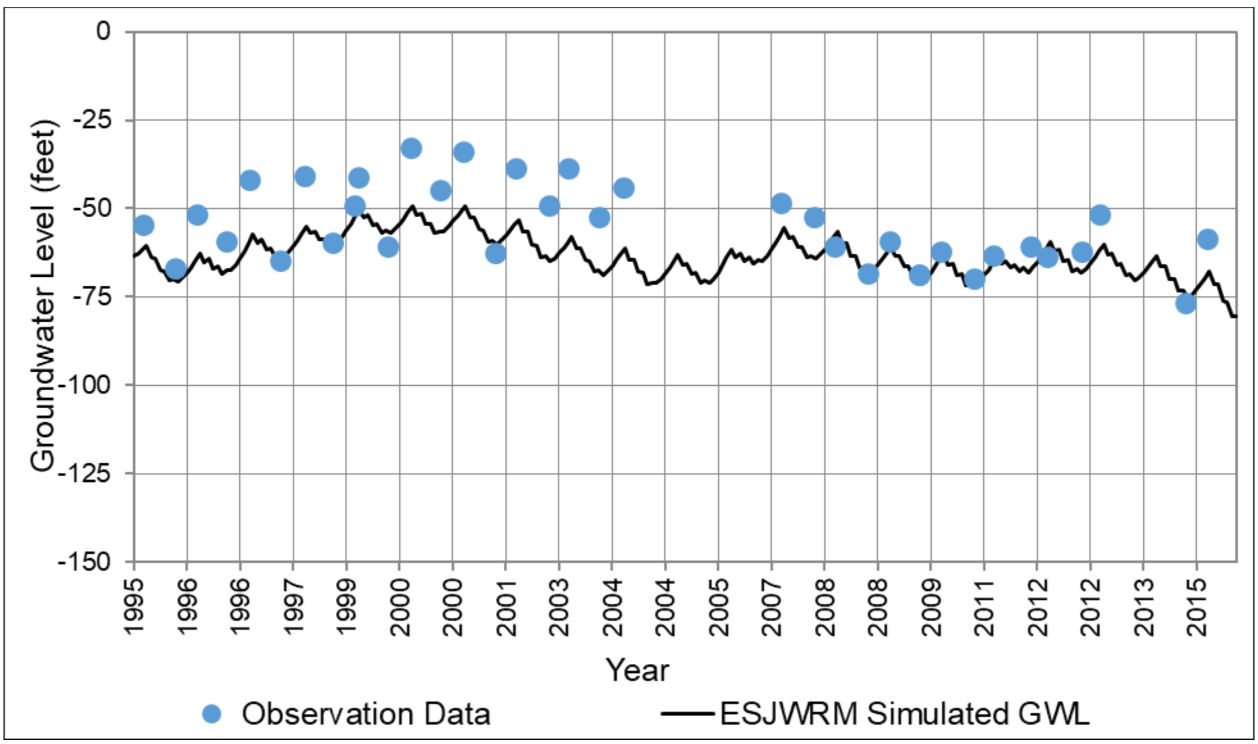


Figure C-30: ESJWRM Groundwater Level Hydrograph – Calibration Well #29

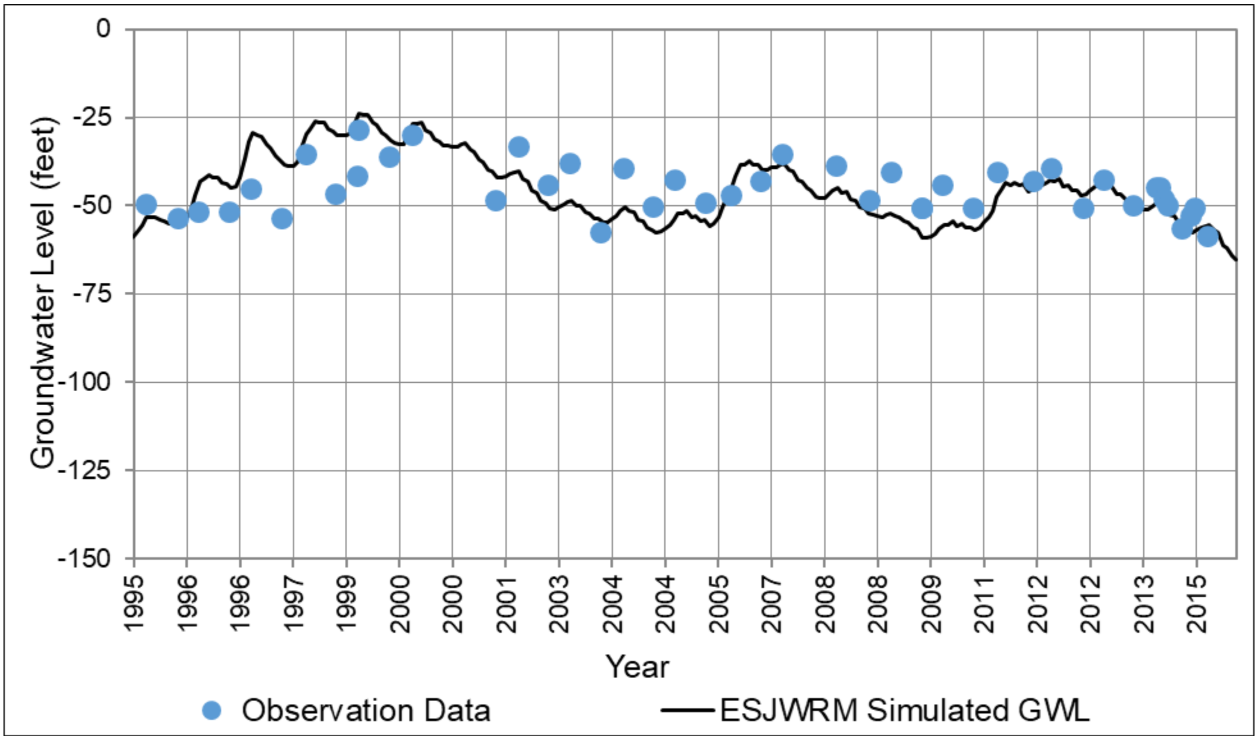


Figure C-31: ESJWRM Groundwater Level Hydrograph – Calibration Well #30

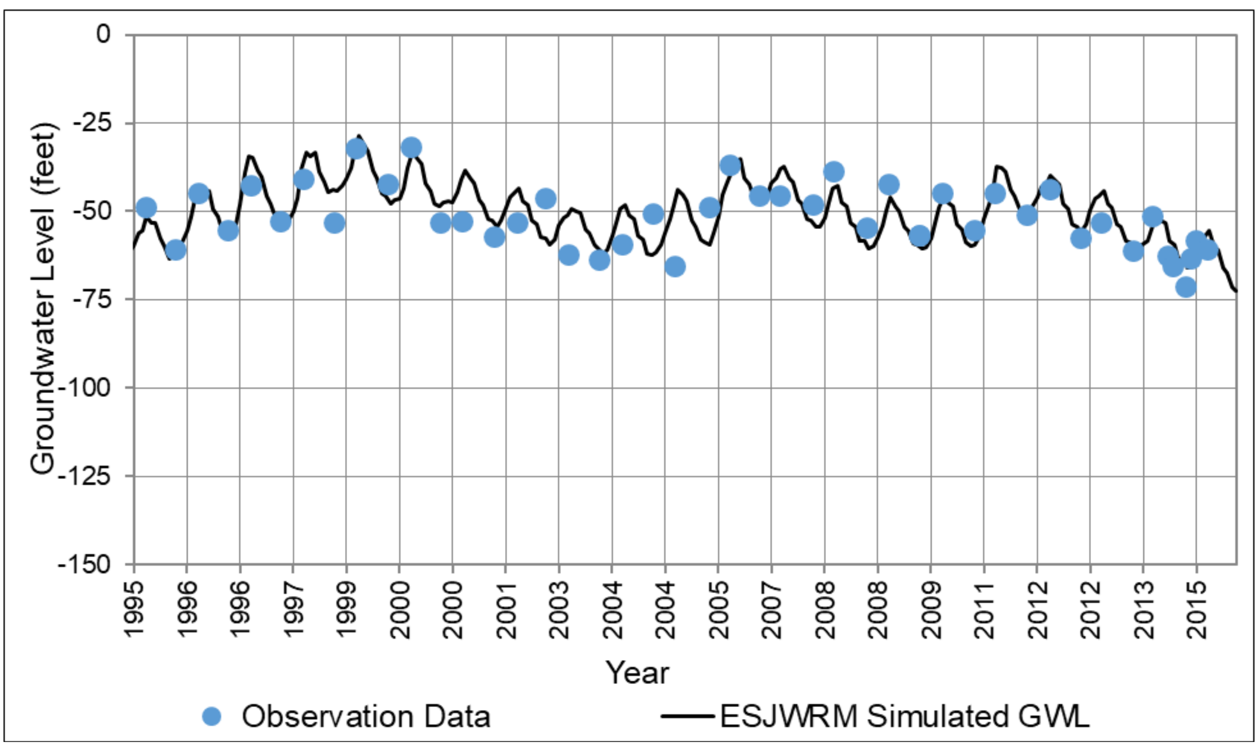


Figure C-32: ESJWRM Groundwater Level Hydrograph – Calibration Well #31

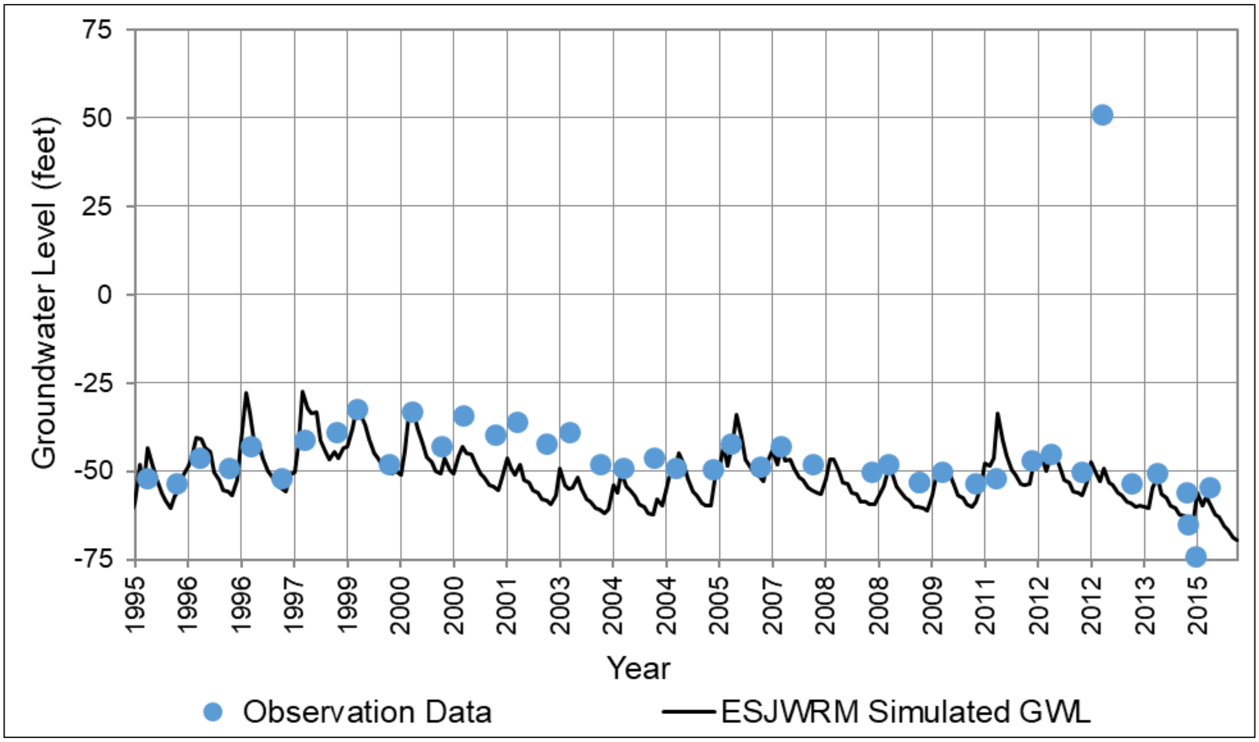


Figure C-33: ESJWRM Groundwater Level Hydrograph – Calibration Well #32

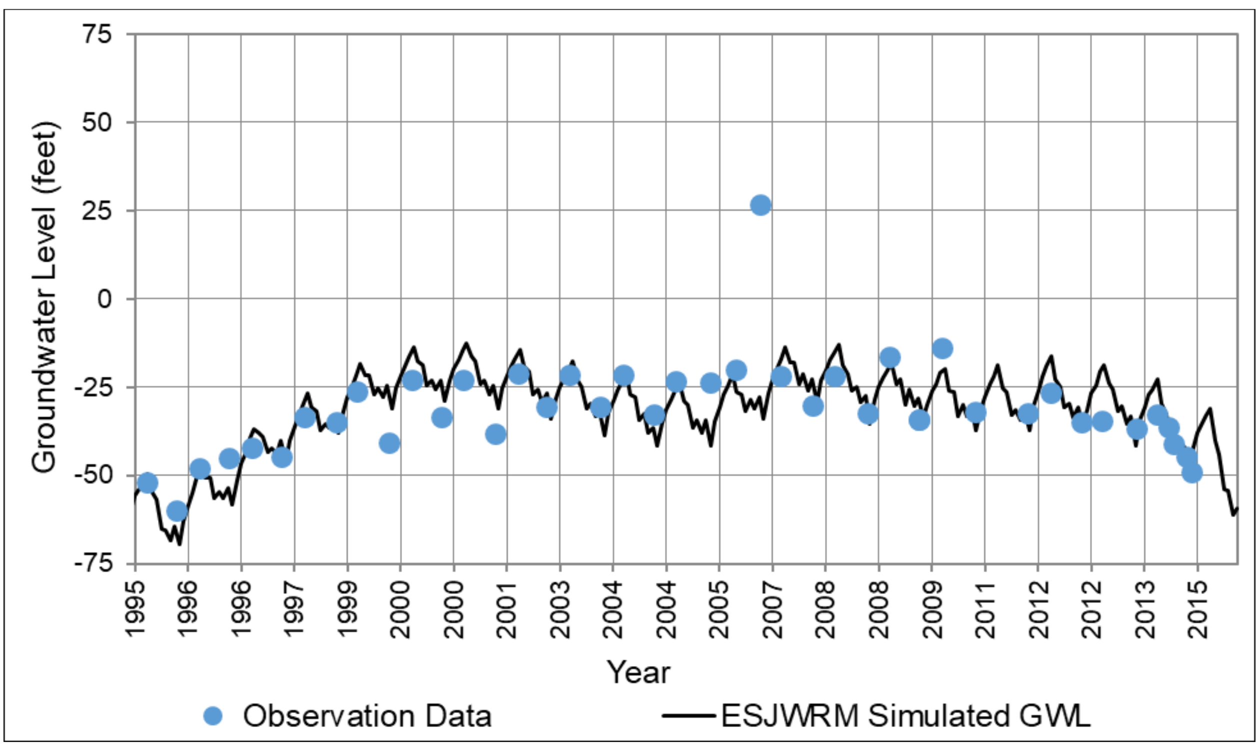


Figure C-34: ESJWRM Groundwater Level Hydrograph – Calibration Well #33

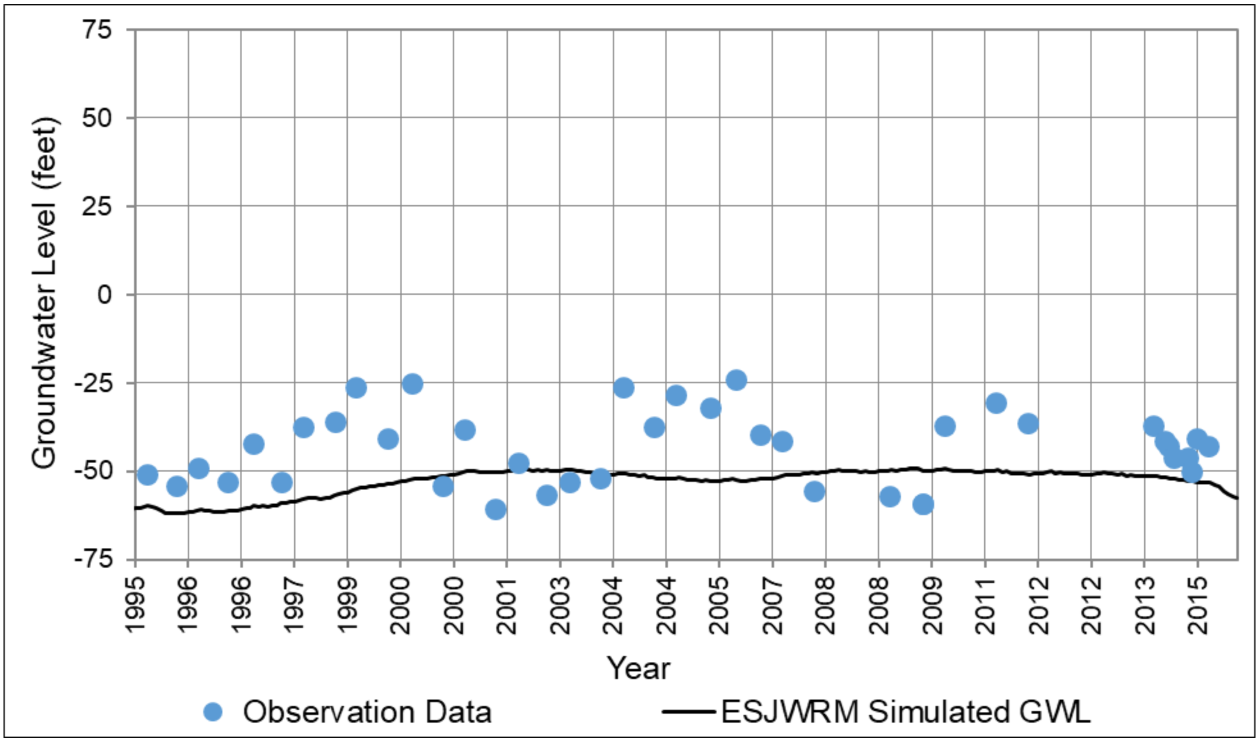


Figure C-35: ESJWRM Groundwater Level Hydrograph – Calibration Well #34

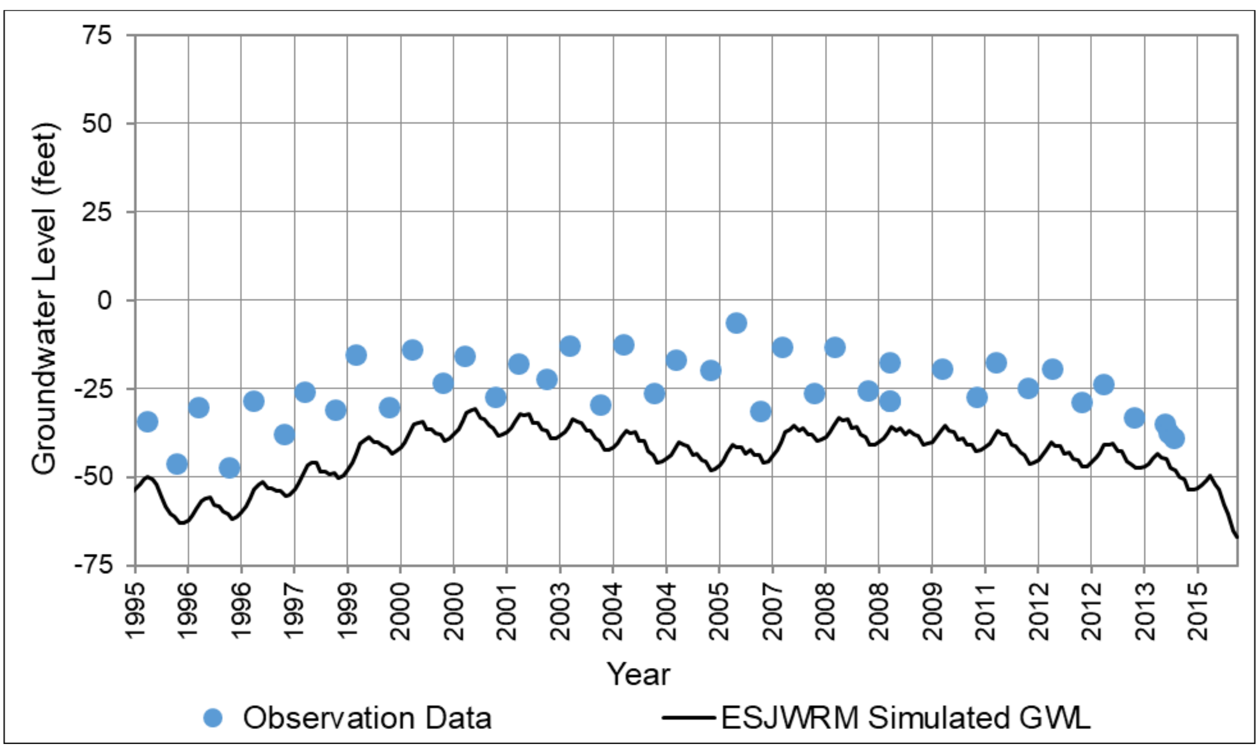


Figure C-36: ESJWRM Groundwater Level Hydrograph – Calibration Well #35

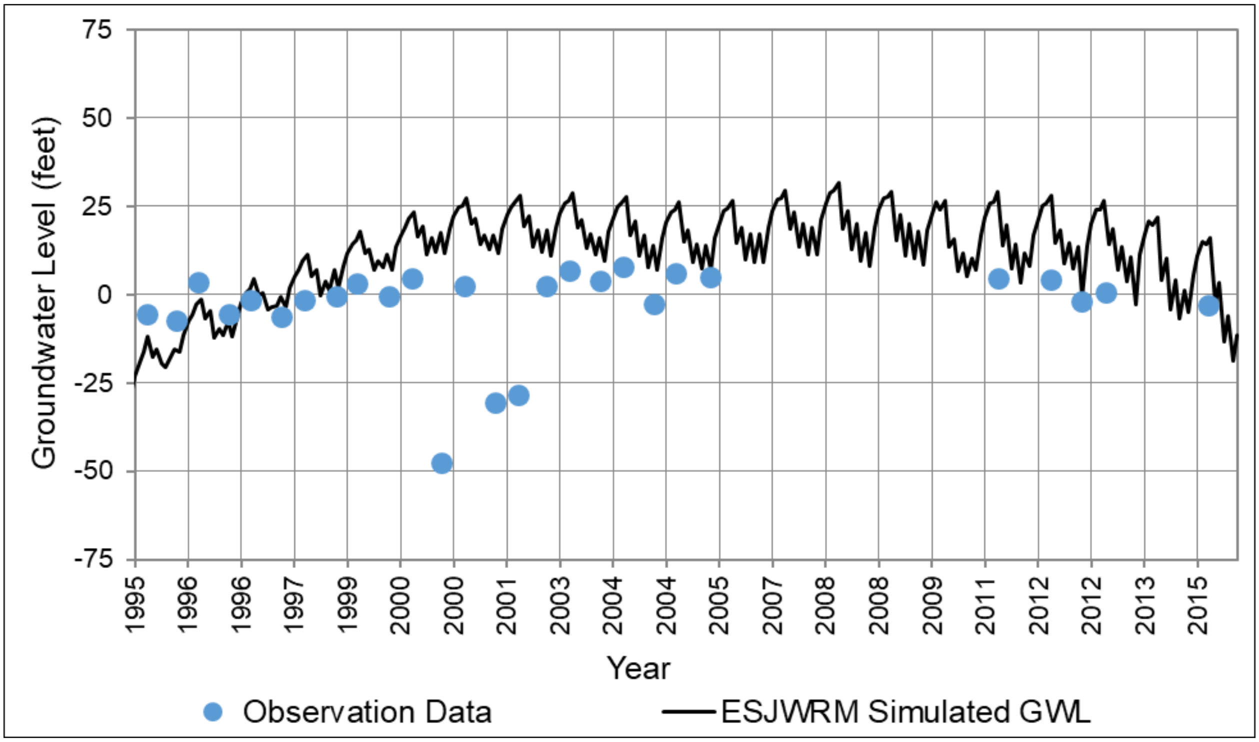


Figure C-37: ESJWRM Groundwater Level Hydrograph – Calibration Well #36

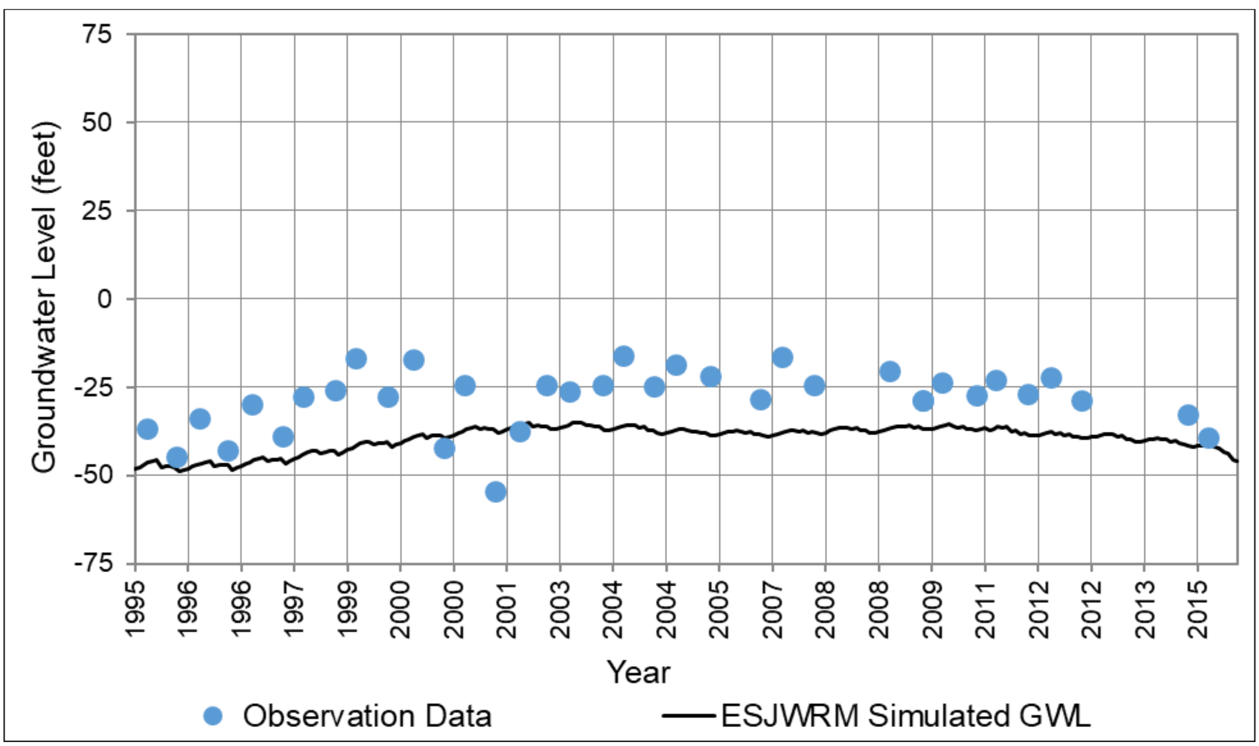


Figure C-38: ESJWRM Groundwater Level Hydrograph – Calibration Well #37

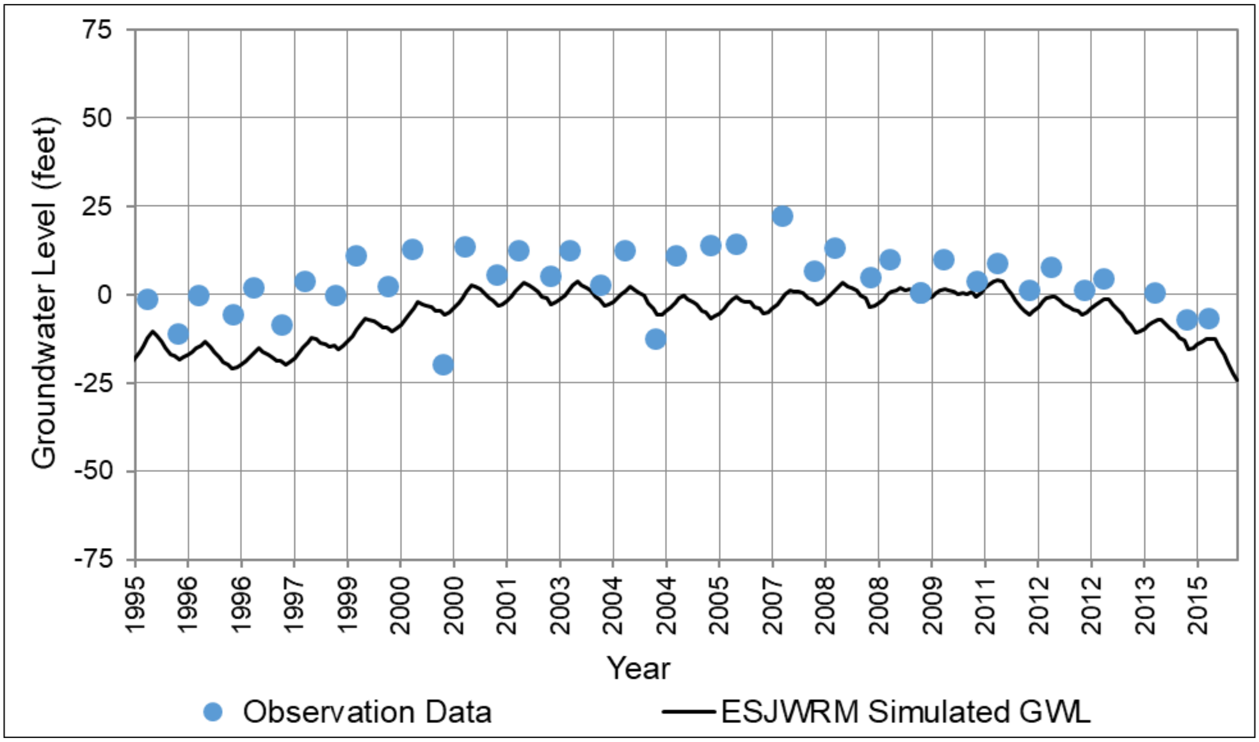
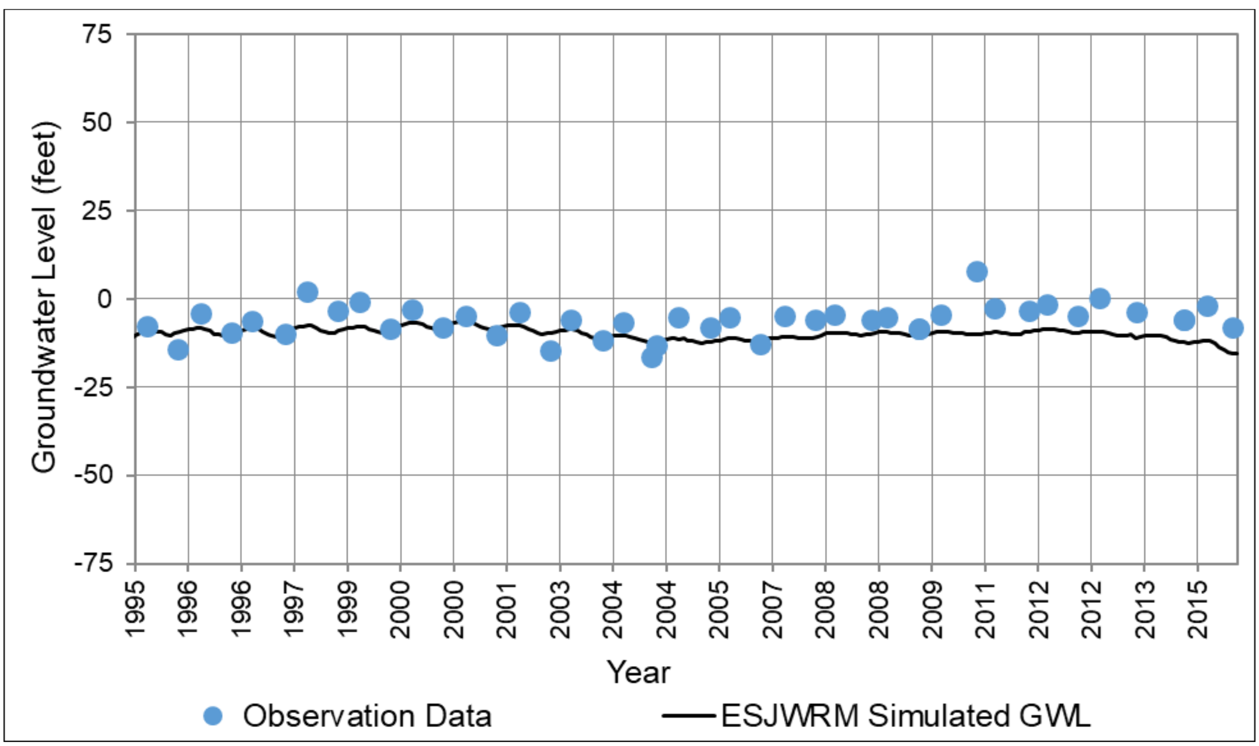


Figure C-39: ESJWRM Groundwater Level Hydrograph – Calibration Well #38



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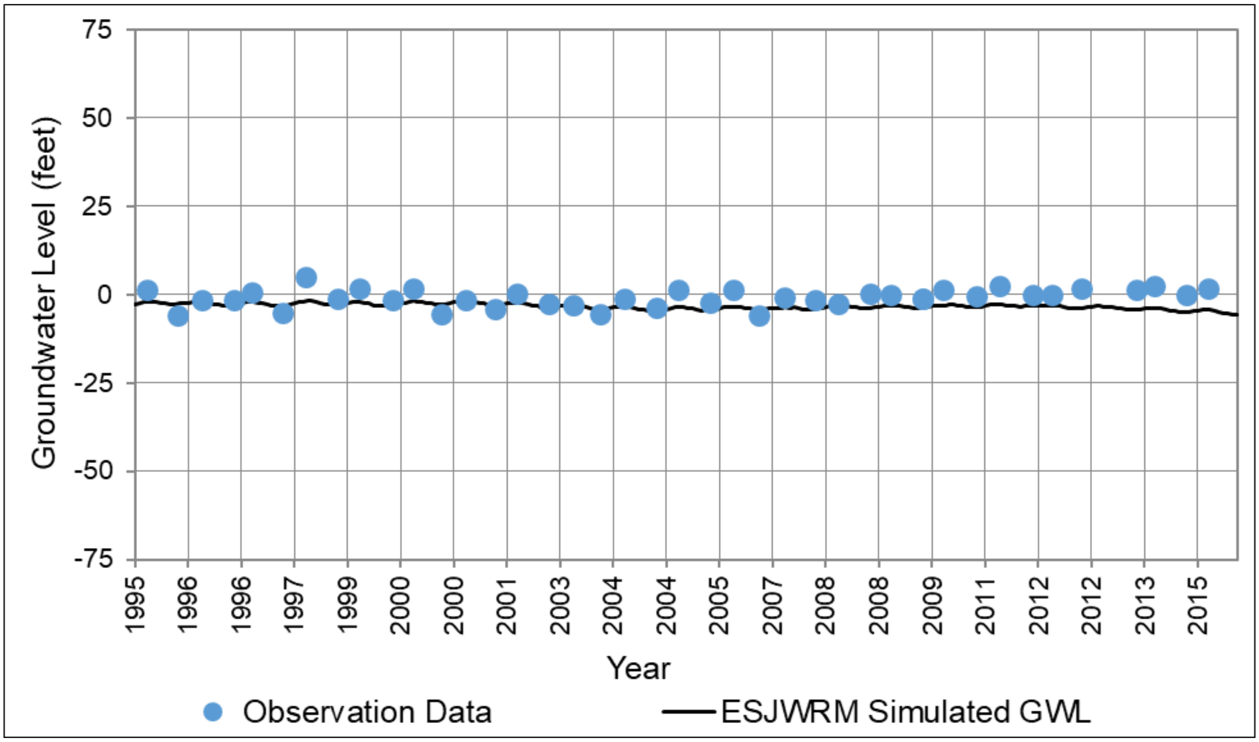


Figure C-41: ESJWRM Groundwater Level Hydrograph – Calibration Well #40

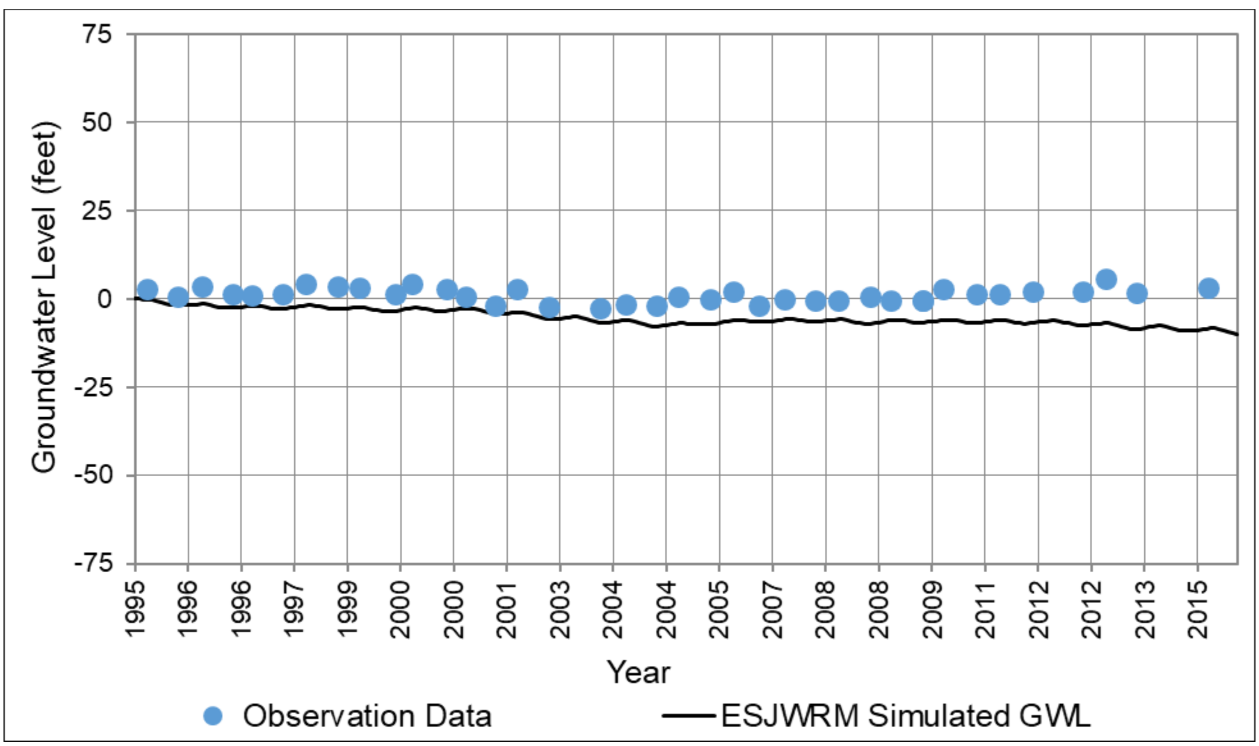


Figure C-42: ESJWRM Groundwater Level Hydrograph – Calibration Well #41

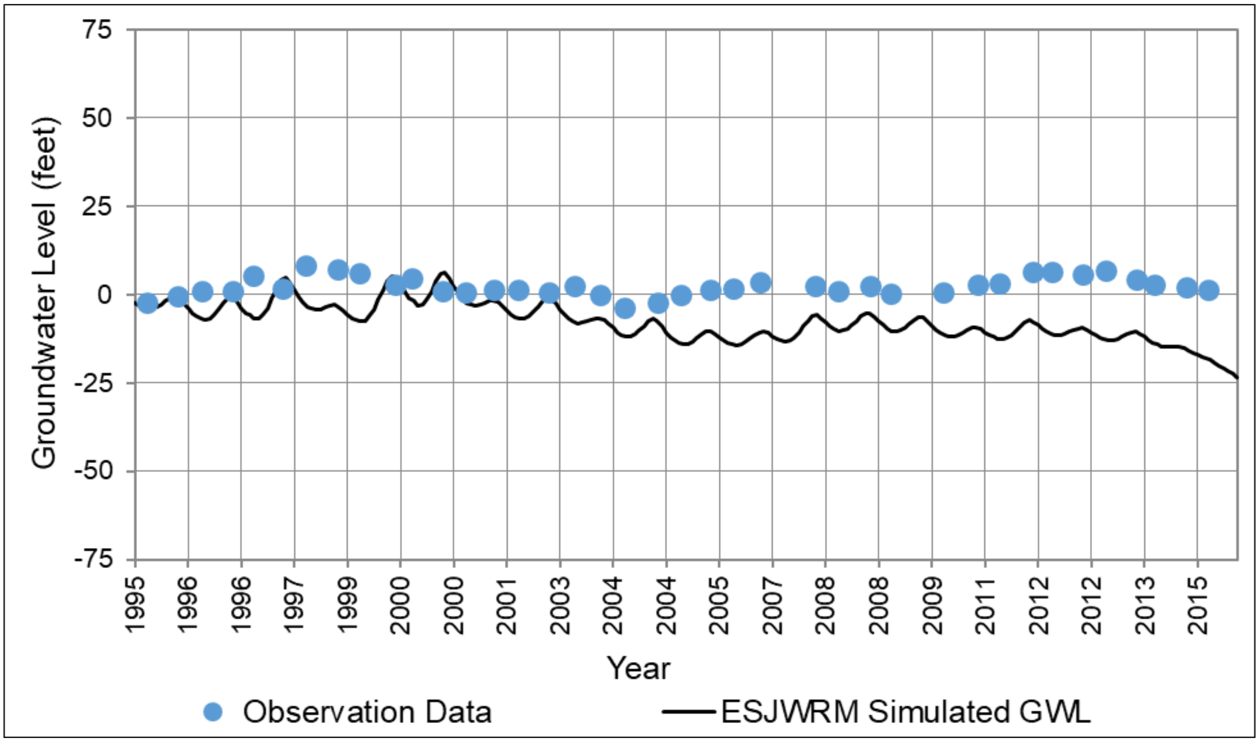
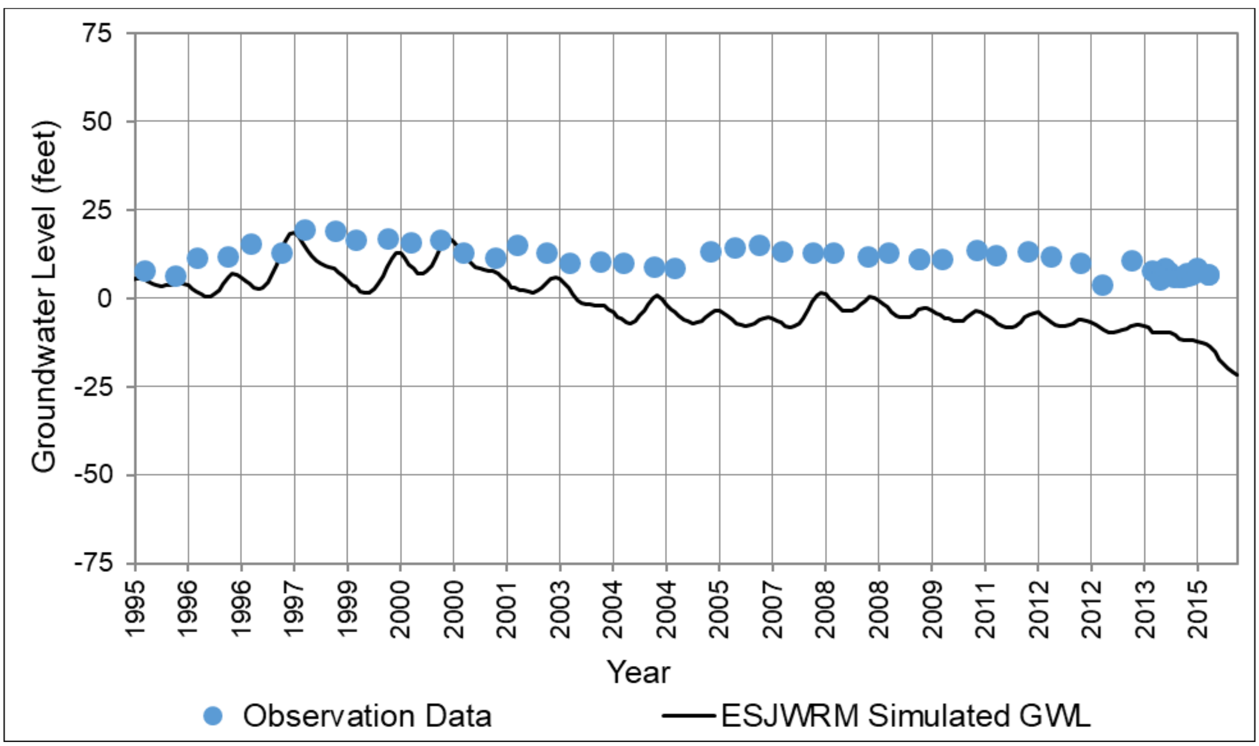


Figure C-43: ESJWRM Groundwater Level Hydrograph – Calibration Well #42



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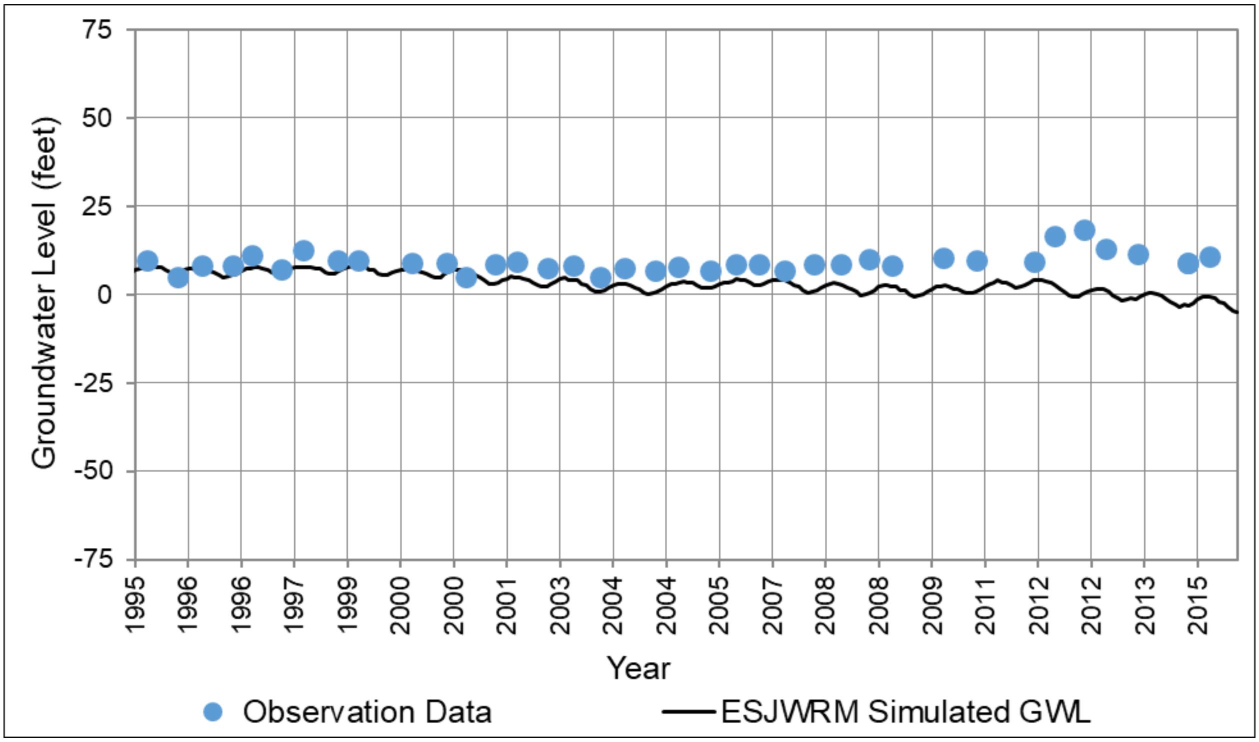

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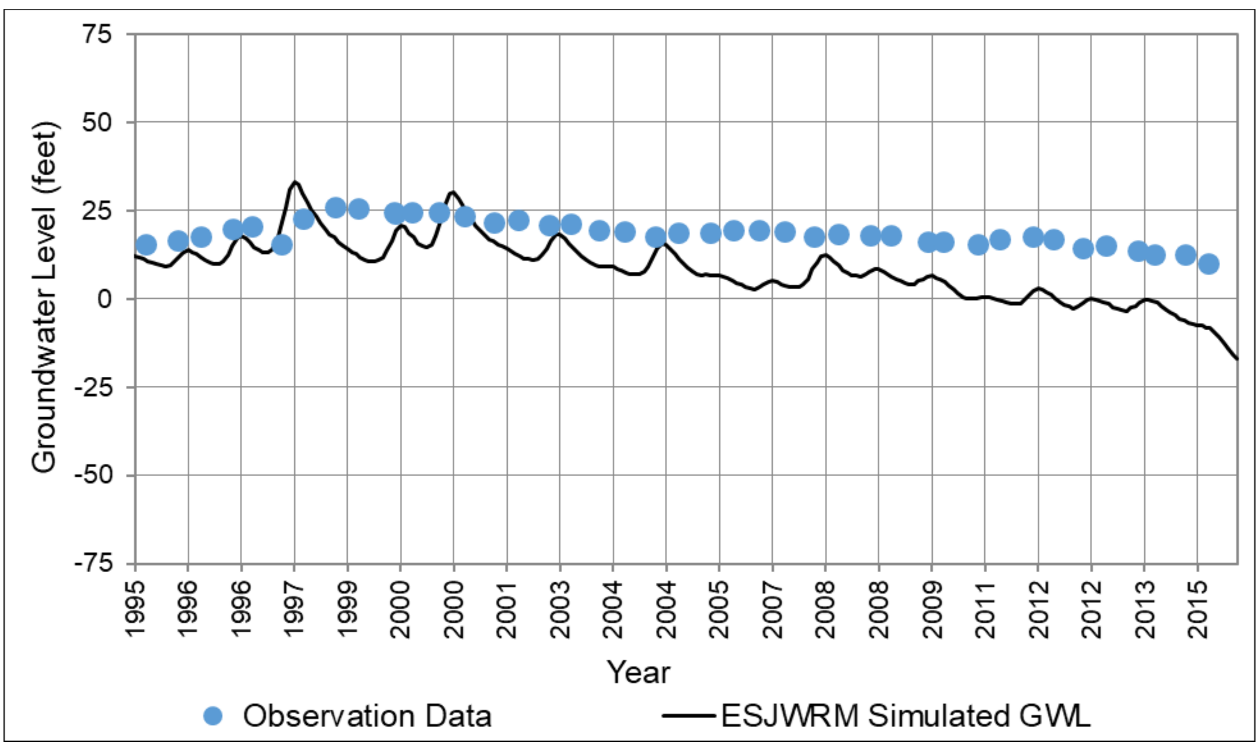

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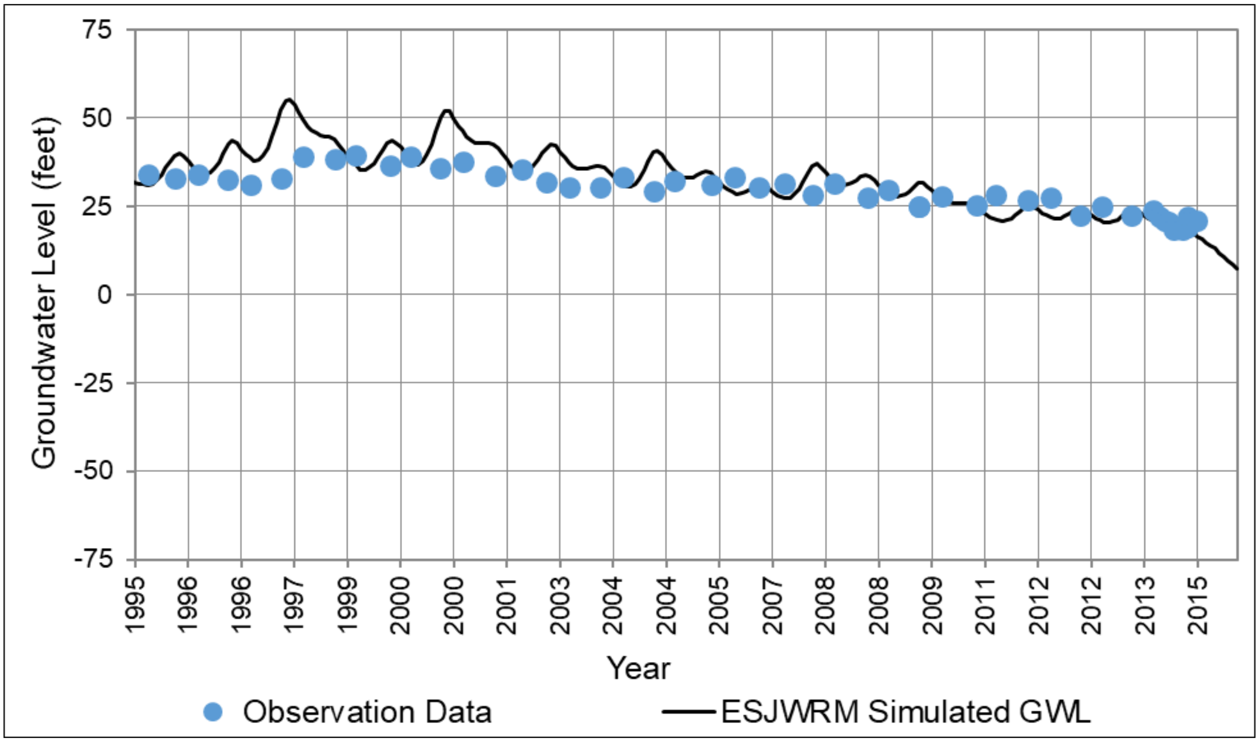

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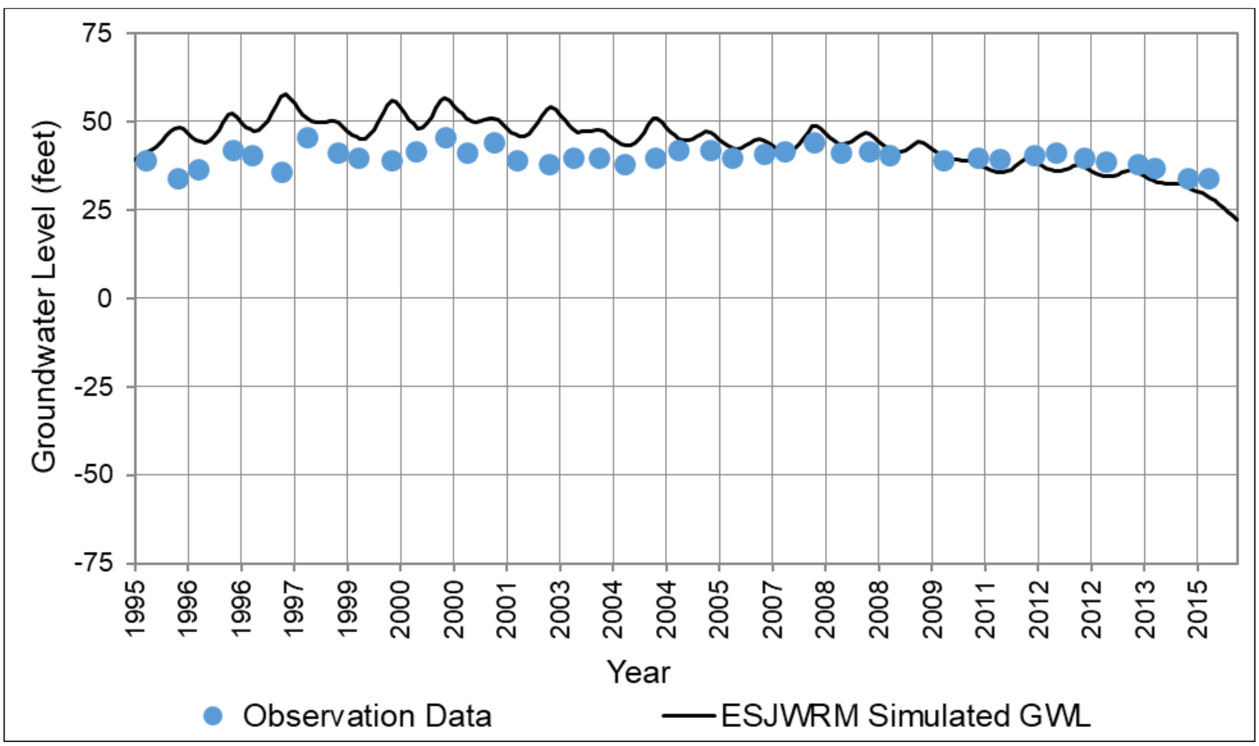

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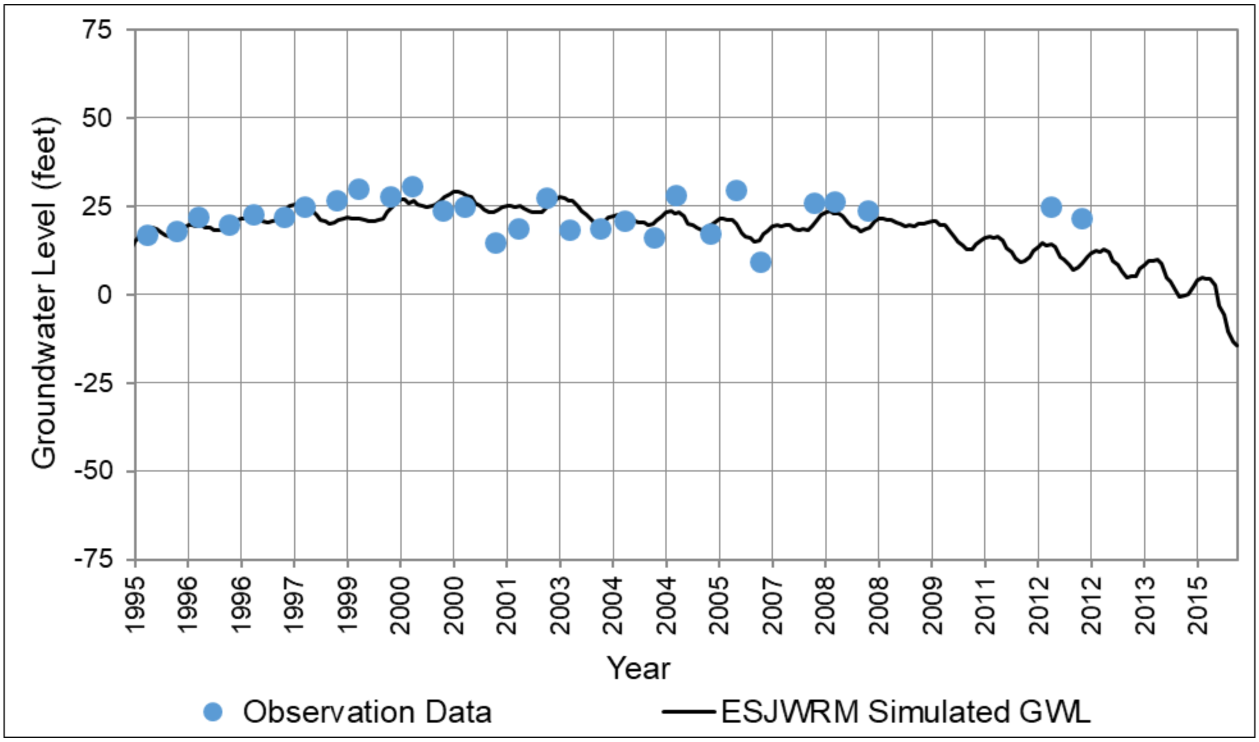

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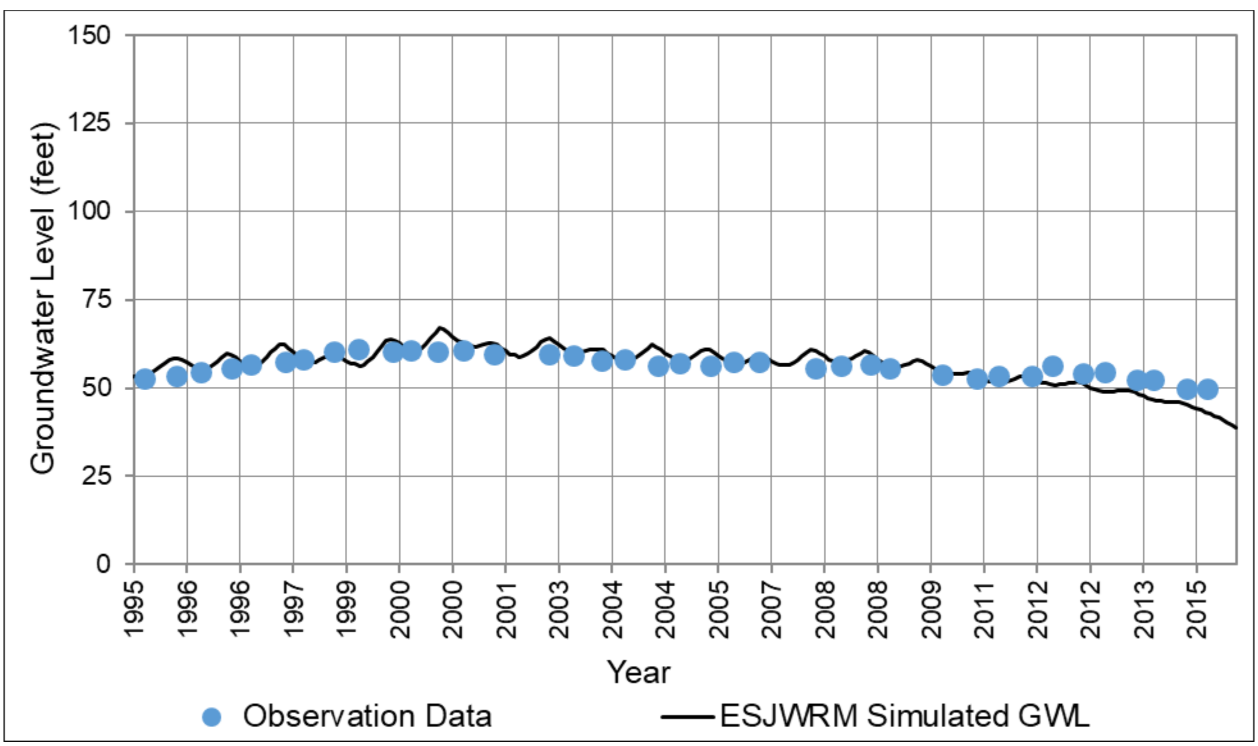

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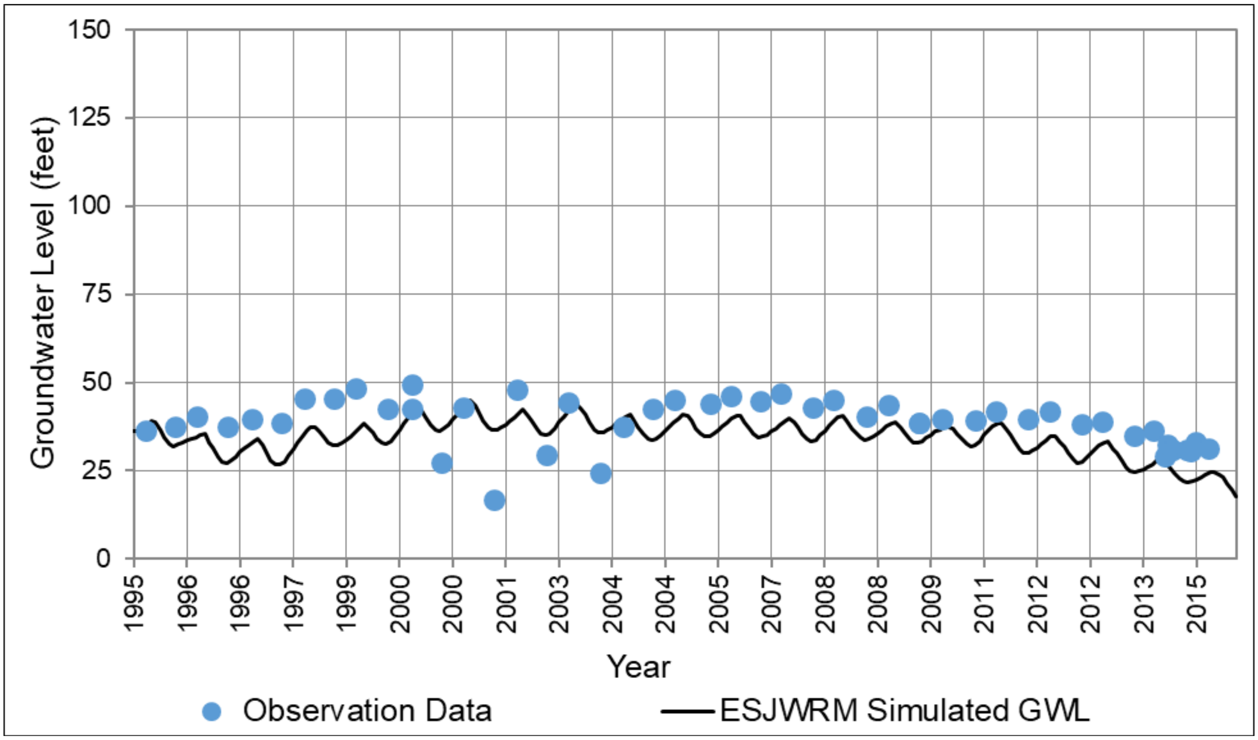

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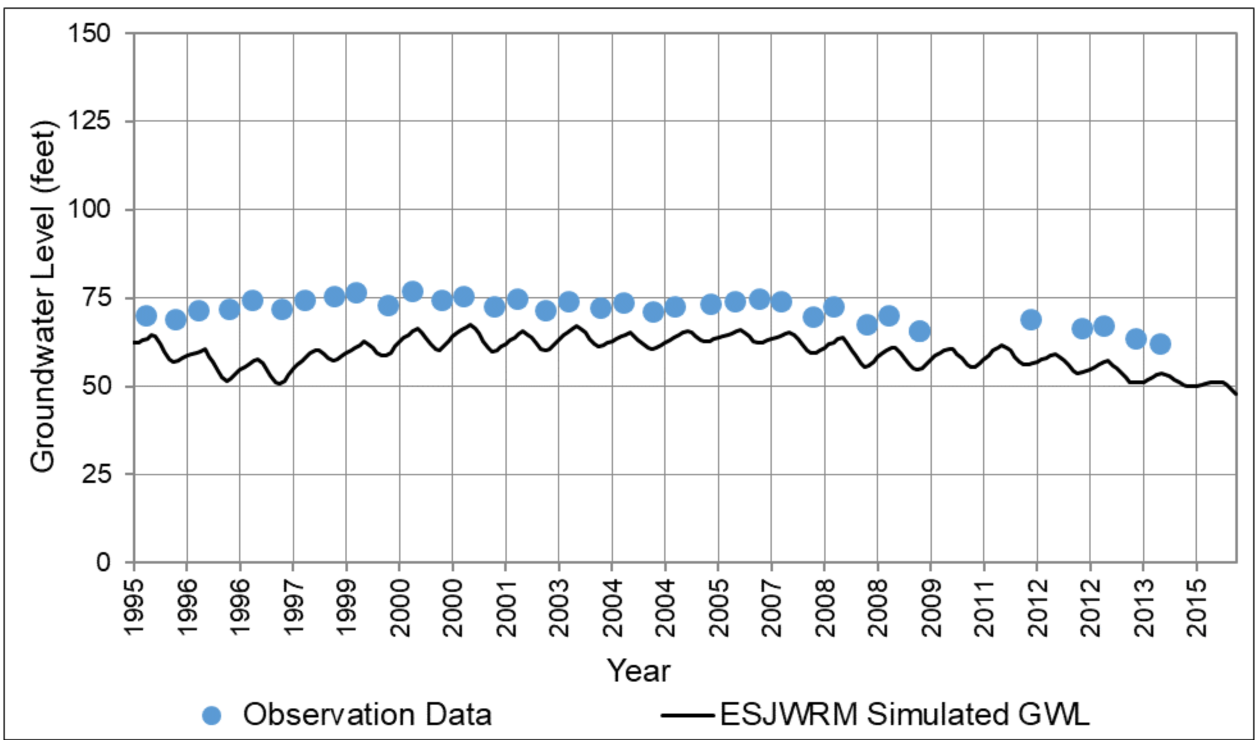

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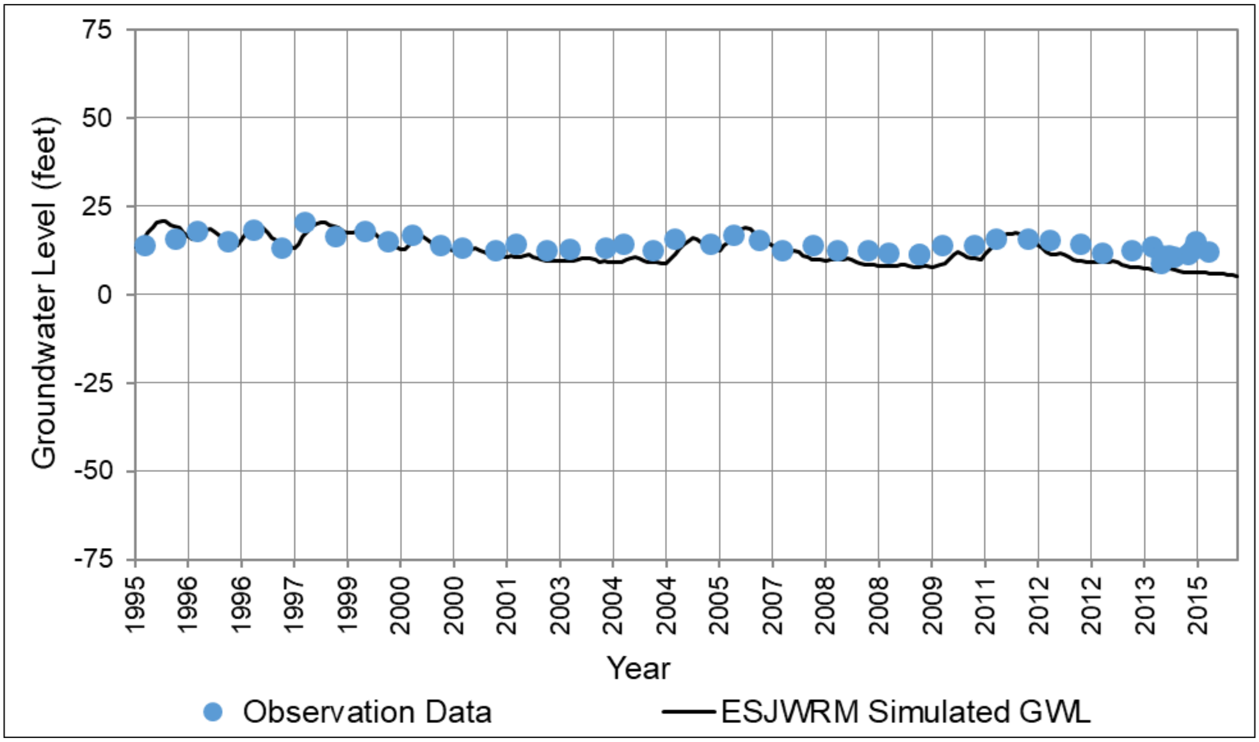

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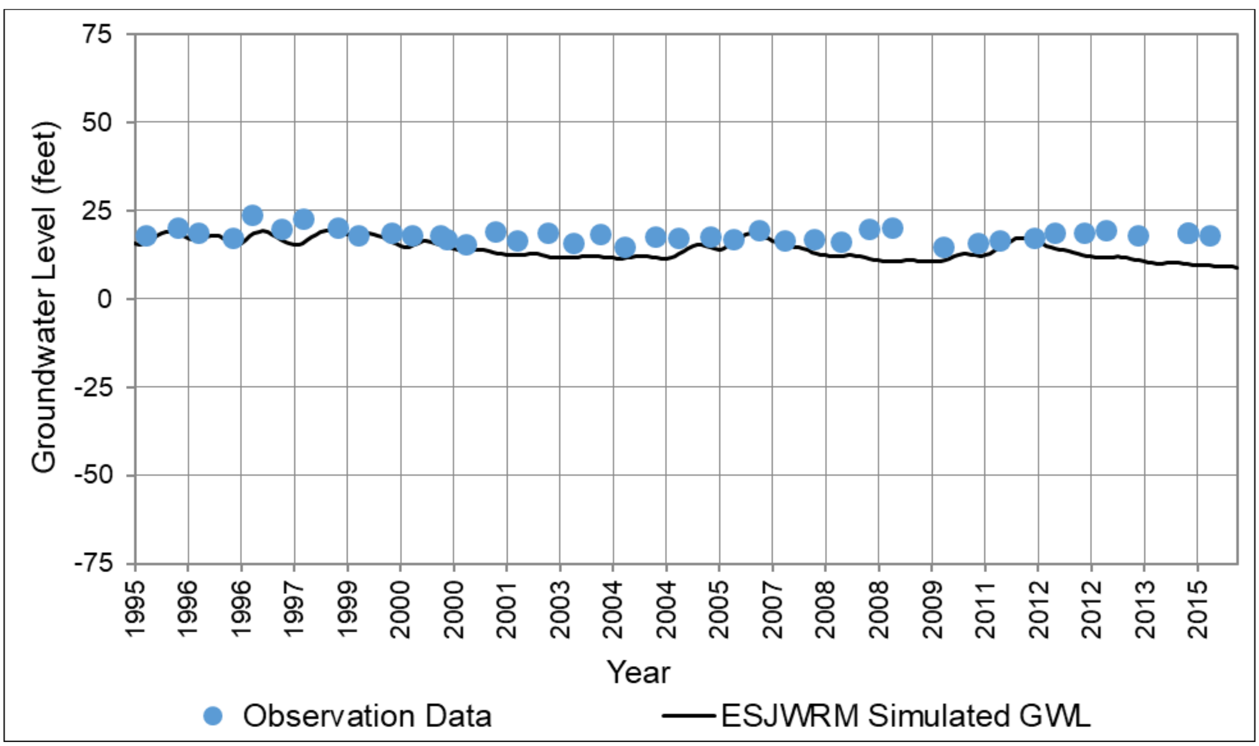

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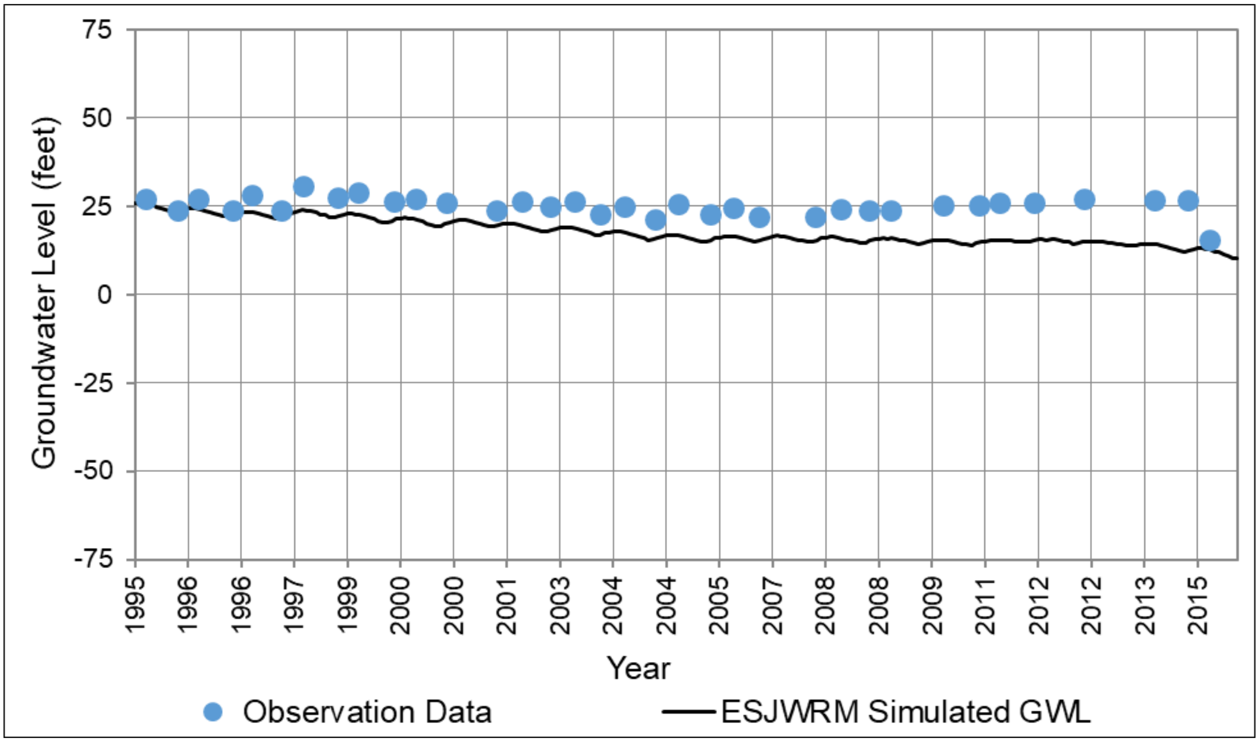

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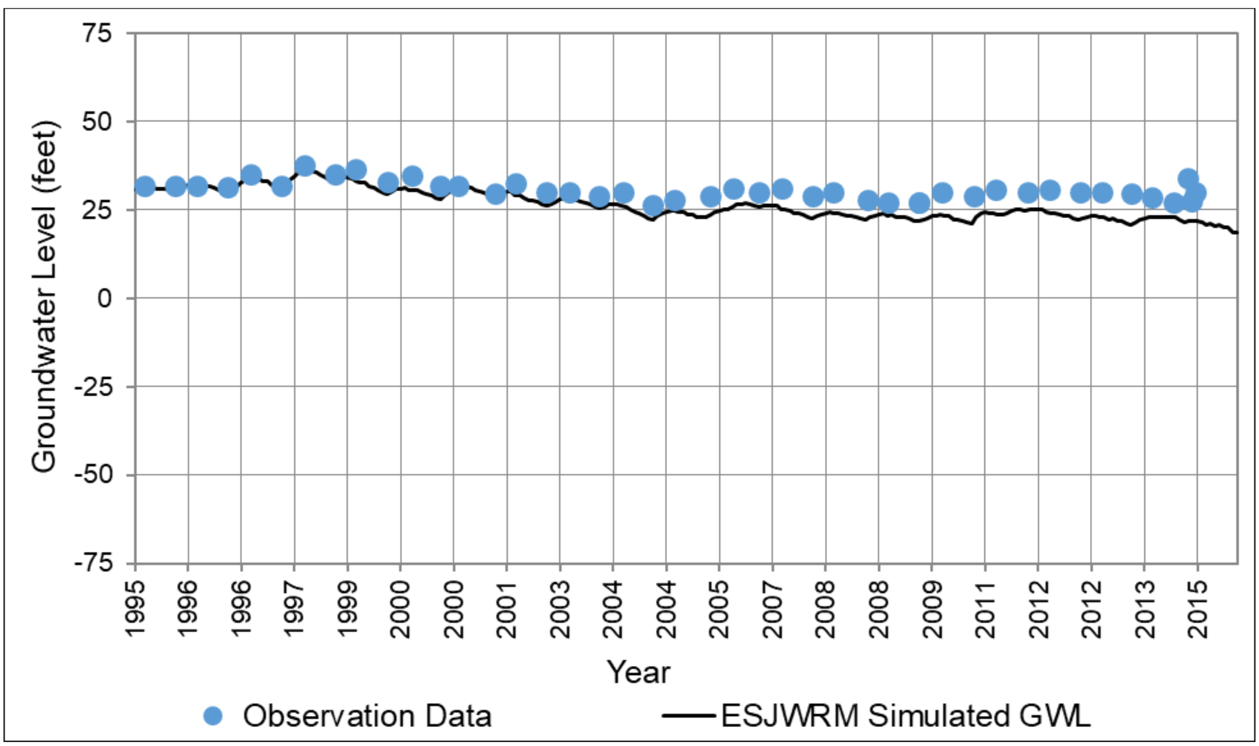

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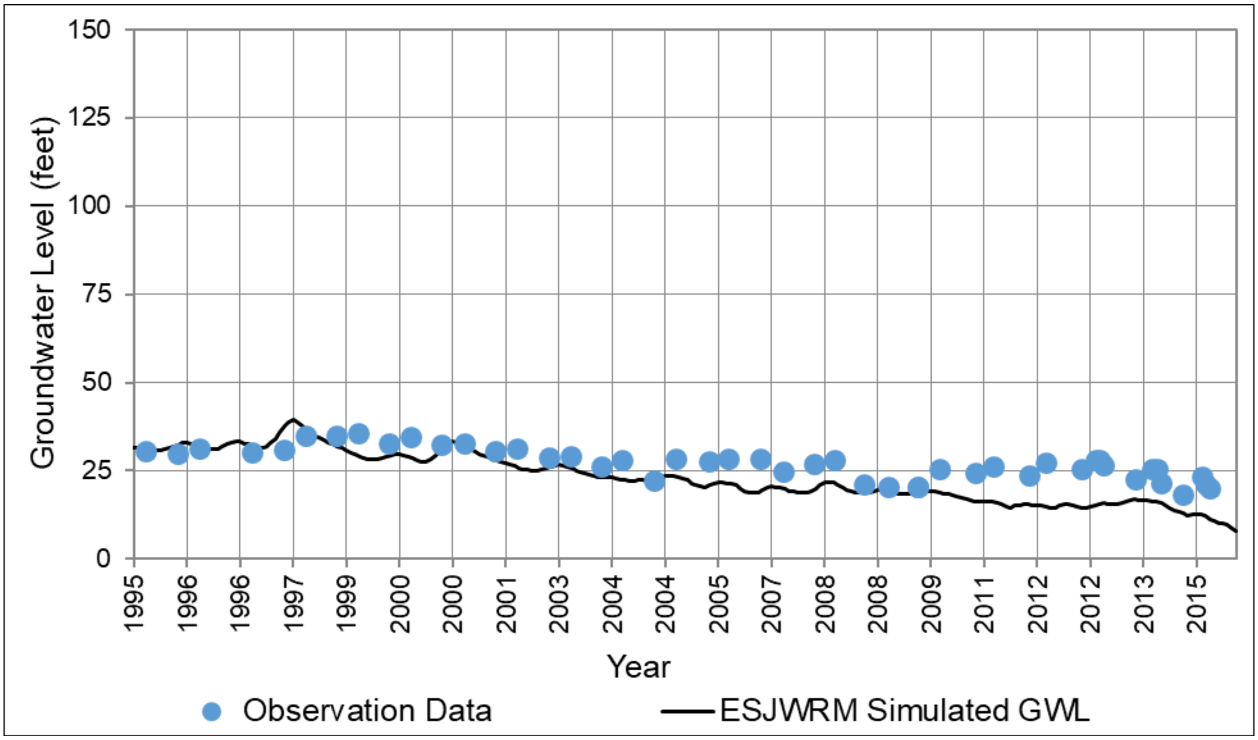

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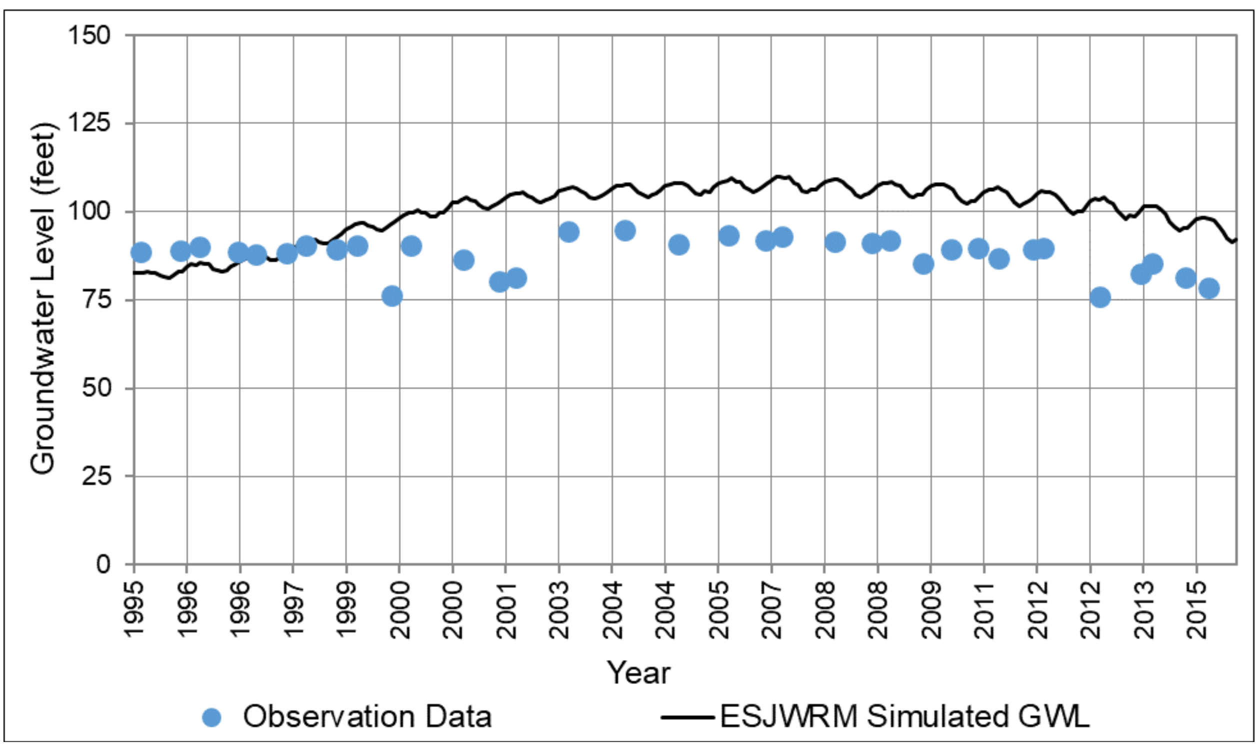

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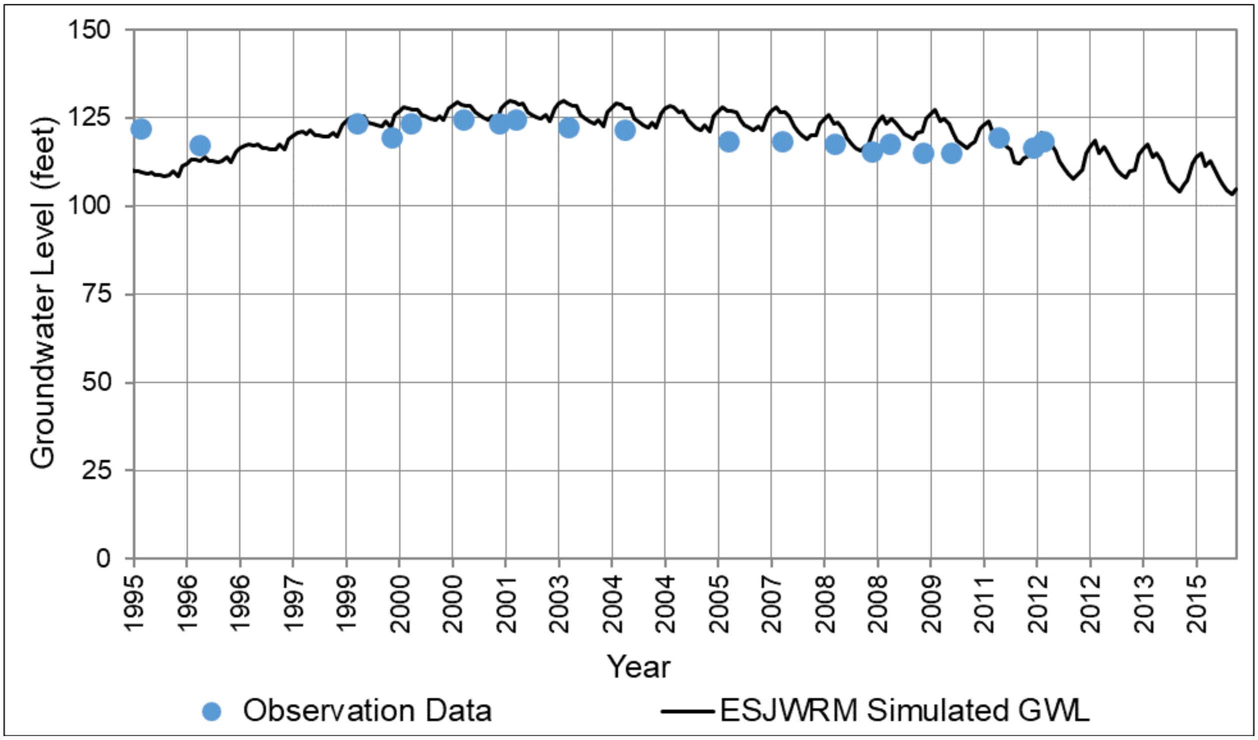

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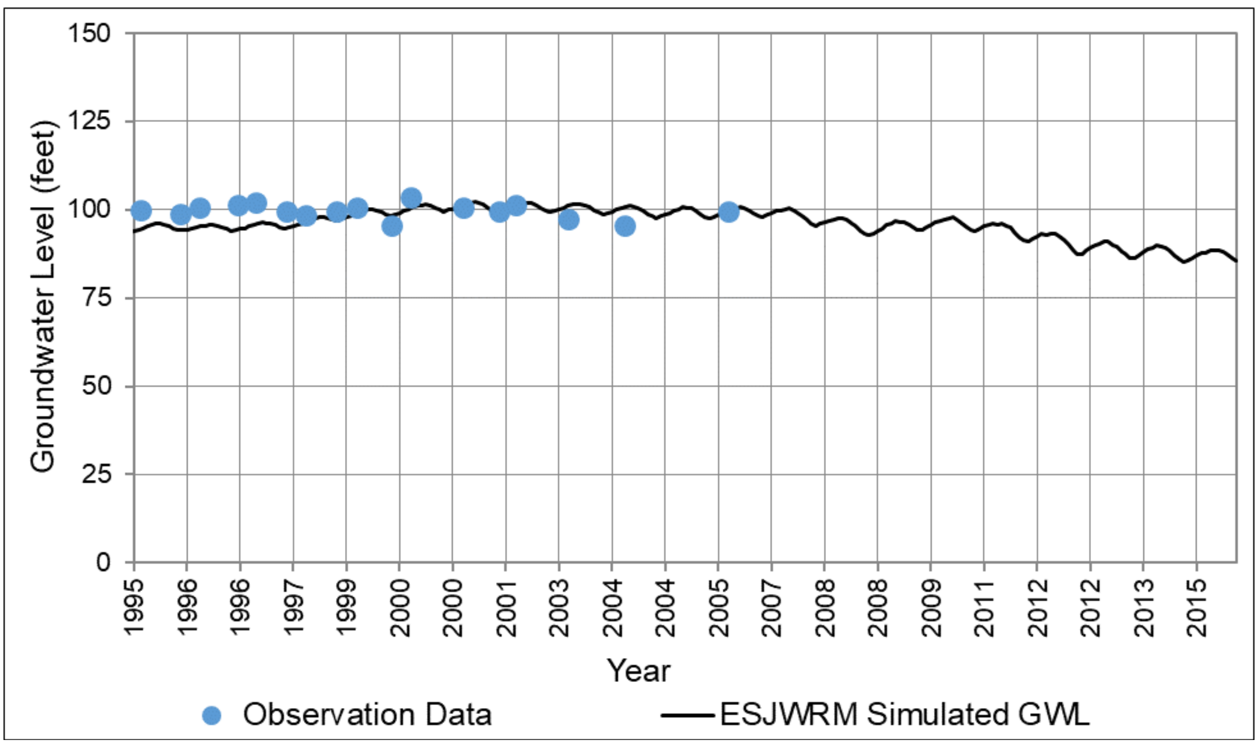


Figure C-60: ESJWRM Groundwater Level Hydrograph – Calibration Well #59

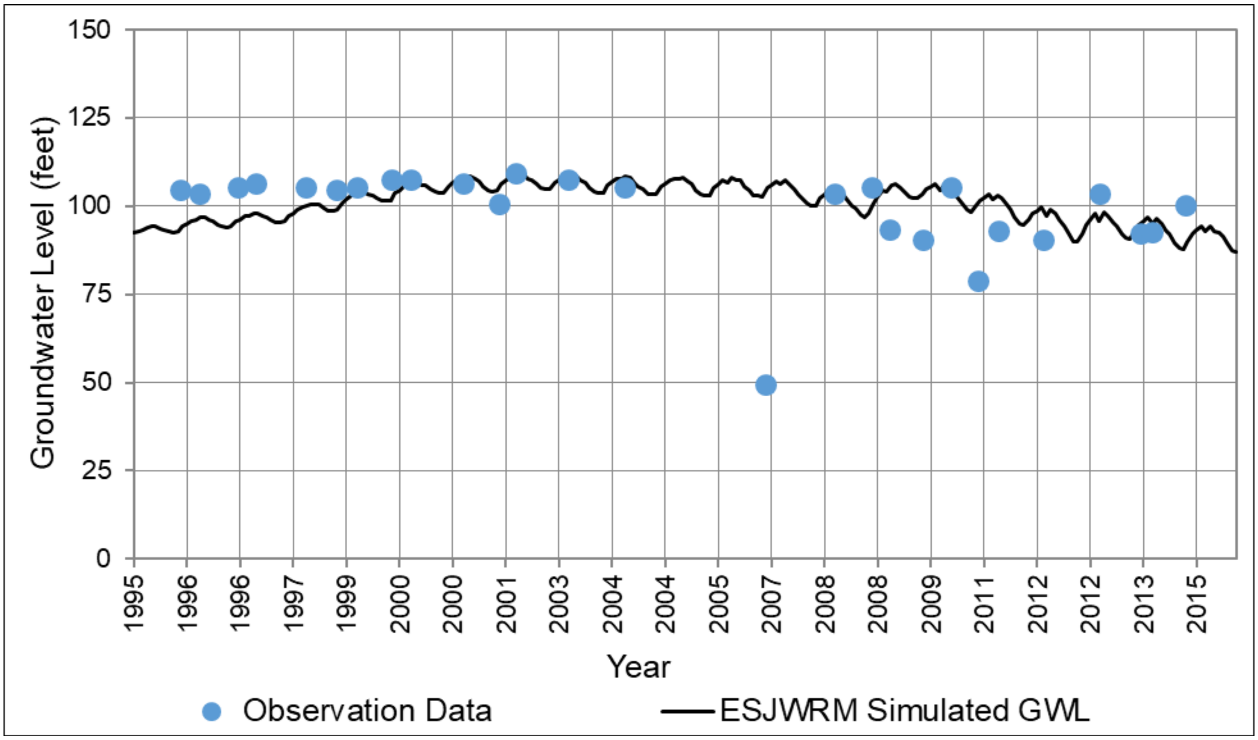


Figure C-61: ESJWRM Groundwater Level Hydrograph – Calibration Well #60

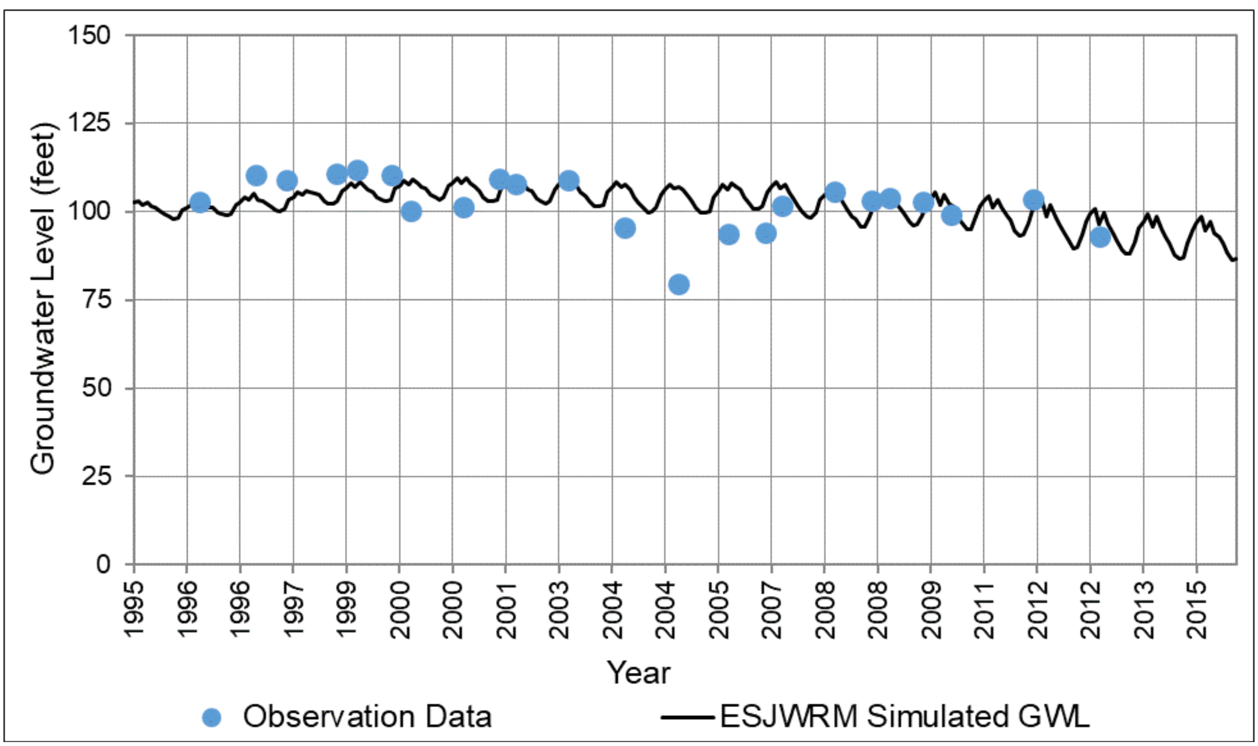
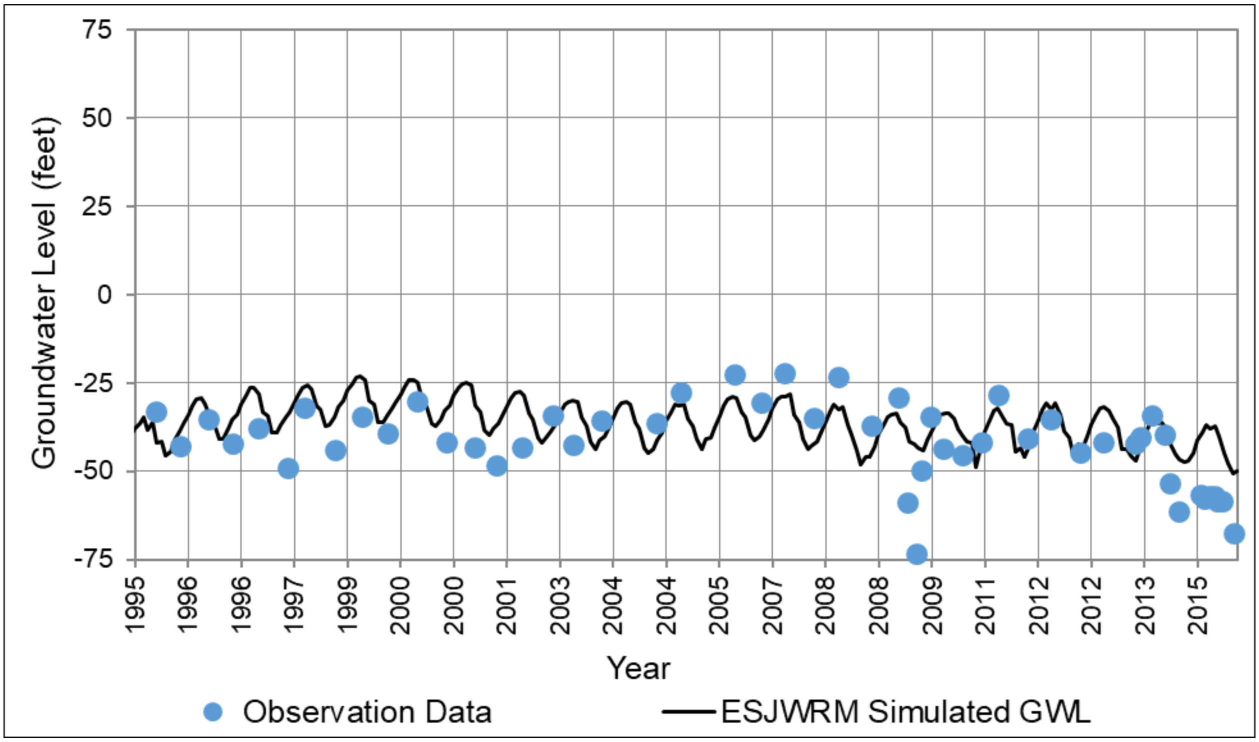


Figure C-62: ESJWRM Groundwater Level Hydrograph – Calibration Well #61



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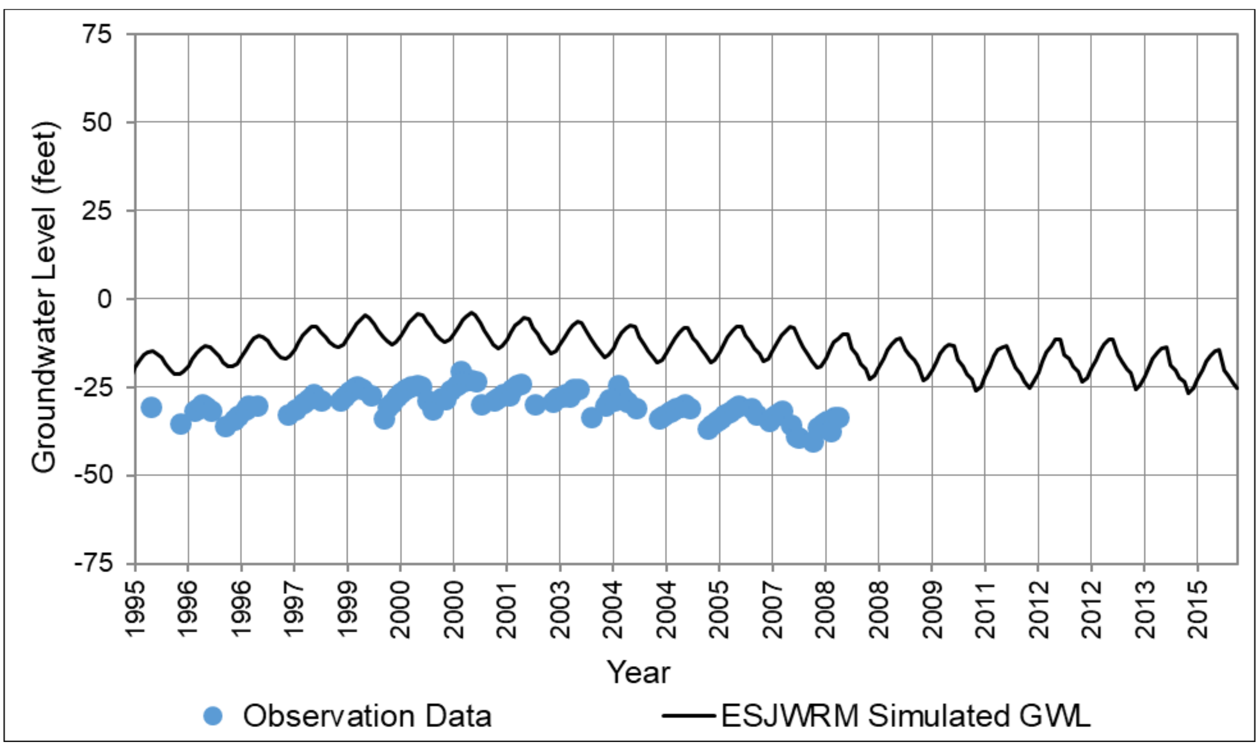

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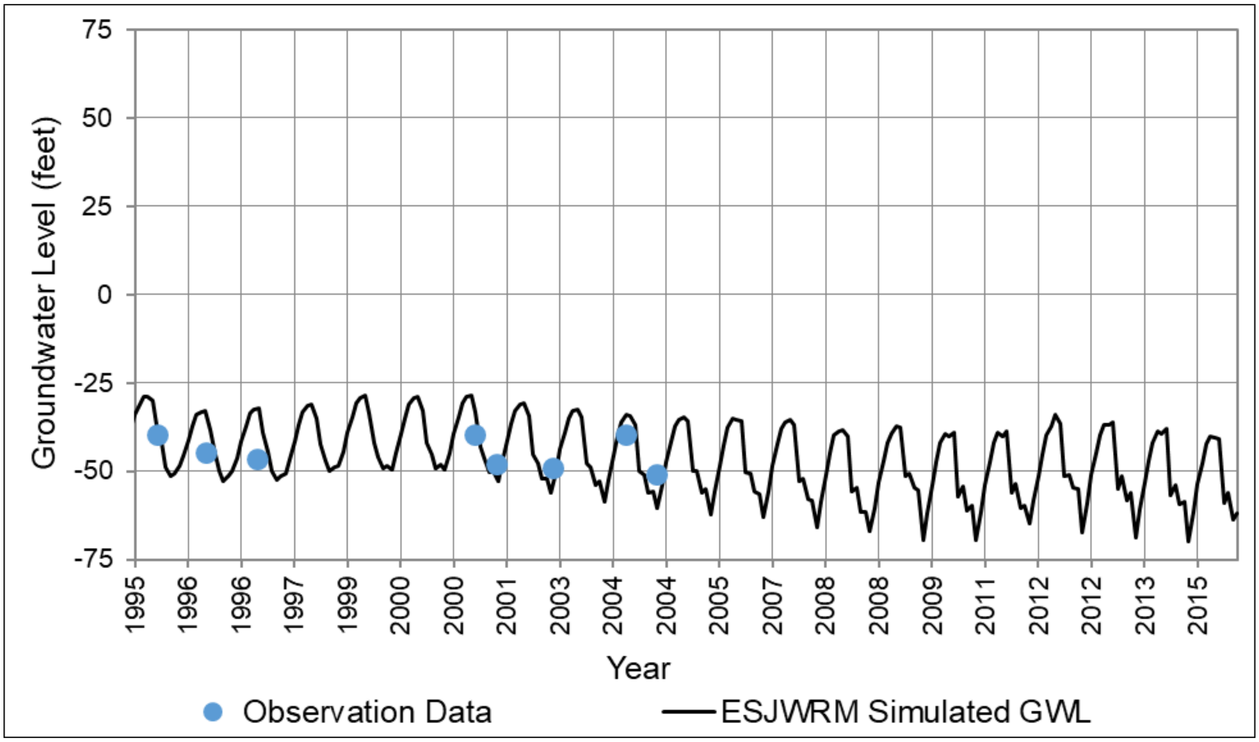

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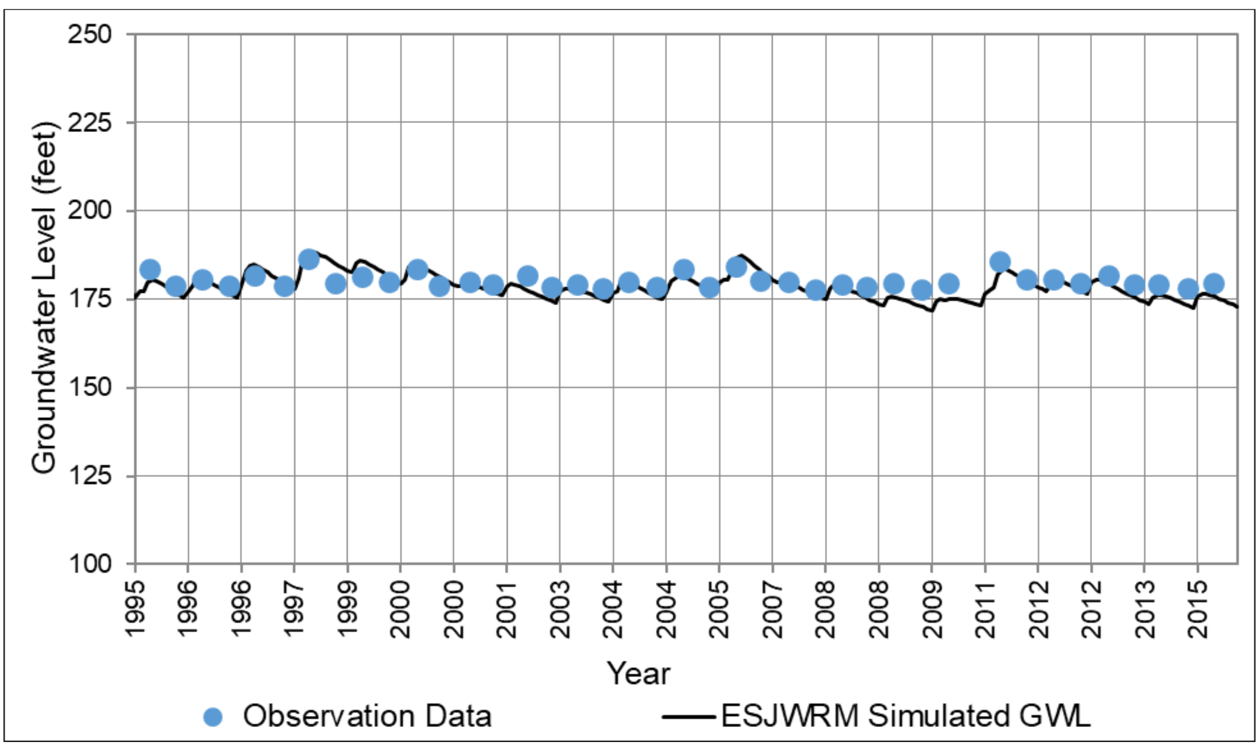

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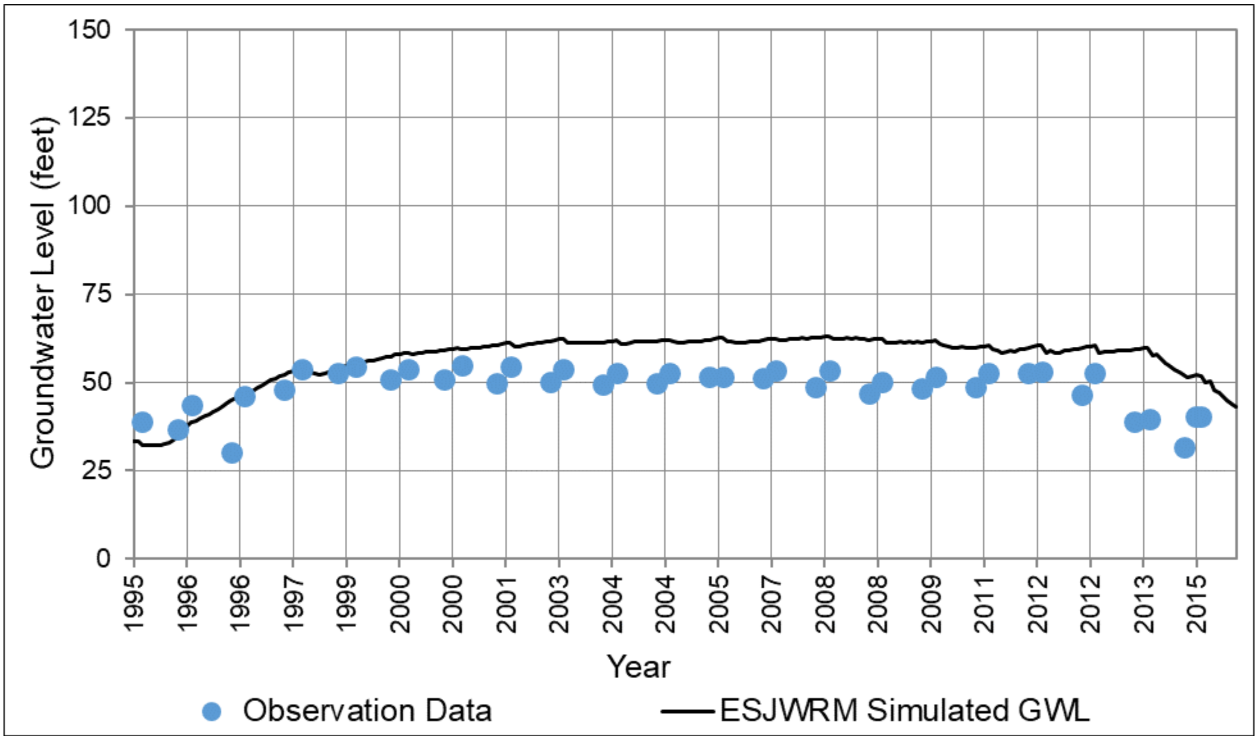


Figure C-67: ESJWRM Groundwater Level Hydrograph – Calibration Well #66

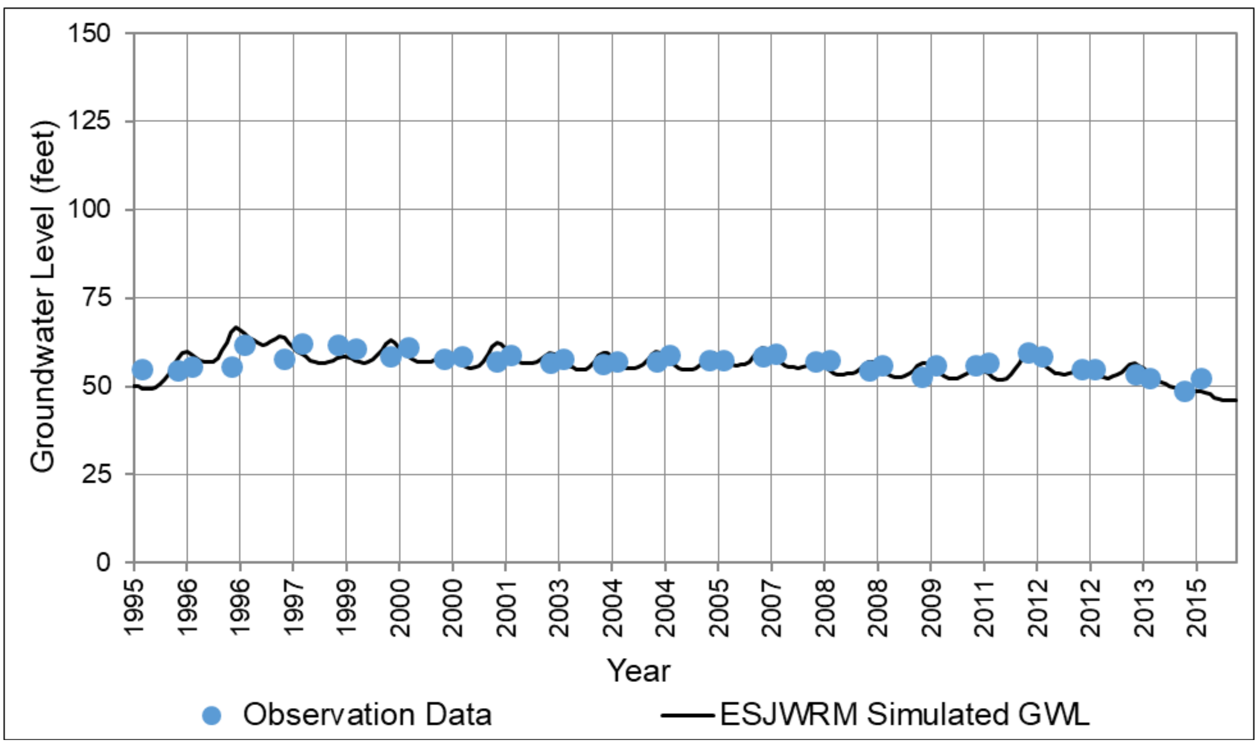


Figure C-68: ESJWRM Groundwater Level Hydrograph – Calibration Well #67

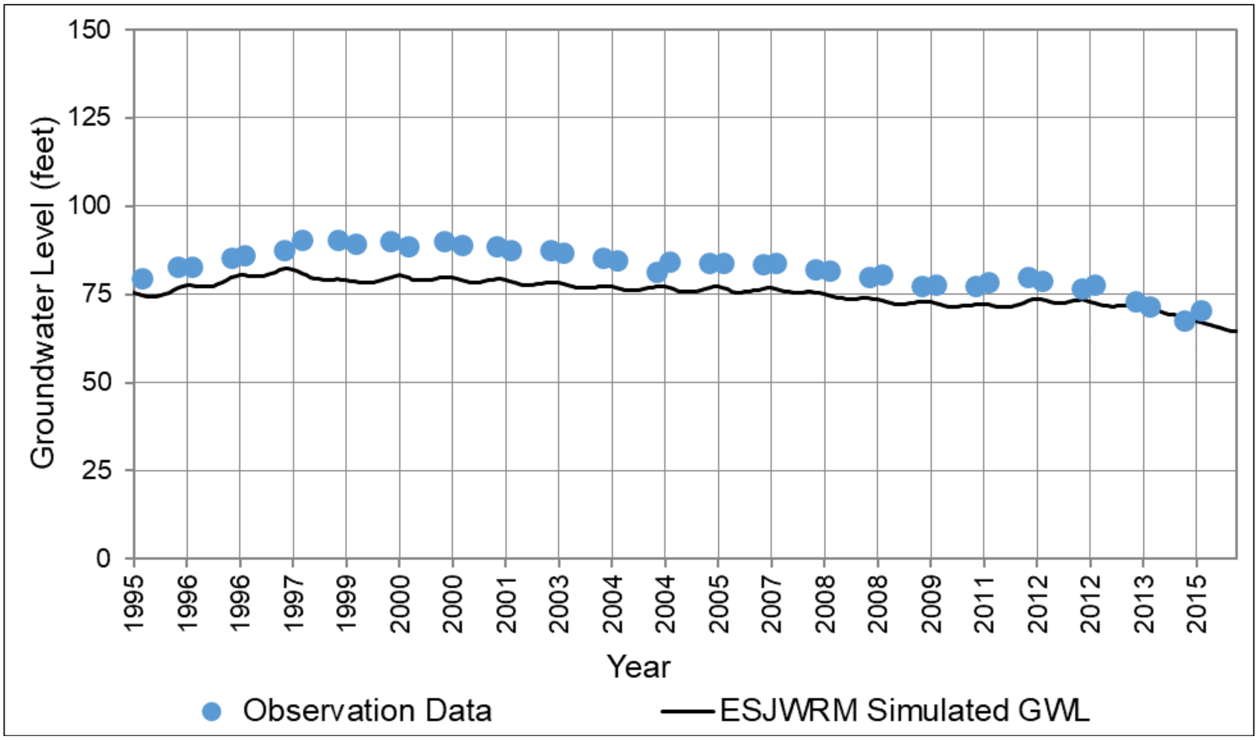


Figure C-69: ESJWRM Groundwater Level Hydrograph – Calibration Well #68

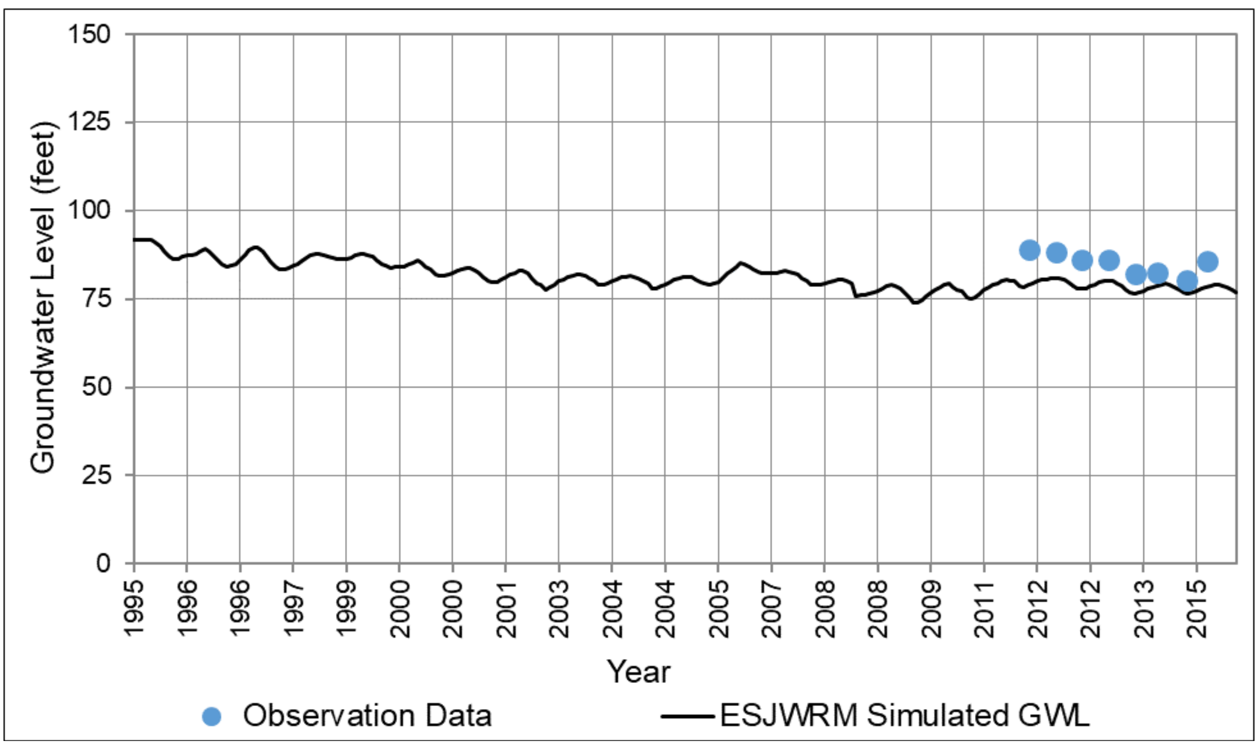


Figure C-70: ESJWRM Groundwater Level Hydrograph – Calibration Well #69

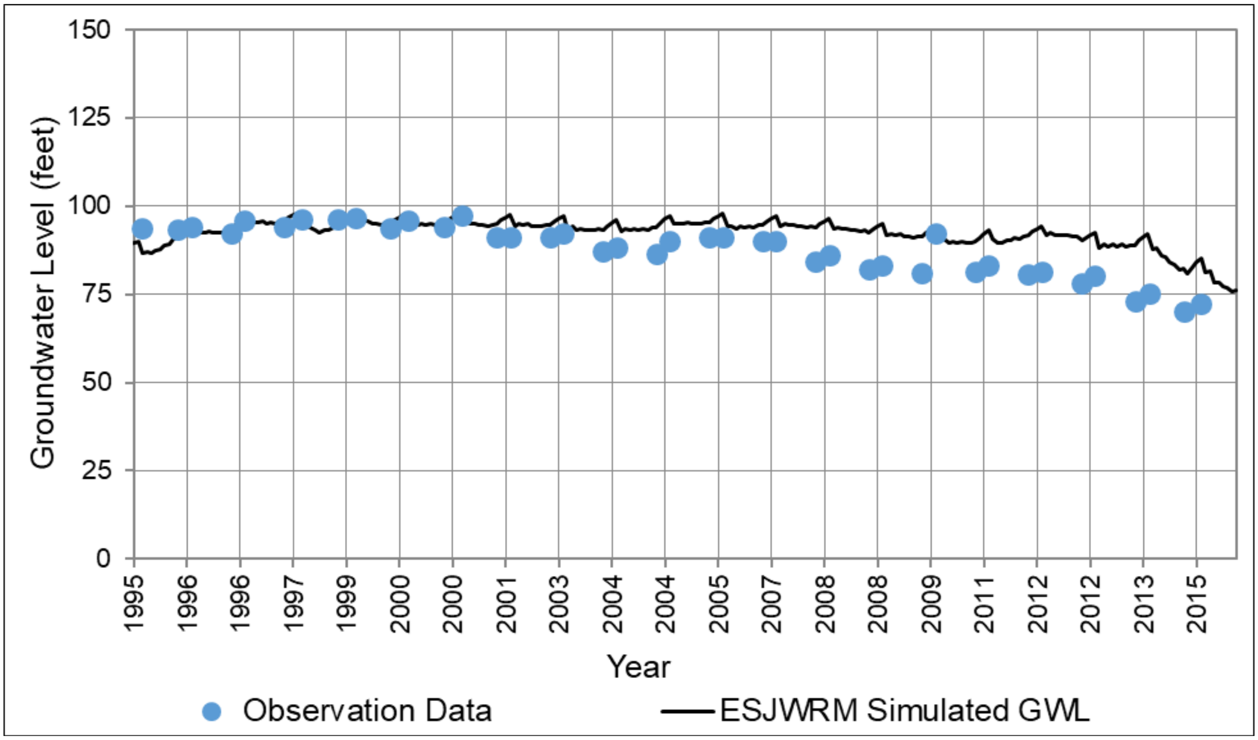
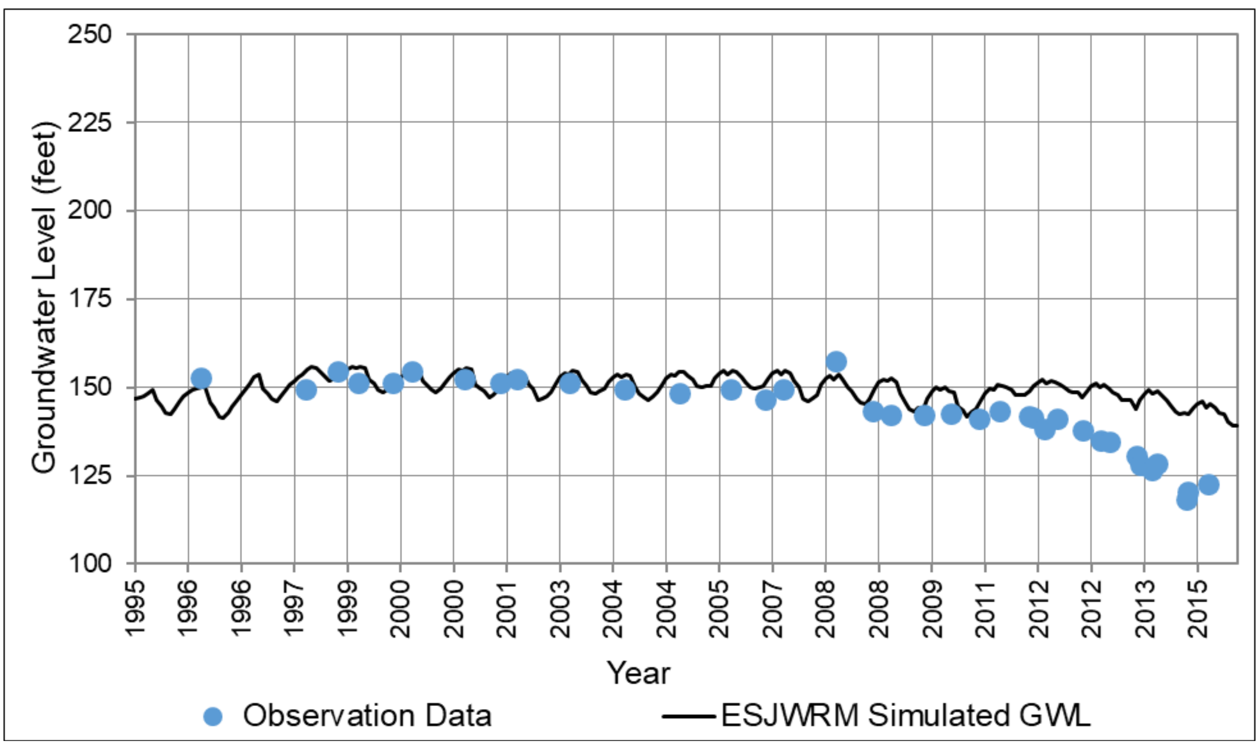


Figure C-71: ESJWRM Groundwater Level Hydrograph – Calibration Well #70



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APPENDIX 2-B.
EASTERN SAN JOAQUIN WATER RESOURCES MODEL (ESJWRM) REPORT VERSION 2.0 UPDATE (2022)

ATTACHMENT 2

Eastern San Joaquin Water Resources Model (ESJWRM)

Version 2.0 Update

Prepared for:

Eastern San Joaquin Groundwater Authority

EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

UPDATED DRAFT

June 2, 2022

Woodard & Curran

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Appendices

1 Historical Calibration Update

The Eastern San Joaquin Water Resources Model (ESJWRM) was developed primarily to evaluate the current and recent historical groundwater conditions of the Eastern San Joaquin Groundwater Subbasin (ESJ Subbasin or Subbasin) and simulate various current and future condition scenarios as part of the Groundwater Sustainability Plan (GSP) preparation process under the Sustainable Groundwater Management Act (SGMA) (Woodard & Curran, 2018a). The fine geographic scale of the model provides the opportunity for individual Groundwater Sustainability Agencies (GSAs) to evaluate the effect of changing ESJ Subbasin conditions on smaller GSA areas. The Eastern San Joaquin Groundwater Authority (ESJGWA) was formed by a Joint Powers Agreement (JPA) and coordinates the SGMA activities for the Subbasin. The ESJGWA members include the 16 GSAs in the Subbasin.

ESJWRM uses the Integrated Water Flow Model (IWFM-2015) platform, has a finite element grid, includes data on a monthly time step, and covers the area of Cosumnes Subbasin, Eastern San Joaquin Subbasin, Modesto Subbasin, and the portion of the City of Lathrop east of San Joaquin River in the Tracy Subbasin. The original development of ESJWRM was from 2016 through 2018, with application of ESJWRM to GSP development occurring from 2018 through 2020 and resulting in a November 2019 GSP (ESJGWA, 2019). The GSP version of the ESJWRM (ESJWRM Version 1.1), which covers Water Years (WY) 1995 through 2015 (October 1994 through September 30, 2015), was documented in an August 2018 report (Woodard & Curran, 2018a) as well as a February 2018 technical memorandum (Woodard & Curran, 2018b). The earlier reports cover the development of the model, the model platform, the model framework, and all input data and results. This report serves as an update to the earlier model report (Woodard & Curran, 2018a) and only discusses portions of the model that were updated as part of the recent effort to develop ESJWRM Version 2.0, as well as a complete discussion of updated model results. This section includes all the updates made to ESJWRM Version 2.0.

1.1 Model Code and Data Updates Since the Groundwater Sustainability Plan

Since the ESJ Subbasin GSP was finalized in November 2019, the ESJWRM has undergone three updates:

1. Extension of Data from Water Year 2016 through Water Year 2019
2. Extension of Data through Water Year 2020
3. Full Model Update and Recalibration (resulting in ESJWRM Version 2.0)

The first two updates were completed as part of the preparation of ESJ Subbasin GSP annual reports to the Department of Water Resources (DWR). These updates only included an extension of model time series data (i.e., land use, surface water diversions, groundwater well pumping, and urban demand) and the model provided estimates of total surface water supplies, groundwater pumping, and change in groundwater storage for the water year covered by the model report. The third and major update is the focus of this report and the majority of the work was performed in 2021. Through discussions with GSAs near the completion of the GSP, several areas for update and refinement in the ESJWRM were identified. The goals of the 2021 model update to ESJWRM Version 2.0 were to:

1. Confirm the data in the ESJWRM is the latest hydrologic, water supply, and operations data available. This includes updating issues identified through discussions with the GSAs as part of the GSP process and including newer data and techniques that were unavailable in the development of the original model.

2. Refine the model calibration to ensure a reasonable representation of the hydrologic conditions in the ESJ Subbasin with the updated data and observation information.
3. Update the projected conditions baseline to estimate conditions in the ESJ Subbasin at buildout (approximately 2040) without GSP projects and potential climate change conditions. This update is discussed in Section 2.
4. Use the updated ESJWRM versions to develop water budgets at the GSA level to understand the water operations for each GSA to support a water accounting framework and assessment of benefits and impacts of sustainability actions at the GSA level. This is discussed in Section **Error! Reference source not found.**.

The data update was completed through extensive outreach to GSAs and Subbasin agencies and coordination with the ESJGWA Technical Advisory Committee (TAC), including meeting presentations and interaction with stakeholders. Data for the model update included a variety of agencies and GSAs. Below is a list of the agencies that provided data and input on the model update:

Agricultural Water Purveyors

- Calaveras County Water District (CCWD)
- Central San Joaquin Water Conservation District (CSJWCD)
- North San Joaquin Water Conservation District (NSJWCD)
- Oakdale Irrigation District (OID)
- South San Joaquin Irrigation District (SSJID)
- Stockton East Water District (SEWD)
- Woodbridge Irrigation District (WID)

Municipal Water Purveyors

- California Water Service Company Stockton District (Cal Water)
- City of Escalon
- City of Lodi
- City of Manteca
- City of Ripon
- City of Stockton
- Linden County Water District (LCWD)
- Lockeford Community Services District (LCSD)
- Stockton East Water District (SEWD)

For the update to ESJWRM Version 2.0, more extensive coordination was appreciated from the following people:

- Eric Houston (City of Stockton)
- Justin Hopkins (SEWD)

- Mike Henry (LCSD)
- Dave Fletcher (LCWD)
- Alan Nakanishi and Travis Kahrs (City of Lodi)
- Jennifer Spaletta (NSJWCD)
- Eric Thorburn and Emily Sheldon (OID)
- Brandon Nakagawa (SSJID)
- Matt Zidar and Glenn Prasad (San Joaquin County)

1.1.1 IWFM Version

The model platform, IWFM-2015, has had several updates since ESJWRM Version 1.1 was originally developed and the IWFM code has been updated to the latest release version (IWFM-2105 Version 1273) for ESJWRM Version 2.0. New IWFM versions typically include error fixes and larger code changes that may impact the underlying calculations and therefore model results. Changes between model versions are documented on DWR's IWFM website (https://water.ca.gov/Library/Modeling-and-Analysis/Modeling-Platforms/Integrated-Water-Flow-Model) and the latest IWFM technical memorandums are available online (Dogrul and Kadir, 2021a and 2021b).

1.1.2 Updated Data from the ESJWRM version used in the Stanislaus River Basin Plan

A modified version of ESJWRM Version 1.1 was prepared as part of the Stanislaus River Basin Plan. The Stanislaus River Basin Plan, a collaborative effort by Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID), is still in draft format and is discussed in the respective agricultural water management plans (AWMP) (OID, 2021) (SSJID, 2021). The changes made to the modified version of ESJWRM Version 1.1 were incorporated into the 2021 update to ESJWRM Version 2.0. The changes were focused on Modesto Subbasin and OID, both in ESJ Subbasin and in Modesto Subbasin. Changes included updating agricultural and urban pumping in Modesto Subbasin, surface water diversion and groundwater pumping time series, surface water diversion and groundwater pumping delivery areas for OID and Modesto Subbasin agencies, target soil moisture percentage, agricultural return flow fraction, and Modesto Reservoir seepage. Changes to the Modesto Subbasin are not discussed in detail in the sections below.

1.1.3 Hydrologic Period

The updated ESJWRM Version 2.0 simulates water years 1995 through 2020 (October 1, 1994 through September 30, 2020). It was extended five water years from ESJWRM Version 1.1. Due to the extension of the period covered by the model, all model data with monthly or annual values had to be extended. These updates are listed in the sections below.

1.1.4 Precipitation

As with ESJWRM Version 1.1, rainfall data for the model area is derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) database used in the DWR's CALSIMETAW (California Simulation of Evapotranspiration of Applied Water) model. The database contains daily precipitation data from October 1, 1921 on a 4-kilometer grid throughout the model area (OSU, 2021). ESJWRM has monthly rainfall data defined for every model element and adjacent foothill watershed in order to preserve the spatial distribution of the monthly rainfall. Each of the model elements was mapped to the nearest of 364 available

PRISM reference nodes, uniformly distributed across the model domain. ESJWRM Version 2.0 includes the mapped precipitation time series for water years 2016 through 2020.

1.1.5 Land Use and Cropping Patterns

ESJWRM Version 2.0 utilizes the same land use categories as ESJWRM Version 1.1 as documented in the earlier reports (Woodard & Curran, 2018a and 2018b). The data through water year 2015 is the same as ESJWRM Version 1.1, except for minor tweaks to land use around the Subbasin's two smallest GSAs, Lockeford Community Services District (LCSD) and Linden County Water District (LCWD). Due to the small size of these GSAs, model elements did not exactly align with GSA boundaries, so agricultural land use associated with the surrounding districts, North San Joaquin Water Conservation District (NSJWCD) for LCSD and Stockton East Water District (SEWD) for LCWD, was included in elements representing these two small urban communities. In discussions with the GSAs, it was agreed that the agricultural land use would be removed from model elements assigned to LCSD (15 elements) and LCWD (5 elements). In total, this edit impacted an average of 250 acres per year.

DWR released a statewide crop mapping for 2016 that was completed using remote sensing methods to collect and process the data at the parcel scale and was then ground truthed for a high overall accuracy (DWR, 2016). This spatial land use data was mapped to ESJWRM model elements and assumed to represent land use for all extended water years (2016 through 2020). Based on discussions with SSJID and comparison with the most recent AWMP (SSJID, 2021), the 2016 land use for SSJID was replaced with the data for 2015 from ESJWRM Version 1.1.

Figure 1: 2016 Land Use

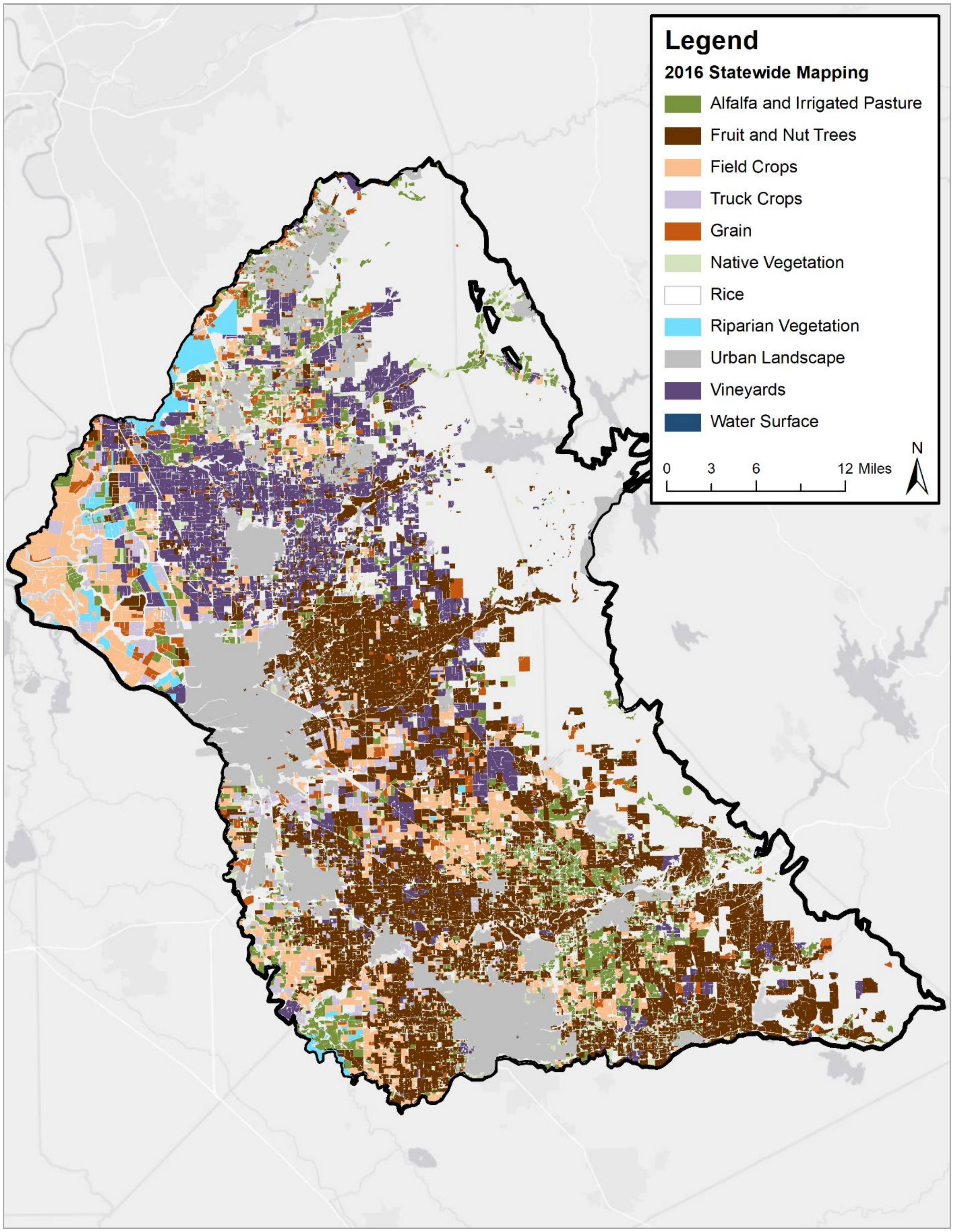
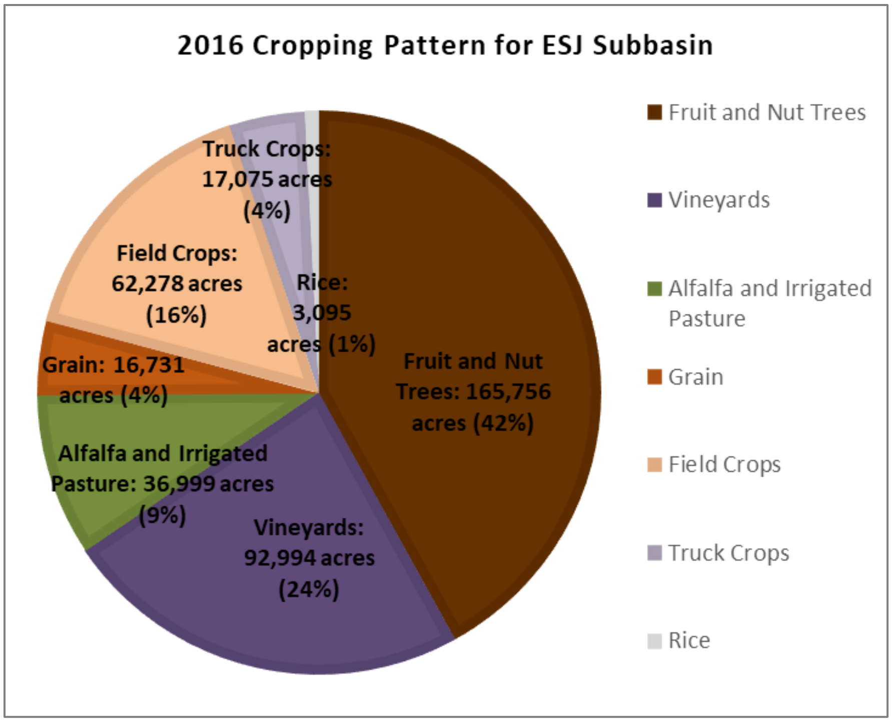


Figure 2: 2016 Cropping Pattern for ESJ Subbasin



1.1.6 Stream Inflow

Stream inflows to the model were extended using updated data from United States Geological Survey (USGS) stream gages and the United States Army Corps of Engineers (USACE) reservoir releases. Dry Creek, with data estimated using a regression after January 1998, was updated using recent monthly averages for similar water year types. A column was added for SSJID system outflows to Stanislaus River, discussed further in Section 1.1.11 below. A table of stream input data may be found in Table 1.

Table 1: Summary of ESJWRM Stream Inflow Data

Stream	Stream Node	Source	Gage Name	Period of Record	Average Annual Streamflow (acre-feet)
Cosumnes River	1	USGS	USGS 11335000: Cosumnes River at Michigan Bar, CA	October 1907 to present/ongoing	397,000
Dry Creek	140	USGS	Estimated in C2VSim by correlation with USGS 11329500: Dry Creek near Galt, CA	Not continuous October 1926 to December 1997	29,000
		USGS	Estimated in C2VSim by correlation with USGS 11335000: Cosumnes River at Michigan Bar, CA	Used October 1987 to September 1995 and January 1998 to September 2015	

Stream	Stream Node	Source	Gage Name	Period of Record	Average Annual Streamflow (acre-feet)
		n/a	Average of Historical Data by Month and Water Year Type	Used October 2015 to present/ongoing	
Mokelumne River	290	USGS	USGS 11323500: Mokelumne River below Camanche Dam, CA	October 1904 to present/ongoing	562,000
Calaveras River	758	USGS	USGS 11308900: Calaveras River below New Hogan Dam near Valley Springs, CA	February 1961 to September 1990	160,000
		USACE	New Hogan Dam releases	October 1990 to present/ongoing	
Stanislaus River	1033	USGS	USGS 11302000: Stanislaus River below Goodwin Dam near Knights Ferry, CA	February 1957 to present/ongoing	576,000
Tuolumne River	1248	USGS	USGS 11289650: Tuolumne River below Lagrange Dam near Lagrange, CA	October 1970 to present/ongoing	905,000
San Joaquin River	1497	USGS	USGS 11303500: San Joaquin River near Vernalis, CA	October 1923 to present/ongoing	3,162,000
SSJID System Outflows to Stanislaus River	1212	SSJID	n/a	n/a	24,000

1.1.7 Boundary Conditions

The boundary conditions in the model remain the same as ESJWRM Version 1.1, with eastern flows from the Sierra Nevada Mountains simulated in the model as small watersheds, Camanche Reservoir seepage estimated using a constrained general head boundary condition, Woodward Reservoir and Modesto Reservoir seepage represented as stream diversions, flows from outside of the model area represented with general head boundary conditions, and groundwater levels at or near zero near the edges of the Sacramento-San Joaquin Delta are represented using specified head boundary conditions.

Data was extended through water year 2020 using a monthly average by water year type. Data for water years 2010 through 2015 were recalculated and updated in the model. The heads near the Delta were adjusted based on analysis of nearby observed groundwater levels.

1.1.8 Urban Demand

Urban demand, comprised of annual population and monthly per capita water use (PCWU), is specified for incorporated urban areas or communities and estimated for rural urban demand. Changes to ESJWRM Version 1.1 were to add specified urban areas for Jenny Lind (in Calaveras County with a portion of the city outside of ESJ Subbasin) and in Modesto Subbasin (Oakdale, Riverbank, Waterford, and Modesto). City of Stockton, which was previously separated into portions for City of Stockton and California Water Service Company Stockton District (Cal Water), was updated to separate out the areas of unincorporated San Joaquin County land from City of Stockton. All urban areas were reviewed and updated to match areas where urban surface water deliveries and urban groundwater pumping was supplied. Urban surface water supply is assumed to have both indoor and outdoor usage, of which excess outdoor use returns to the model streams or percolates into the groundwater system.

Updated population for water years 2016 through 2020 using data from the California Department of Finance (DOF, 2021). The population for the entire Stockton area was updated for the entire model simulation period to data from the California Department of Finance. Based on review by LCSD, LCSD population for the entire model simulation period was updated using historical population and population projections in the 2016 LCSD Municipal Services Review (LCSD, 2016). The rural population, or people not in incorporated areas, was estimated by calculating an estimate of the rural population per acre in San Joaquin County and applying that population estimate to the unincorporated acreage of the model.

Urban demand was calculated for each area as the sum of the surface water (if the agency received surface water) and the groundwater pumping. The updated water supply is discussed in the sections below for surface water (Section 1.1.9) and groundwater (Section 1.1.1). The PCWU was then calculated for each agency as the monthly calculated demand divided by the annual population. Calculating the PCWU directly from the supplied water mitigates issues with urban surplus or shortage in the land and water use budget.

1.1.9 Surface Water Diversions

Surface water diversions were fully reorganized and renumbered in ESJWRM Version 2.0 and many additional diversions were included that were not in ESJWRM Version 1.1. Diversion edits included splitting NSJWCD's agricultural diversion from Mokelumne River into two time series for the NSJWCD north and south service areas; including NSJWCD recharge projects; refinement of NSJWCD recharge and irrigation schedules; adjustments to Lodi's data; adding the urban delivery of Calaveras River water from Calaveras County Water District (CCWD) to Jenny Lind (assuming 43% of Jenny Lind lies within ESJ Subbasin); updating OID north and south and SSJID deliveries to better represent what the AWMPs report for farm deliveries, recycled water deliveries, annual contract deliveries, and canal and drain seepage; separating urban deliveries to City of Stockton area into separate time series for City of Stockton, Cal Water, and San Joaquin County users in City of Stockton; separating SEWD diversion losses from Calaveras and Stanislaus Rivers into separate time series; additional diversions to Modesto Subbasin included as part of model refinements for the Stanislaus River Basin Plan; and the update of surface water delivery estimates for areas of the Delta and riparian user areas along the rivers.

All GSAs were provided all model historical supply data to review and update during the development of ESJWRM Version 2.0. Additionally, all surface water diversion delivery groups were reviewed and updated to reflect a more recent understanding of Subbasin surface water operations. A summary of diversions simulated in the model is provided in Table 2, along with fractions for recoverable loss (i.e., percolation or canal seepage), non-recoverable loss (i.e., evaporation), and delivery (i.e., amount delivered is equal to the total amount minus the recoverable and non-recoverable losses). ESJWRM Version 2.0 includes 66 diversions, 61 of which are listed in Table 2 and 5 diversions that are placeholders that are not currently being used in the model. The Projected Conditions Baseline Version 2.0 averages are also included in Table 2 and are discussed in Section 2.1.3.

Table 2: Summary of ESJWRM Surface Water Deliveries

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
1	Mokelumne River to North San Joaquin WCD North System for Ag	Mokelumne River	North San Joaquin WCD North System	Ag	50%	0%	50%	360	0	NSJWCD
2	Mokelumne River to North San Joaquin WCD South System for Ag	Mokelumne River	North San Joaquin WCD South System	Ag	50%	0%	50%	1,900	2,000	NSJWCD
3	Mokelumne River to North San Joaquin WCD for CALFED GW Recharge Project	Mokelumne River	CALFED GW Recharge Project	Recharge	100%	0%	0%	260	800	NSJWCD
4	Mokelumne River to North San Joaquin WCD For Tracy Lake Recharge Project	Mokelumne River	Tracy Lake Recharge Project	Recharge	50%	0%	50%	320	3,200	NSJWCD
5	Mokelumne River to City of Lodi (by agreement with Woodbridge ID) for M&I	Mokelumne River	City of Lodi	Urban	0%	0%	100%	5,500	4,700	Lodi
6	Mokelumne River to City of Lodi (by agreement with NSJWCD) for M&I	Mokelumne River	City of Lodi	Urban	0%	0%	100%	370	0	Lodi

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
7	Mokelumne River to City of Lodi (banked from agreement with WID) for M&I	Mokelumne River	City of Lodi	Urban	0%	0%	100%	560	0	Lodi
8	Mokelumne River to Woodbridge ID for Ag	Mokelumne River	Woodbridge Irrigation District	Ag	30%	2%	68%	58,800	44,200	WID
9	Mokelumne River Export to Contra Costa WD (by agreement with Woodbridge ID)	Mokelumne River	Export out of model	Urban	0%	0%	100%	2,000 (one year only)	0	WID
10	Mokelumne River to City of Stockton for Delta Water Supply Project (by agreement with Woodbridge ID) for M&I	Mokelumne River	City of Stockton	Urban	0%	0%	100%	7,700	10,500	City of Stockton
11	San Joaquin River at Empire Tract to City of Stockton for Delta Water Supply Project for M&I	San Joaquin River	City of Stockton	Urban	0%	0%	100%	8,500	21,600	City of Stockton
12	Calaveras River to Bellota Pipeline to Stockton East WD WTP for M&I	Calaveras River	Export out of model (imported in Diversions 14, 15, and 16)	Urban	0%	0%	100%	13,800	13,100	SEWD

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
13	Stanislaus River at Goodwin Dam to Farmington Flood Control Basin to Lower Farmington Canal to Peters Pipeline to Stockton East WD WTP for M&I	Import (outside of ESJWRM)	Export out of model (imported in Diversions 14, 15, and 16)	Urban	0%	0%	100%	29,400	49,900	SEWD
14	Stockton East WD WTP to City of Stockton for M&I	Import (exported in Diversions 12 and 13)	City of Stockton	Urban	0%	0%	100%	18,800	5,100	UWMP
15	Stockton East WD WTP to Cal Water for M&I	Import (exported in Diversions 12 and 13)	Cal Water	Urban	0%	0%	100%	21,800	19,300	UWMP
16	Stockton East WD WTP to San Joaquin County in Stockton for M&I	Import (exported in Diversions 12 and 13)	San Joaquin County in Stockton	Urban	0%	0%	100%	1,400	1,500	UWMP
17	Calaveras River to Calaveras County WD for Ag	Import (outside of ESJWRM)	Calaveras County WD	Ag	9%	1%	90%	1,100	1,300	CCWD
18	Calaveras River to Jenny Lind for M&I	Import (outside of ESJWRM)	Jenny Lind	Urban	0%	0%	43%	1,800	1,800	CCWD

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
19	Calaveras River to Stockton East WD for Ag	Calaveras River	Stockton East Water District	Ag	0%	0%	100%	23,600	21,100	SEWD
20	Calaveras River to Stockton East WD Losses	Calaveras River	Stockton East Water District, including canals	Recharge	89%	11%	0%	19,300	15,200	SEWD
21	Calaveras River to Farmington Groundwater Recharge Program	Calaveras River	Farmington Groundwater Recharge Program	Recharge	100%	0%	0%	1,400	5,200	SEWD
22	San Joaquin River to North Delta for Ag	San Joaquin River	North Delta Subregion	Ag	5%	1%	94%	139,600	125,800	Estimated by model
23	San Joaquin River to South Delta for Ag	San Joaquin River	South Delta Subregion	Ag	5%	1%	94%	26,700	18,500	Estimated by model
24	Stanislaus River at Goodwin Dam to Farmington Flood Control Basin to Lower Farmington Canal to Stockton East WD for Ag	Import (outside of ESJWRM)	Stockton East Water District	Ag	0%	0%	100%	4,400	6,800	SEWD
25	Stanislaus River to Stockton East WD Losses	Import (outside of ESJWRM)	Stockton East Water District, including canals	#N/A	88%	12%	0%	900	1,200	SEWD

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
26	Stanislaus River at Goodwin Dam to Farmington Flood Control Basin via Little Johns Creek and Lower Farmington Canal to Central San Joaquin WCD for Ag	Import (outside of ESJWRM)	Central San Joaquin WCD	Ag	15%	2%	83%	30,000	24,300	SEWD
27	Stanislaus River to Farmington Groundwater Recharge Program	Import (outside of ESJWRM)	Farmington Groundwater Recharge Program	Recharge	100%	0%	0%	3,300	4,900	SEWD
28	Stanislaus River at Goodwin Dam to Oakdale ID North for Ag	Import (outside of ESJWRM)	Export out of model (imported in Diversions 52, 55, and 57)	Ag	0%	0%	0%	98,800	88,000	OID
29	Stanislaus River at Goodwin Dam to Oakdale ID South for Ag [Modesto Subbasin]	Import (outside of ESJWRM)	Export out of model (imported in Diversions 53, 54, 56, and 58)	Ag	0%	0%	0%	136,400	121,500	OID
30	Stanislaus River to Woodward Reservoir to South San Joaquin ID for Ag	Import (outside of ESJWRM)	Export out of model (imported in Diversions 59, 60, and 61)	Ag	0%	0%	0%	189,500	150,000	SSJID

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
31	Stanislaus River to Woodward Reservoir to South San Joaquin ID Division 6 for Ag	Import (outside of ESJWRM)	Export out of model (imported in Diversions 59, 60, and 61)	Ag	0%	0%	0%	5,200	7,000	SSJID
32	Woodward Reservoir Seepage	Import (outside of ESJWRM)	Woodward Reservoir	Recharge	100%	0%	0%	17,100	16,000	SSJID
33	Stanislaus River to Woodward Reservoir to Nick C. DeGroot WTP to City of Manteca for M&I	Import (outside of ESJWRM)	City of Manteca	Urban	0%	0%	100%	6,800	10,700	UWMP
34	Stanislaus River to Woodward Reservoir to Nick C. DeGroot WTP to City of Escalon for M&I	Import (outside of ESJWRM)	City of Escalon	Urban	0%	0%	100%	0	0	UWMP
35	Stanislaus River to Woodward Reservoir to Nick C. DeGroot WTP to City of Lathrop for M&I [Tracy Subbasin]	Import (outside of ESJWRM)	City of Lathrop	Urban	0%	0%	100%	1,400	6,300	UWMP
36	Stanislaus River to Woodward Reservoir to Nick C. DeGroot WTP to City of Ripon for M&I	Import (outside of ESJWRM)	City of Ripon	Urban	0%	0%	100%	0	0	UWMP

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
37	Tuolumne River to Modesto ID for Ag [Modesto Subbasin]	Import (outside of ESJWRM)	Modesto ID	Ag	3%	19%	78%	232,500	196,000	Stanislaus River Basin Plan ESJWRM Update
38	Tuolumne River to City of Modesto (via Modesto ID) for M&I [Modesto Subbasin]	Import (outside of ESJWRM)	Element group representing City of Modesto	Urban	3%	1%	96%	30,700	27,100	Stanislaus River Basin Plan ESJWRM Update
39	Cosumnes River to Riparian for Ag [Cosumnes Subbasin]	Cosumnes River	Riparian diverters along river	Ag	10%	2%	88%	2,800	2,300	C2VSim
40	Dry Creek to Riparian for Ag [Split Across Subbasins]	Dry Creek	Riparian diverters along river	Ag	10%	2%	88%	5,600	6,400	C2VSim
41	Mokelumne River to Riparian for Ag	Mokelumne River	Riparian diverters along river	Ag	10%	2%	88%	9,600	11,300	C2VSim
42	Calaveras River to Riparian for Ag	Calaveras River	Riparian diverters along river	Ag	10%	2%	88%	11,400	10,900	C2VSim
43	Stanislaus River to Riparian for Ag [Split Across Subbasins]	Stanislaus River	Riparian diverters along river	Ag	15%	3%	82%	30,600	30,400	C2VSim
44	Tuolumne River to Riparian for Ag [Modesto Subbasin]	Tuolumne River	Riparian diverters along river	Ag	15%	3%	82%	6,100	6,300	C2VSim

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
45	San Joaquin River to Riparian for Ag [Split Across Subbasins]	San Joaquin River	Riparian diverters along river	Ag	15%	3%	82%	5,800	5,900	C2VSim
46	Modesto ID Groundwater Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	Modesto ID	Ag	0%	0%	100%	21,500	24,300	Stanislaus River Basin Plan ESJWRM Update
47	Tuolumne River to Modesto Reservoir Seepage [Modesto Subbasin]	Import (outside of ESJWRM)	Modesto Reservoir	Recharge	100%	0%	0%	23,000	23,000	Stanislaus River Basin Plan ESJWRM Update
48	City of Modesto GW Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	City of Modesto	Urban	3%	1%	96%	33,100	32,200	Stanislaus River Basin Plan ESJWRM Update
49	City of Oakdale GW Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	City of Oakdale	Urban	3%	1%	96%	4,600	4,800	Stanislaus River Basin Plan ESJWRM Update
50	City of Waterford GW Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	City of Waterford	Urban	3%	1%	96%	1,700	1,500	Stanislaus River Basin Plan ESJWRM Update

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
51	City of Riverbank GW Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	City of Riverbank	Urban	3%	1%	96%	4,500	4,400	Stanislaus River Basin Plan ESJWRM Update
52	Farm Deliveries to Oakdale ID North for Ag	Import (exported in Diversion 28)	Oakdale ID in ESJ Subbasin	Ag	0%	0%	100%	78,900	75,100	OID AWMP
53	Farm Deliveries to Oakdale ID South for Ag [Modesto Subbasin]	Import (exported in Diversion 29)	Oakdale ID in Modesto Subbasin	Ag	0%	0%	100%	121,000	114,400	OID AWMP
54	Recycled Water to Oakdale ID South for Ag [Modesto Subbasin]	Import (exported in Diversion 29)	Oakdale ID in Modesto Subbasin	Ag	0%	0%	100%	3,300	3,300	OID AWMP
55	Deliveries to Annual Contracts by Oakdale ID North for Ag	Import (exported in Diversion 28)	Oakdale ID in ESJ Subbasin	Ag	0%	0%	100%	2,100	2,600	OID AWMP
56	Deliveries to Annual Contracts by Oakdale ID South for Ag [Modesto Subbasin]	Import (exported in Diversion 29)	Oakdale ID in Modesto Subbasin	Ag	0%	0%	100%	2,300	2,500	OID AWMP
57	Canal and Drain Seepage in Oakdale ID North	Import (exported in Diversion 28)	Oakdale ID in ESJ Subbasin	Recharge	100%	0%	0%	17,800	17,500	OID AWMP

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			ESJWRM Version 2.0 Average Annual Diversion*** (acre-feet)	PCBL Version 2.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
58	Canal and Drain Seepage in Oakdale ID South [Modesto Subbasin]	Import (exported in Diversion 29)	Oakdale ID in Modesto Subbasin	Recharge	100%	0%	0%	18,300	18,000	OID AWMP
59	Farm Deliveries to South San Joaquin ID for Ag	Import (exported in Diversions 30 and 31)	South San Joaquin ID	Ag	0%	0%	100%	144,000	120,000	SSJID AWMP
60	Direct Diversion from Main Distributary Canal to South San Joaquin ID for Ag	Import (exported in Diversions 30 and 31)	South San Joaquin ID	Ag	0%	0%	100%	1,400	0	SSJID AWMP
61	Main Distributary Canal and Lateral Seepage in South San Joaquin ID	Import (exported in Diversions 30 and 31)	South San Joaquin ID	Recharge	90%	10%	0%	33,200	28,200	SSJID AWMP

*RL = Recoverable Loss (canal seepage or recharge)

**NL = Non-Recoverable Loss (evaporation)

*** Averages calculated only for years with diversions occurring (i.e., non-zero average)

1.1.10 Groundwater Pumping

Groundwater pumping within ESJWRM is separated into well- or element-based pumping. The former largely includes district-operated wells that feed into the surface water supply network, while the latter includes estimated private groundwater pumping.

Updates to ESJWRM Version 2.0 for well pumping was the addition of Modesto Subbasin wells included in the model updates made for the Stanislaus River Basin Plan and the addition of two OID wells. OID and SSJID district wells were updated to export water out of the model since the district groundwater pumping is included in the farm deliveries to SSJID, OID North, and OID South included as surface water deliveries. Additionally, all groundwater pumping delivery groups were reviewed and updated to reflect a more recent understanding of Subbasin operations. Table 3 lists the number of wells by type and agency included in ESJWRM.

Element pumping is estimated by IWFM within the model simulation. Element pumping in ESJWRM Version 2.0 was updated to remove all model-calculated groundwater pumping for urban uses in urban areas.

Table 3: Summary of ESJWRM Well Pumping

Agency	Number of Urban Pumping Wells	Number of Agricultural Pumping Wells	Average Annual Urban Pumping (acre-feet)	Average Annual Agricultural Pumping (acre-feet)
Cal Water	56	---	8,200	0
Escalon	4	---	1,400	0
Lathrop	6	---	2,200	0
Linden County WD	4	---	440	0
Lockeford CSD	4	---	510	0
Lodi	29	---	13,600	0
Manteca	15	31	9,300	1,300
Oakdale ID*	---	26	0	6,700
Ripon	9	9	3,900	1,000
SEWD	5	---	590**	0
SSJID	---	28	0	5,200
Stockton	37	---	8,500	0
Other Modesto Subbasin Wells	---	246	0	68,000
Total Average Annual Pumping (acre-feet)			48,640	82,200

* Includes wells located both in ESJ Subbasin and Modesto Subbasin

** Average only when wells were active (WY 2015-2020)

1.1.11 Agricultural Operations

Factors that apply to the agricultural operations represented in the model include agricultural return flow fractions, agricultural reuse fractions, and target soil moisture content.

Both SSJID and OID report large amounts of tailwater as outflow from the districts' drainage systems in their respective AWMPs (SSJID, 2021) (OID, 2021). For OID, the amount of tailwater from the district lands is represented through adjustments to the return flow fraction, which controls how much of applied water ultimately ends up as drainage to model stream nodes. For SSJID, since the majority of the tailwater ends up back in Stanislaus River the reported system outflows are included as a stream inflow to Stanislaus River below SSJID. The return flow fraction was likewise adjusted for SSJID's area.

The reuse fraction is the percent of applied water that can be reused as irrigation to meet demand. Based on analysis of the OID 2020 AWMP (OID, 2021), the reuse fraction for OID model elements was set to 2%.

The target soil moisture specifies the fraction of field capacity that IWFM will iterate to and was utilized to adjust OID demand, first in the adjusted version of ESJWRM Version 1.1 prepared for the Stanislaus River Basin Plan and then adjusted based on analysis of the OID 2020 AWMP (OID, 2021).

Canal and drain seepage for the agricultural agencies is included in surface water diversion information and discussed in Section 1.1.9 above. For agencies that may have surface water agreements where a portion of the delivery losses is assumed to occur in the river (e.g., NSJWCD), the interaction between the stream and the groundwater system is simulated separately in ESJWRM and assumed to account for the conveyance losses. This is considered a special case in the operational water budget discussed in Section **Error! Reference source not found.**.

All other files that control agricultural operations were extended through water year 2020 by repeating the recent historical data.

1.2 Calibration Updates and Results

The goals of model calibration are (1) to achieve a reasonable water budget for each component of the hydrologic cycle modeled (i.e., land and water use, soil moisture, stream flow, and groundwater) and (2) to maximize the agreement between simulated and observed groundwater levels at selected well locations and simulated and observed streamflow hydrographs at selected gaging stations. These objectives are achieved through verification of the model input data and adjustment of model parameters.

Due to uncertainty in the model initial conditions, a one year "ramp up" period is included to allow groundwater levels to stabilize. Thus, the model calibration period for the ESJWRM is October 1995 through September 2020 or water years 1996 through 2020 (25 years).

1.2.1 Calibration Process

Model calibration begins after data analysis and input data file development is completed. The calibration effort can be broken down into subsets that align with packages within the IWFM platform. As an integrated groundwater model, the results of each part of the simulation are dependent on one another. The model calibration can be considered a systematic process that includes the following activities:

- Collect data and set calibration targets
- Calibrate land and water use
- Calibrate groundwater system
- Calibrate stream system
- Refine groundwater level calibration using PEST

- Perform sensitivity analysis
- Conduct additional refinements to model as necessary

1.2.1.1 Agricultural Demand Calibration

As part of the calibration of the land and water use budget, root zone parameters are adjusted as needed to achieve reasonable estimates of agricultural demand and to develop the components of a balanced root zone budget. Demand calibration serves as the foundation of the IWFM calibration for agricultural areas, as demand estimated often translates directly to groundwater pumping, which is the primary stress on the groundwater system. To adjust agricultural demand, element-level root zone parameters, particularly the soil hydraulic conductivity, were adjusted in accordance with the hydrologic soil group and area of the model. Soil hydraulic conductivity was adjusted in the areas of the model representing OID North, NSJWCD, and SSJID to better match reported groundwater pumping, demand, and per unit water use.

During agricultural demand calibration, also called root zone calibration, the curve numbers assigned to different land uses were also reviewed. Based on review of percolation of precipitation occurring in different areas of the model, the curve numbers for native and riparian land uses were adjusted. Additionally, refinements were made to the unsaturated zone initial soil moisture to standardize the amount of water in the unsaturated zone from year to year.

1.2.1.2 PEST-Assisted Aquifer Calibration

Aquifer parameter calibration of ESJWRM utilized a parametric grid covering the model area that reflected the scale at which parameters were adjusted throughout the calibration process. The parametric grid, originally adopted from DWR's California Central Valley Groundwater-Surface Water Simulation Model with coarse grid (C2VSimCG) nodes, was slightly modified to cover the entire ESJWRM model along the boundaries and additional nodes were added or moved within areas of the model to provide better control. Aquifer parameters included in ESJWRM are horizontal hydraulic conductivity, vertical hydraulic conductivity, specific storage, and specific yield.

Due to the complexities of calibrating an integrated water resources model, a hybrid approach for calibration was utilized to perform a manual calibration on initial water budgets and regional groundwater conditions and a PEST-assisted calibration using PEST (Doherty, 2015) to achieve a refinement of the calibrated parameters that would result in a more accurate simulation. The use of the PEST software package is discussed further in Section 1.2.2.2.

1.2.2 Calibration Verification

ESJWRM was calibrated to local data and information, surface water flows, groundwater hydrographs, and groundwater contours. The sources used to check model results include local knowledge (mainly gathered during TAC meetings), agricultural water management plans, urban water management plans, other local planning efforts, measured groundwater levels, and observed streamflow data.

1.2.2.1 Streamflow Calibration

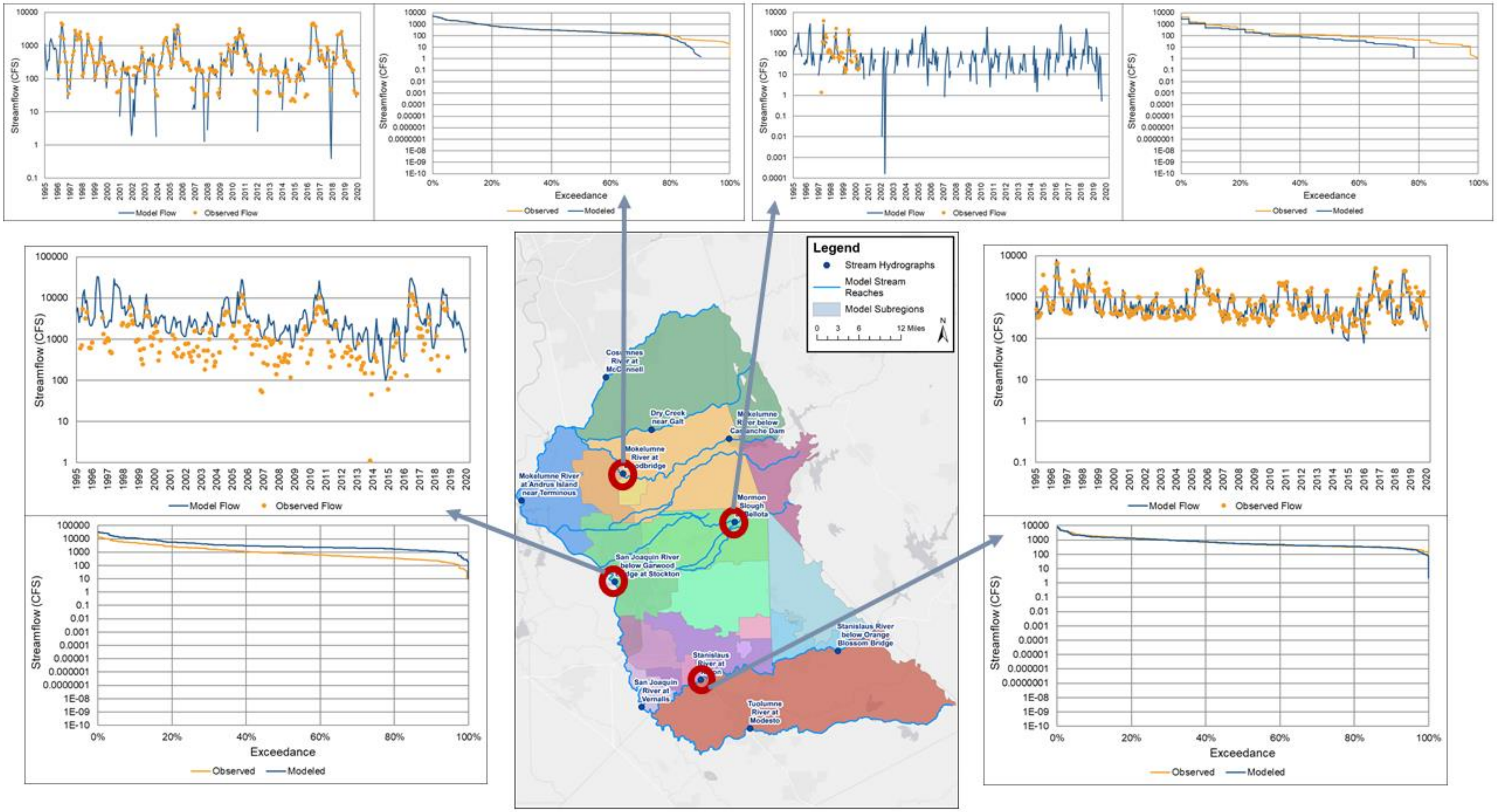
Streamflow calibration is primarily performed by comparing the simulated streamflow with local observation data for 11 stream gages located on major streams. Data for these gages came from USGS, USACE, or the California Data Exchange Center (CDEC). Two of these stream gages (Mokelumne River below Camanche

Dam and San Joaquin River near Vernalis) are duplicates of gages used to estimate stream inflow into the model area and were not referenced for streamflow calibration and only included as verification of the model setup.

Streambed hydraulic conductivity was adjusted during model calibration based on examination of stream flow hydrographs and stream reach water budgets. The portion of Mokelumne River through Camanche Reservoir (Reach 3) was assigned a streambed hydraulic conductivity of zero since all the surface water-groundwater interaction is already represented by the constrained general head boundary condition representing Camanche Reservoir. Additionally, streambed hydraulic conductivities were examined in the overlapping models of DWR's California Central Valley Groundwater-Surface Water Simulation Model with fine grid (C2VSimFG) and the Cosumnes-South American-North American Integrated Water Resources Model (CoSANA) and adjusted for some corresponding streams.

Simulated stream flows were compared with observed records and exceedance charts were also used to check the model performance when simulating high and low flows at each gage location. Calibration results for select stream gages are included in Figure 3.

Figure 3: Streamflow Calibration



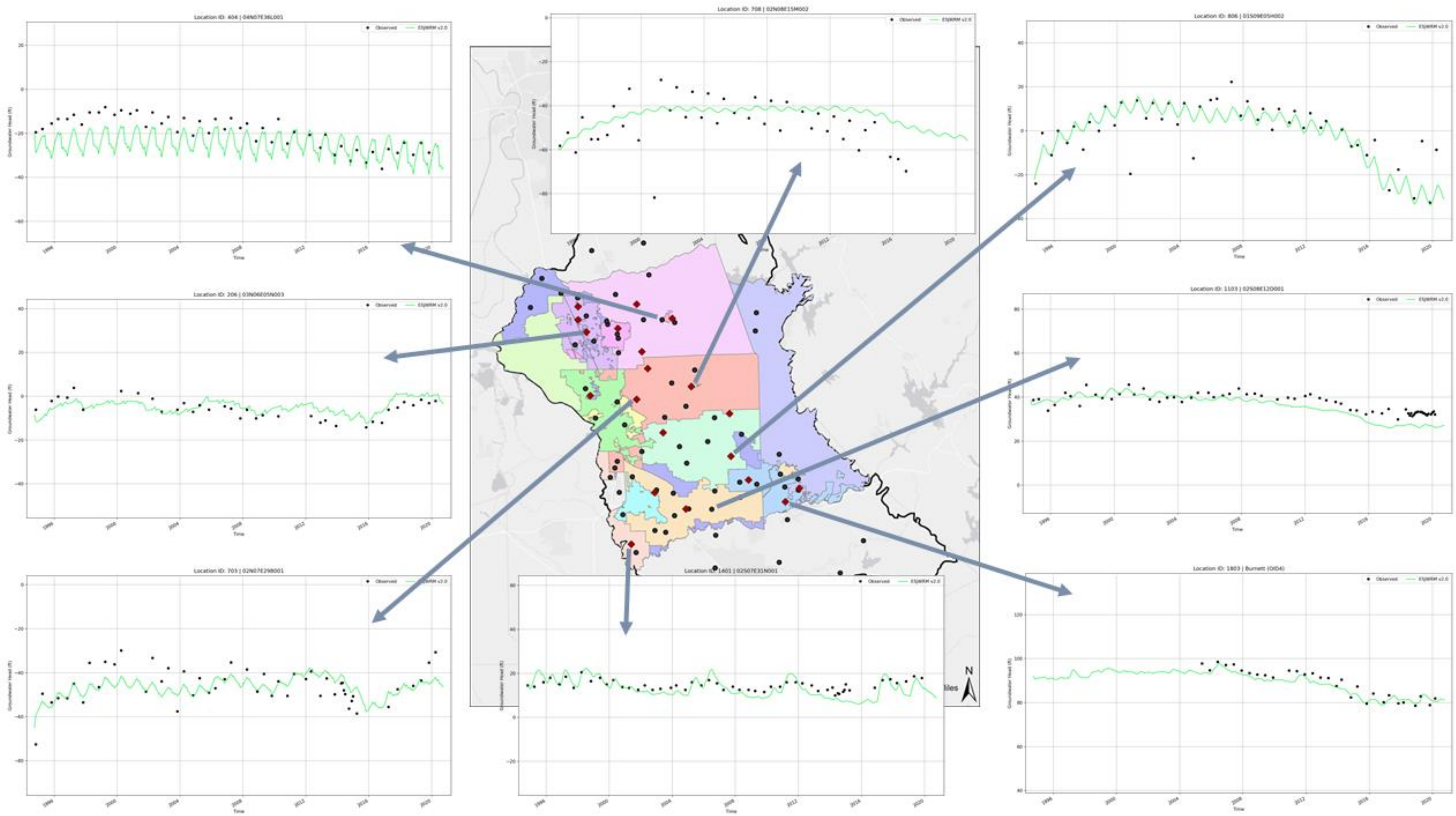
1.2.2.2 Groundwater Level Calibration

The goal of groundwater level calibration is to achieve the maximum agreement between simulated and observed groundwater elevations at calibration wells while maintaining reasonable values for aquifer parameters. During the calibration of ESJWRM Version 1.1, 70 wells were ultimately selected that were representative of the long-term conditions of groundwater levels both at a local and regional scale in ESJWRM. This same set of calibration points was kept for ESJWRM Version 2.0, with the addition of GSP Representative Monitoring Network wells if they were not already included.

Simulated groundwater levels are calibrated to observed levels through adjustments to hydrogeologic parameters or aquifer parameters including hydraulic conductivity, specific storage, and specific yield. The automated parameter estimation tool, PEST, was used to assist in refinement of aquifer parameters to improve model calibration. PEST-assisted calibration is performed to interact with ESJWRM via input and output files and iteratively modifies parameter values to reduce an objective function representative of the model residual error. These modifications are made within identified bounds of reasonable values for each parameter. PEST-assisted calibration focused on the aquifer parameters such as horizontal and vertical conductivities and storage parameters. Between PEST-assisted calibration iterations, the modeling team revisited the land system and small watershed budgets and made manual adjustments where needed, until calibration goals were met.

The results of the groundwater level calibration indicate that the ESJWRM reasonably simulates the long-term hydrologic responses under various hydrologic conditions. Figure 4 shows a selection of calibration wells with their resulting groundwater level hydrographs showing the updated calibration of ESJWRM Version 2.0. All ESJWRM Version 2.0 groundwater level hydrographs may be downloaded as a Google Earth KMZ file at (Link to be provided).

Figure 4: Groundwater Level Calibration



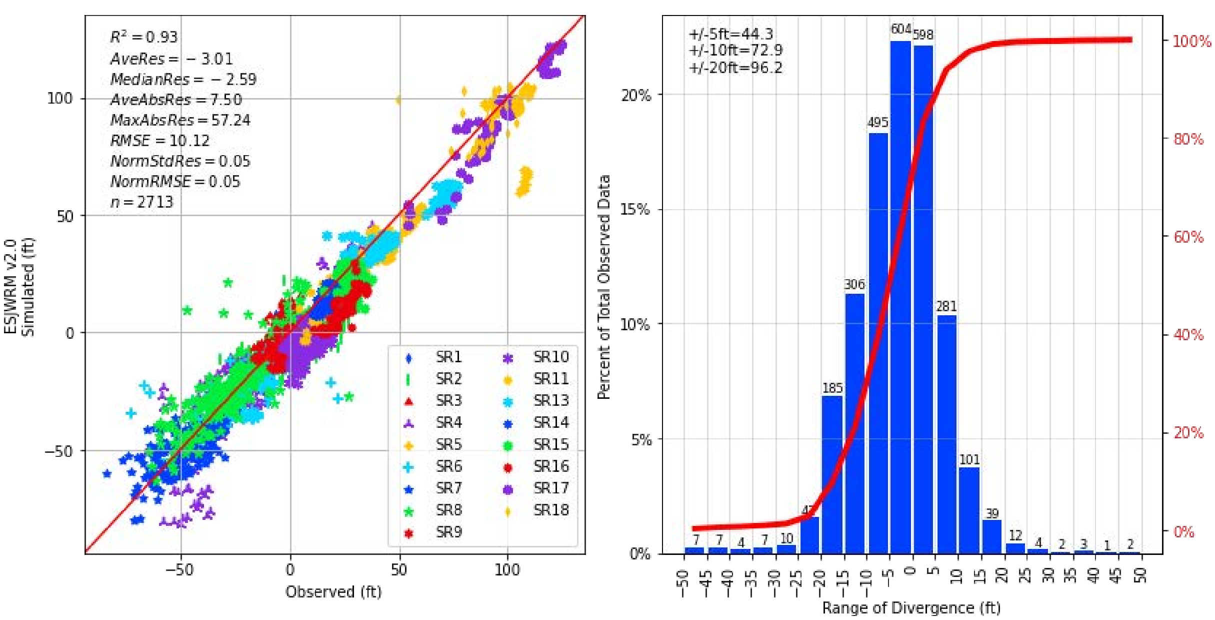
The ESJWRM calibration status was measured using two metrics: the groundwater level trend and the relationship between simulated and observed groundwater levels. The statistics were evaluated to meet the American Standard Testing Method (ASTM) standard. In addition to quantifiable metrics, the ESJWRM calibration was evaluated by generating reasonable regional groundwater flow directions and producing realistic water budgets.

The "Standard Guide for Calibrating a Groundwater Flow Model Application" (ASTM D5981) states that "the acceptable residual should be a small fraction of the head difference between the highest and lowest heads across the site." The residual is defined as the simulated head minus the observed head. An analysis of all calibration water levels within the model indicated the presence of 200+ feet of water level changes. Using 10 percent as the "small fraction", the acceptable residual level would be 20 feet. Calibration goals for the groundwater level residuals were set such that no more than 10 percent of the observed groundwater levels would exceed the acceptable residual level of 20 feet.

- 44% of observed groundwater levels are within +/- 5 feet of its respective simulated values
- 73% of observed groundwater levels are within +/- 10 feet of its respective simulated values
- 96% of observed groundwater levels are within +/- 20 feet of its respective simulated values

The residual histogram and scatter plot of simulated versus observed values for the ESJ Subbasin original calibration wells for the calibration period is shown in Figure 5. The scatter plot colors points by input data subregion. The highest elevations are seen in model subregions closer to the foothills (e.g., Subregion 5 and 17).

Figure 5: Calibration Statistics



1.2.3 Sensitivity Analysis

Sensitivity analysis is a way of investigating how sensitive certain model results are to changes in certain model parameters. A sensitive parameter is when the simulation results are greatly affected by changes in that parameter within its valid range. Conversely, an insensitive parameter means the changes in that parameter within its valid range do not affect the simulation results greatly.

Model parameters that are sensitive can be the largest sources of error and uncertainty when not precisely measured and well understood. For this reason, sensitivity analysis is an important step of the model calibration process. The sensitivity analysis serves the following purposes:

- To improve the understanding of input-output relationships
- To quantify the impact of inaccuracies in model parameters
- To evaluate the stability and robustness of the model
- To understand the overall range of accuracy of the model results

For these purposes, the following set of calibration parameters were selected for investigation under ESJWRM sensitivity analysis:

- Aquifer horizontal hydraulic conductivity (Kh) changed globally by factors of 0.5, 0.67, 1.5, 2.0
- Aquifer vertical hydraulic conductivity (Kv) changed globally by factors of 0.5, 0.67, 1.5, 2.0
- Aquitard vertical hydraulic conductivity (Kaqt) changed globally by factors of 0.5, 0.67, 1.5, 2.0
- Specific yield (Sy) changed globally by factors of 0.8, 1.2
- Specific storage (Ss) changed globally by factors of 0.1, 0.2, 5, 10
- Streambed hydraulic conductivity (Kstr) changed globally by factors of 0.2, 0.5, 2.0, 5.0
- Boundary condition conductance for both general and constrained general head (BC_Cond) changed globally by factors of 0.5, 0.67, 1.5, 2.0
- Saturated soil hydraulic conductivity (Ksoil) changed globally by factors of 0.2, 0.5, 2.0, 5.0
- Target soil moisture (TSM) changed globally by setting all values to 0.6 or 0.8

In the process of evaluating the sensitivity of model results to certain parameter changes, the results from the 32 sensitivity runs were analyzed for the ESJ Subbasin and model as a whole and compared to the calibrated model in terms of the groundwater residual statistics. As the changes to the input parameters for sensitivity analysis were made globally, the changes in the model performance were also considered on a global or subregional scale. An improvement in the model performance based on changes in one parameter at a global scale does not necessarily mean improvements in the overall model performance and/or calibration, as the model is calibrated to a number of target parameters, only some of which may be included in the performance assessment during the sensitivity analysis.

Figure 6 presents the relative change in the three groundwater level residual statistics used in the evaluation of model calibration performance for 10 parameters in the entire EJSWRM for the calibration period. These three groundwater level residual statistics are:

- Root mean square error (RMSE): This statistic is a measure of how spread out the residuals are.
- Average residual: This statistic measures how inaccurate simulation results are with respect to the corresponding observations on average.
- Correlation coefficient (R^2): This statistic is a measure of the strength of the linear relationship between the simulated and observed pairs.

In the calibrated model residual statistics shown in Figure 5, the RMSE is 10.12 feet, the average residual is -3.01 feet, and the R^2 is 0.93. In Figure 6, the impact of the parameter sensitivity on the average residual from the calibration value of -3.01 feet is always too much of an increase or almost no change. In all the runs, the R^2 of 0.93, which ideally would increase in a better calibrated model, either decreases or remains about the same as the calibrated model. Similarly, the RMSE of 10.12 feet would decrease in a better calibrated model; however, all the sensitivity runs either increase or have no impact on the RMSE.

Figure 7 and Figure 8 look at the change in calibration period average ESJ Subbasin change in storage and deep percolation (both parameters from the hydrologic groundwater budget). Both figures show how sensitive change in storage and deep percolation are to changes in parameters, notably aquifer horizontal hydraulic conductivity (Kh), streambed hydraulic conductivity (Kstr), saturated soil hydraulic conductivity (Ksoil), and target soil moisture (TSM). Even relatively minor changes to those parameters can have large impacts on the ultimate model results.

None of the sensitivity runs resulted in a significant improvement in statistics or results. This means that the model is stable and that the calibration is at or near an optimal point when global parameter changes are considered.

Figure 6: Sensitivity of Groundwater Level Residual Statistics in Entire ESJWRM

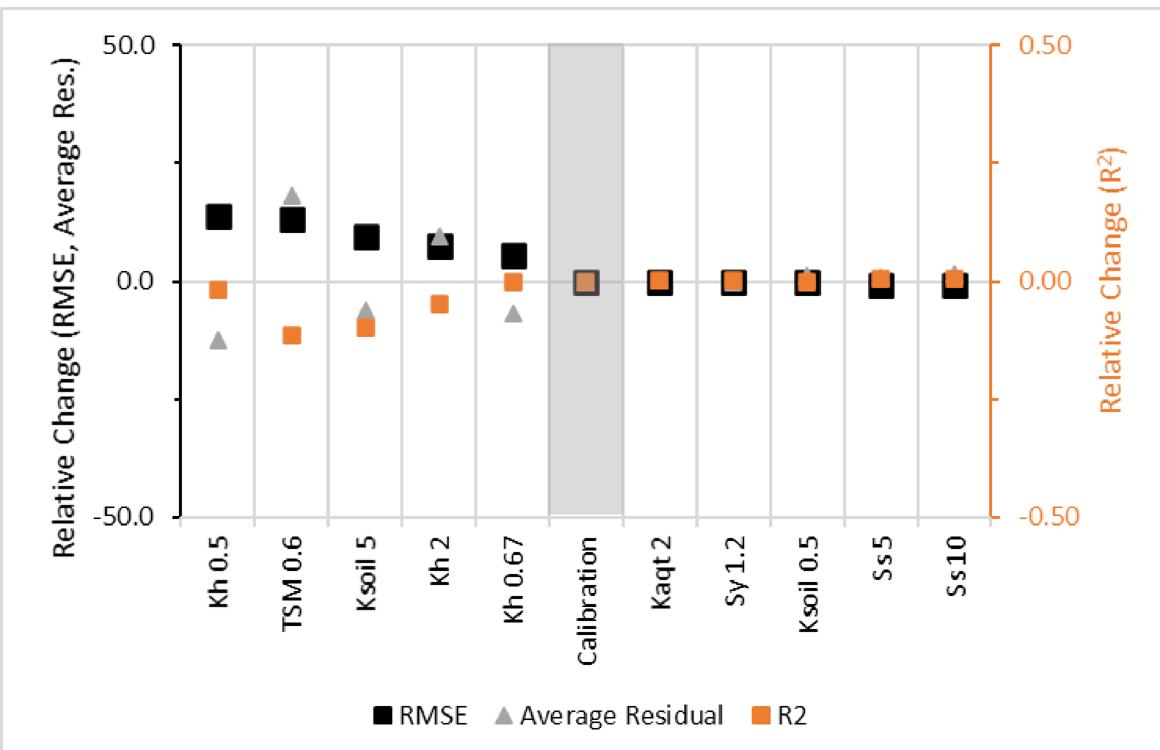


Figure 7: Sensitivity of Change in Groundwater Storage in ESJ Subbasin

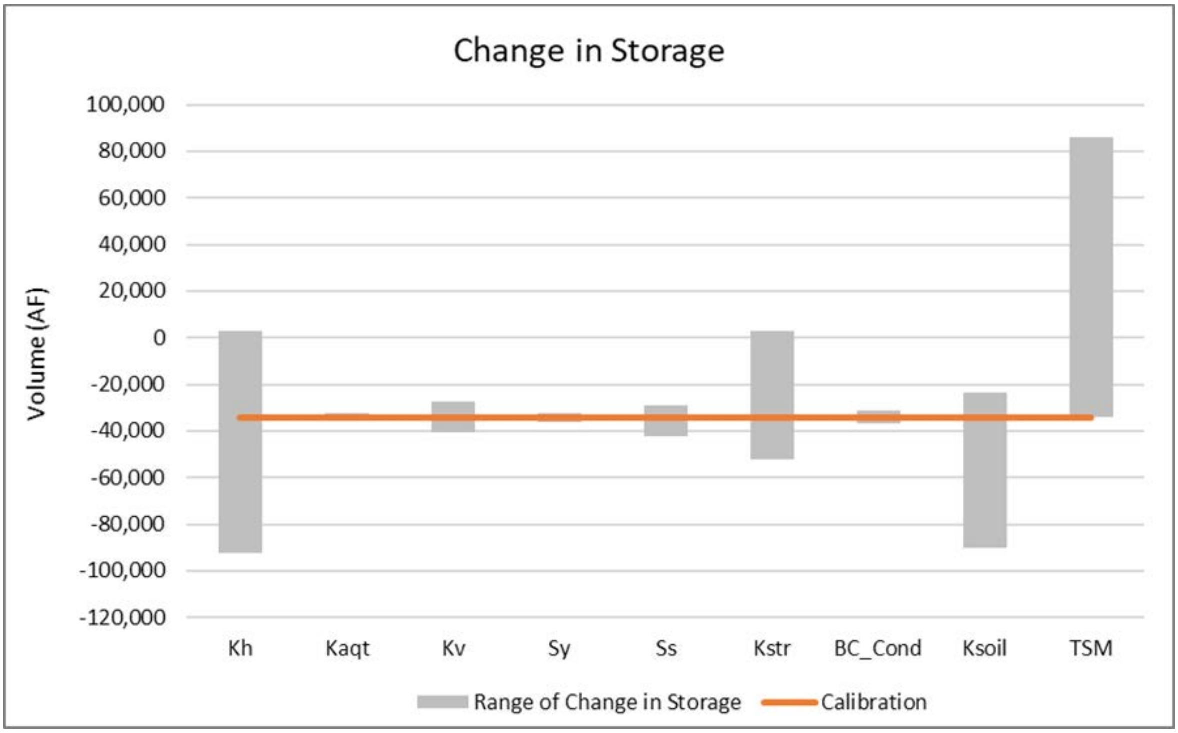
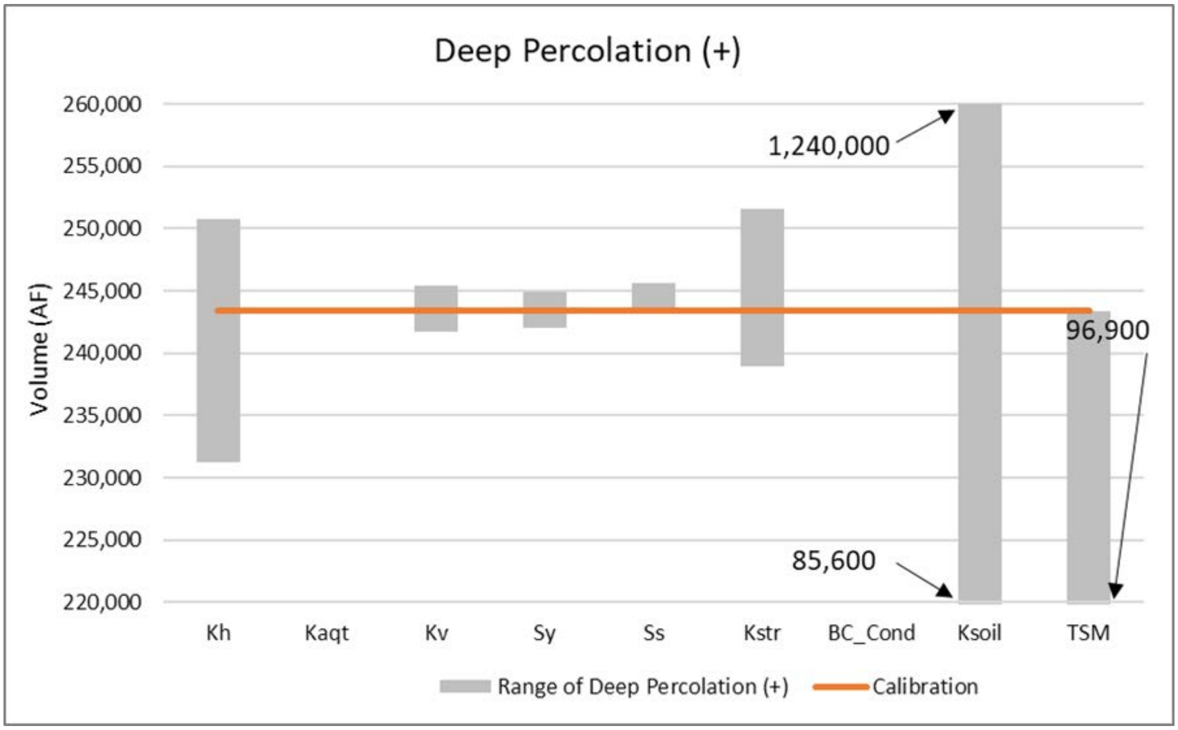


Figure 8: Sensitivity of Deep Percolation in ESJ Subbasin



1.3 Historical Model Results

A water budget balances supplies, demands, and any subsequent change in storage occurring within the specific portion of the hydrologic cycle. IWFM automatically outputs budgets at the subregion scale for processes involving groundwater, land surface, streams, root zone, small watersheds, and unsaturated zone. IWFM can output budgets down to a single element or any specific grouping of elements.

During this step of the calibration process, model results are reviewed and summarized into monthly and annual (by water year) budgets. The primary budgets reviewed for calibration are the land and water use budget and the groundwater budget. After extensive budget analysis, key model datasets and parameters are adjusted, particularly groundwater aquifer parameters, to better match local budgets from local agricultural water purveyors and local planning efforts. The ESJWRM Version 2.0 water budget results are summarized in the following sections.

1.3.1 Land and Water Use Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
    - Groundwater pumping
    - Surface water deliveries
    - Shortage (if applicable)
- Outflows:
    - Demand (either agricultural or urban)
    - Surplus (if applicable)

The average annual water demand for the Subbasin within the calibration period was 1,262 thousand acre-feet (TAF), consisting of 1,145 TAF agricultural demand and 117 TAF urban demand. This demand was met by an annual average of 567 TAF of surface water deliveries (512 TAF of agricultural and 55 TAF of urban deliveries) and was supplemented by 699 TAF of groundwater production (638 TAF of agricultural and 62 TAF of urban pumping). The average annual water shortage for the Subbasin within the calibration period was 5 TAF. Of this annual average, all of the surplus is from agricultural excess and the urban shortage is extremely minor at 0.15 TAF. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. The small agricultural surplus indicates a minor misalignment of demands and supplies likely due to the timing, volume, or delivery location of the supplies. The annual simulated land and water use budgets for the calibration period are presented in Figure 9 and Figure 10 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands and water supplies. If supply and demand do not balance, there is a surplus or shortage indicated on the land and water use budget.

Table 4 shows the annual averages described above for ESJWRM Version 2.0's calibration period. Compared to ESJWRM Version 1.1 ESJ Subbasin averages, which had a calibration period through 2015 instead of 2020, the biggest differences in ESJWRM Version 2.0 for the comparable calibration period are in the agricultural land and water use budget. Due to refinements to the agricultural surface water diversions (primarily due to OID, but also due to changes to SSJID, Delta, and riparian diversions), the surface water deliveries increased by 70 TAF compared to ESJWRM Version 1.1. Additional root zone calibration adjusted agricultural demand for several agencies (OID North, NSJWCD, and SSJID), resulting in ESJWRM Version 2.0 having more demand than ESJWRM Version 1.1. The refinement of delivery groups and estimated diversions reduced the surplus in ESJWRM Version 1.1 by 11 TAF, which resulted in less element pumping in ESJWRM Version 2.0. For the urban budget, the refinement of delivery groups (especially for Stockton area urban users), how demand was input into the model, and diversion amounts eliminated the surplus in ESJWRM Version 1.1.

The corresponding land and water use budgets for both agricultural and urban water demands are included for each GSA in Appendix A. OID is separated out into two separate water budgets: North and South. OID North is a GSA and OID South (not a GSA) is part of Modesto Subbasin. LCSD and LCWD do not have any agricultural demand and therefore a figure is not included.

Table 4: Eastern San Joaquin Subbasin Land and Water Use Budget Annual Averages

Land and Water Use Budget Component	ESJWRM Version 2.0 Annual Average for WY 1996-2020
Agricultural Area (thousand acres)	385
Agricultural Demand (TAF)	1,145
Agricultural Groundwater Pumping (TAF)	638
Agricultural Surface Water Deliveries (TAF)	512
Agricultural Surplus (TAF)[1]	5
Urban Area (thousand acres)	96
Urban Demand (TAF)	117
Urban Groundwater Pumping (TAF)	62
Urban Surface Water Deliveries (TAF)	55
Urban Shortage (TAF)[1]	0

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 9: Eastern San Joaquin Subbasin Agricultural Demand

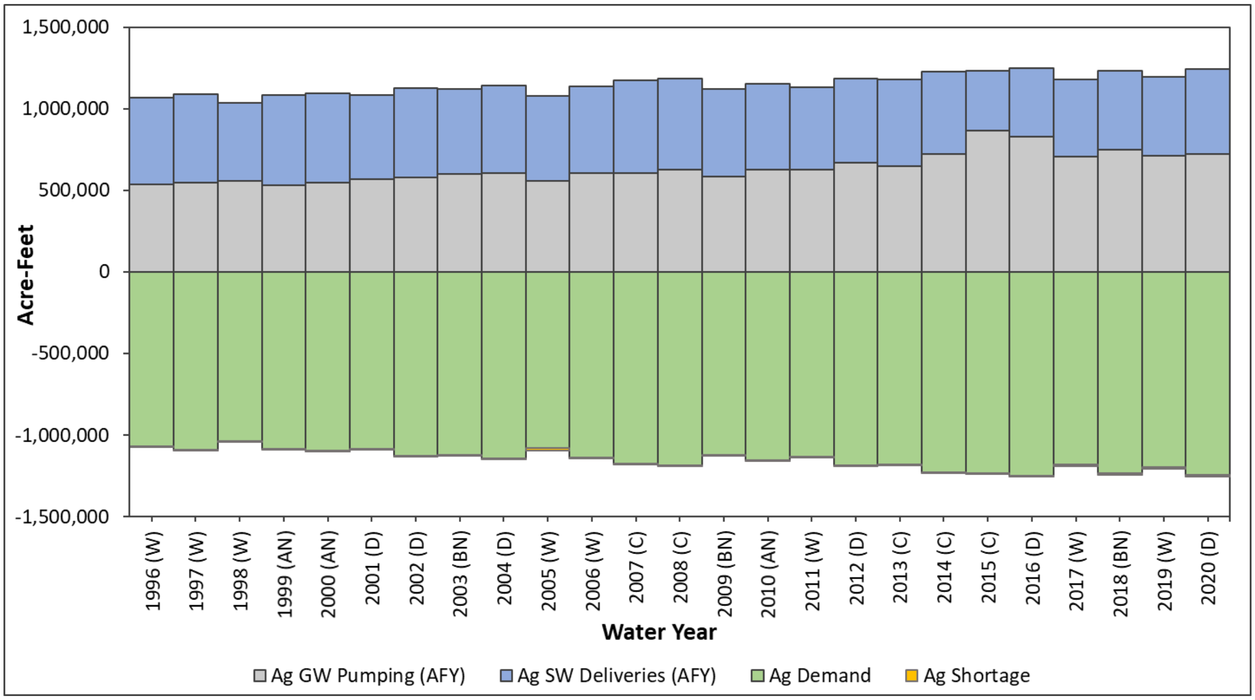
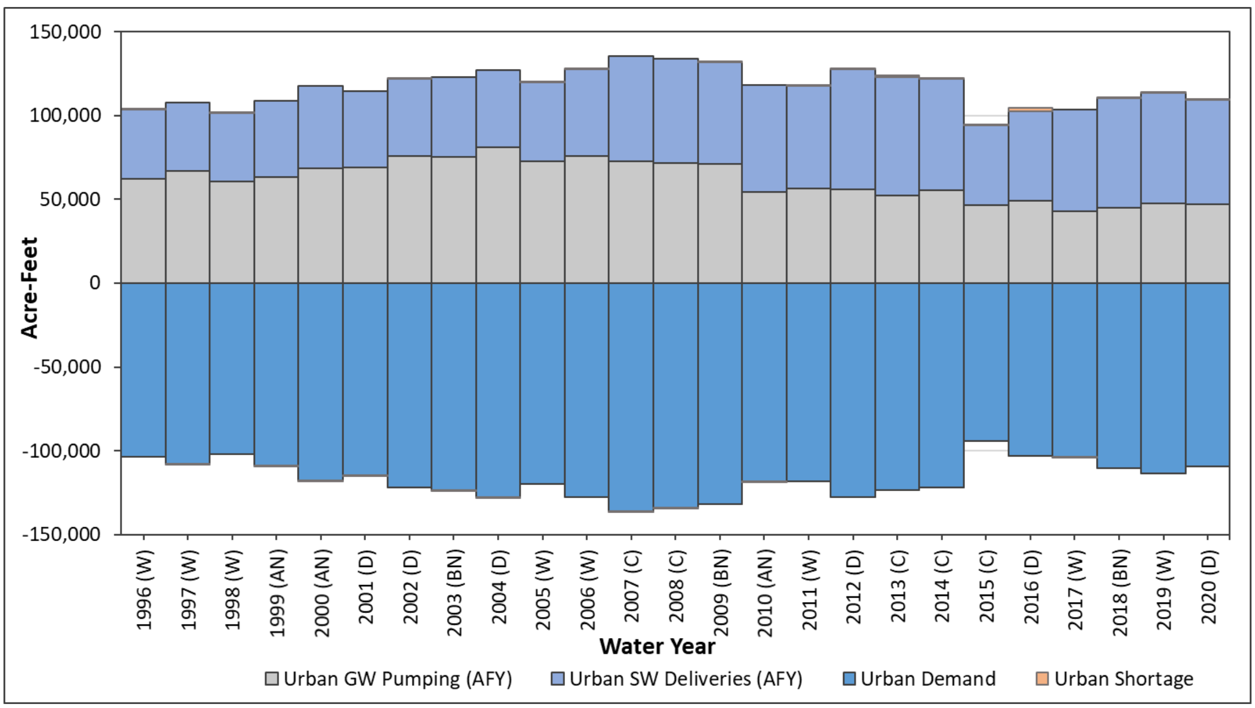


Figure 10: Eastern San Joaquin Subbasin Urban Demand



1.3.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget, corresponding to the major hydrologic processes affecting groundwater flow in the ESJ Subbasin, are:

- Inflows:
    - Deep percolation (from rainfall and irrigation applied water)
    - Gain from stream (or recharge due to stream seepage)
    - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
    - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
    - Groundwater pumping
    - Loss to stream (or outflow to streams and rivers)
    - Boundary outflow (to surrounding groundwater subbasins)
    - Change in groundwater storage (can be either an inflow or outflow)

The largest component in the groundwater budget is an average annual 709 TAF of pumping, offset by 262 TAF of deep percolation, a net gain from stream of 129 TAF, 169 TAF of other recharge, and a net boundary inflow of 113 TAF annually. The cumulative change in groundwater storage can be calculated from the change in groundwater storage. The groundwater storage in ESJ Subbasin during the calibration period was an average of 37 TAFY. These averages are shown in Table 5 and the Subbasin annual groundwater budget is shown in Figure 11.

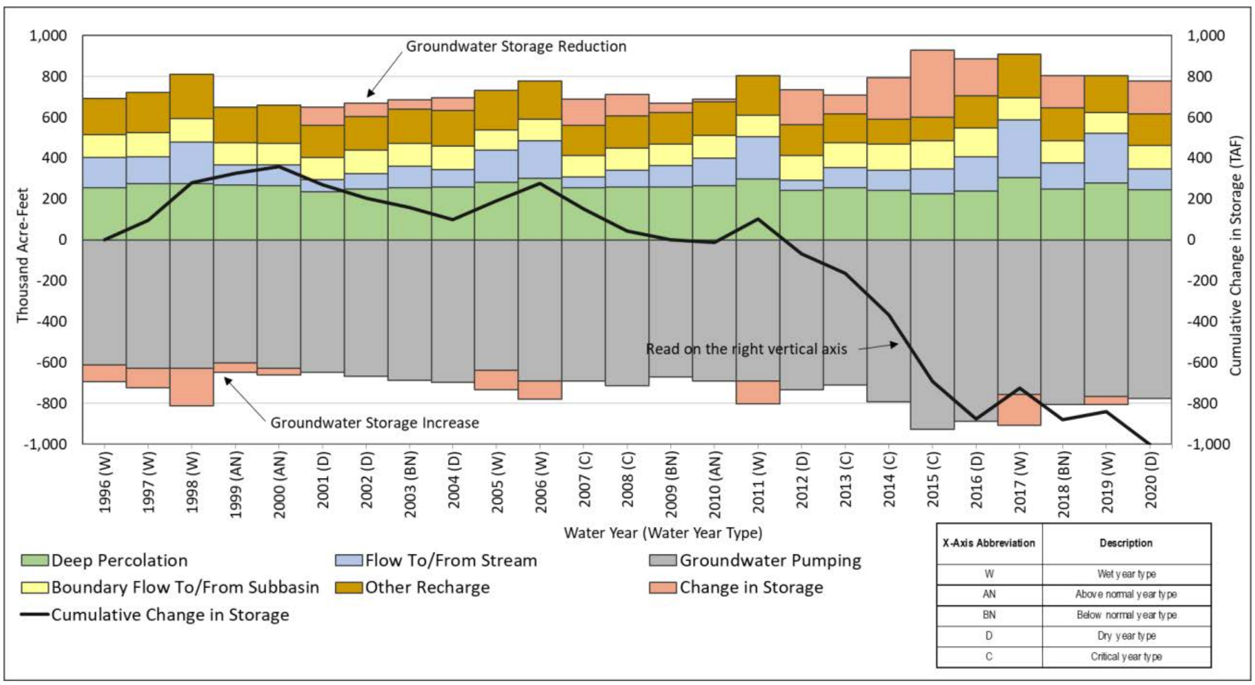
Table 5 shows the annual averages described above for ESJWRM Version 2.0's calibration period. The average annual change in storage estimation determined using ESJWRM Version 1.1 was 41 TAF. The latest update and calibration of the model to ESJWRM Version 2.0 has refined this estimate to an average annual change in storage of 37 TAF over the extended calibration period through 2020. The difference in these estimates is due in large part to the difference in the calibration period, as well as the overhaul of surface water data, especially with regards to OID, and the update to the overall model calibration. This difference in change in storage is well within the ranges observed in the sensitivity analysis discussed in Section 1.2.3.

Other differences observed in the groundwater budget between ESJWRM Version 2.0 and ESJWRM Version 1.1, using the comparable calibration period, are an increase in deep percolation in ESJWRM Version 2.0, most likely caused by increased applied surface water and changes to the root zone calibration, and a decrease in net stream seepage in ESJWRM Version 2.0 due to changes in groundwater levels near streams caused by other groundwater budget components.

Table 5: Eastern San Joaquin Subbasin Hydrologic Groundwater Budget Annual Averages

Hydrologic Groundwater Budget Component	ESJWRM Version 2.0 Annual Average for WY 1996-2020
Deep Percolation (TAF)	262
Other Recharge (TAF)	169
Net Stream Seepage (TAF)	129
Net Boundary Inflow (TAF)	113
Groundwater Pumping (TAF)	709
Change in Groundwater Storage (TAF)	37

Figure 11: Eastern San Joaquin Subbasin Hydrologic Groundwater Budget



2 Projected Conditions Baseline Update

The refinements and enhancements made to the historical data for the updated historical calibration ESJWRM (ESJWRM Version 2.0) required an update to the projected conditions baseline ESJWRM. The version of the Projected Conditions Baseline (PCBL) presented in the GSP finalized in November 2019 is called PCBL Version 1.0. The updated version of the PCBL using ESJWRM Version 2.0 extended dataset and calibration results is referred to as PCBL Version 2.0. This section presents the key data sources and assumptions used to develop the PCBL Version 2.0 and provides the model results.

The PCBL used to develop the projected water budgets represents estimated long-term hydrologic conditions of the Subbasin under the foreseeable future level of development. The future level of development represents approximately water year 2040 or the closest information available from planning documents.

2.1 Assumptions Used to Develop Projected Conditions Baseline Update

This section discusses the assumptions made in converting PCBL Version 1.0 to PCBL Version 2.0. The data and calibration parameters were updated to be consistent with the historical ESJWRM Version 2.0. Initial groundwater levels and soil conditions in the PCBL represent those at the end of the simulation period of the historical ESJWRM Version 2.0 (September 30, 2020).

2.1.1 Hydrology

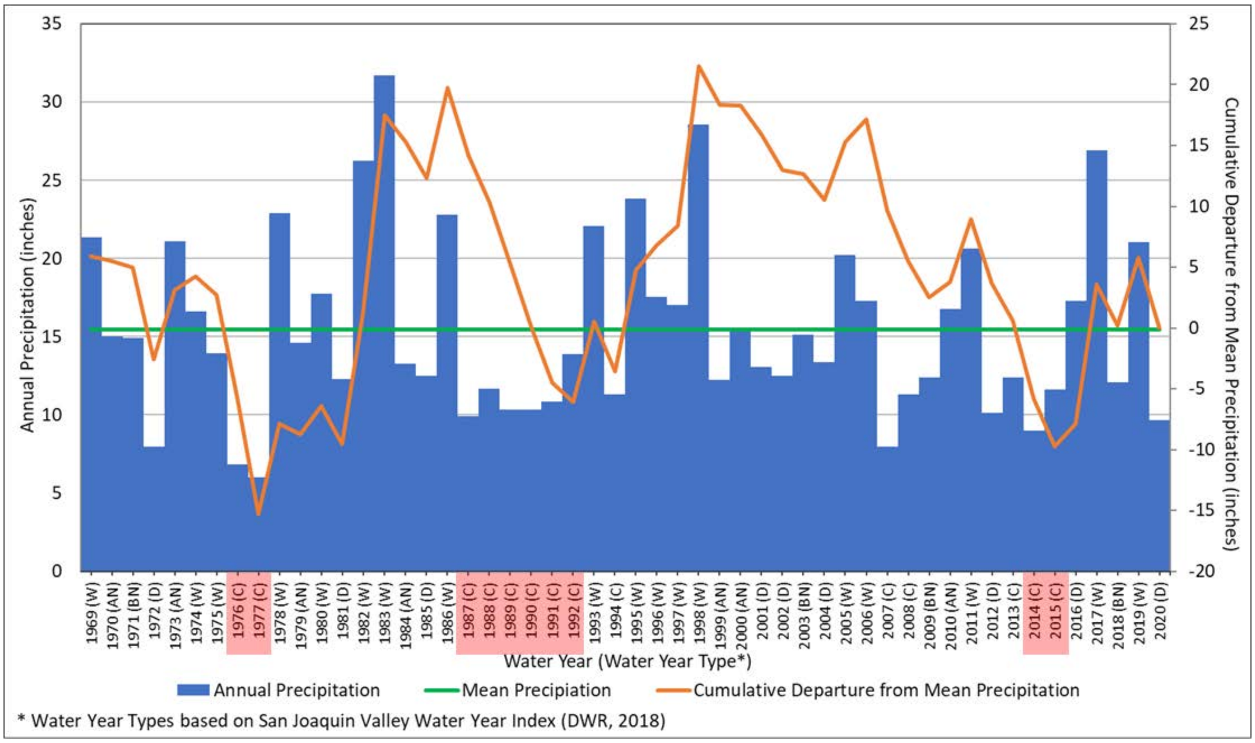
The GSP version of PCBL Version 1.0 included 50 years of hydrology data from water years 1969 through 2018 (October 1968 through September 30, 2018) and was documented in the ESJ Subbasin GSP (ESJGWA, 2019). The updated version PCBL Version 2.0 uses 52 years of hydrology data from water years 1969 through 2020 (October 1968 through September 30, 2020). The projected 52 years of hydrology used in PCBL Version 2.0 was maintained and extended to meet the SGMA requirements to evaluate how the Subbasin's surface and groundwater systems may react under representative hydrologic conditions.

2.1.1.1 Precipitation and Hydrologic Water Year Types

Historical precipitation or rainfall in the ESJ Subbasin was used to identify the hydrologic period that would provide a representation of wet, dry, and extreme periods needed for PCBL Version 2.0. Figure 12 shows the Subbasin annual precipitation (blue columns), average precipitation (green line) of approximately 15 inches, and cumulative departure from mean precipitation (orange line) for each water year from 1969 through 2020. This plot represents the spatially-averaged precipitation across ESJ Subbasin elements developed from PRISM precipitation data. The long-term average precipitation is subtracted from annual precipitation within each water year to develop the departure from average precipitation for each water year. Starting at the first year analyzed, the departures are added cumulatively for each subsequent year. Wet years have a positive departure and upward slopes, dry years have a negative departure and downward slopes, and a year with exactly average precipitation would have zero departure. More severe events are shown by steeper slopes and greater changes.

Each year on the x-axis in Figure 12 is indicated with the San Joaquin Valley Water Year Hydrologic Classification Index published by DWR. The 52 years of the PCBL, from WY 1969 through 2020, represent a range of hydrologic conditions, as identified by the water year types in the San Joaquin Valley Water Year Hydrologic Classification, which classifies water years 1901 through 2020 as Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critical (C) based on inflows to major reservoirs or lakes. A description of how this index is calculated and the specific data used to calculate this index is available online from CDEC at http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST. In the 52 years of hydrology used in the PCBL Version 2.0, there are 14 Critical years, 9 Dry years, 4 Below Normal years, 7 Above Normal years, and 18 Wet years.

Figure 12: Historical Precipitation in Eastern San Joaquin Subbasin



To facilitate assumptions for baseline water supplies and demands, the five San Joaquin Valley water year types were aggregated into three water year type groups. Critical and Dry years are combined into one category in the baseline water year types (called Dry years), Above Normal and Below Normal years are also combined into one category (Normal years), and Wet years remain in one category (called Wet years). With this breakdown, the three baseline water year types have a distribution of 23 Dry years, 11 Normal years, and 18 Wet years. These baseline water year types (Table 6) are used in the remainder of the PCBL data development and results discussion.

As evident in Figure 12, there are three periods of extreme drought in which there are sequences of critical years where the cumulative departure from mean precipitation drops significantly in a steep slope. To capture future extreme dry year periods that may occur in the PCBL, the following 10 water years were designated as Drought periods: 1976-1977, 1987-1992, and 2014-2015. Drought years are highlighted in red on the x-axis of Figure 12 and distinguished in Table 6. Though the most recent drought lasted from 2012 through 2015, the selected baseline drought years only included 2014 and 2015 as those were the most critical years in which supplies and demands were most impacted.

An 11-year period (WY 2010-2020) of historical hydrology was selected to form the basis of projected data developed by averaging recent historical data. This period was selected because of the reliability of the historical data in ESJWRM Version 2.0 during these years and because the distribution of water year types was relatively consistent with the overall PCBL hydrology.

Table 6: Baseline Hydrologic Water Year Types

Baseline Year	Water Year	San Joaquin Valley Water Year Hydrologic Classification	Baseline Year Type		Baseline Year	Water Year	San Joaquin Valley Water Year Hydrologic Classification	Baseline Year Type
1	1969	Wet	Wet		27	1995	Wet	Wet
2	1970	Above Normal	Normal		28	1996	Wet	Wet
3	1971	Below Normal	Normal		29	1997	Wet	Wet
4	1972	Dry	Dry		30	1998	Wet	Wet
5	1973	Above Normal	Normal		31	1999	Above Normal	Normal
6	1974	Wet	Wet		32	2000	Above Normal	Normal
7	1975	Wet	Wet		33	2001	Dry	Dry
8	1976	Critical	Drought		34	2002	Dry	Dry
9	1977	Critical	Drought		35	2003	Below Normal	Normal
10	1978	Wet	Wet		36	2004	Dry	Dry
11	1979	Above Normal	Normal		37	2005	Wet	Wet
12	1980	Wet	Wet		38	2006	Wet	Wet
13	1981	Dry	Dry		39	2007	Critical	Dry
14	1982	Wet	Wet		40	2008	Critical	Dry
15	1983	Wet	Wet		41	2009	Below Normal	Normal
16	1984	Above Normal	Normal		42	2010	Above Normal	Normal
17	1985	Dry	Dry		43	2011	Wet	Wet
18	1986	Wet	Wet		44	2012	Dry	Dry
19	1987	Critical	Drought		45	2013	Critical	Dry
20	1988	Critical	Drought		46	2014	Critical	Drought
21	1989	Critical	Drought		47	2015	Critical	Drought
22	1990	Critical	Drought		48	2016	Dry	Dry
23	1991	Critical	Drought		49	2017	Wet	Wet
24	1992	Critical	Drought		50	2018	Below Normal	Normal
25	1993	Wet	Wet		51	2019	Wet	Wet
26	1994	Critical	Dry		52	2020	Dry	Dry

2.1.1.2 Evapotranspiration

No changes to evapotranspiration in ESJ Subbasin were implemented in PCBL Version 2.0. ESJWM Version 2.0 evapotranspiration by land use type and by model subregion is assumed to be consistent into the future.

2.1.1.3 Streamflow

No change was assumed in PCBL Version 2.0 to all stream inflows. SSJID system outflows were calculated based on the 11-year aggregated water year type average of historical data for WY 2010-2020.

2.1.2 Land Use and Cropping Patterns

PCBL Version 2.0 used the latest land use dataset available and incorporated urban buildout to reflect the 2040 land use conditions. Land use and cropping patterns are based on the most recent, comprehensive, and model-wide land use survey from DWR (DWR, 2018d), with adjustments based on local information and input. This spatial land use data was mapped to ESJWRM model elements and is used as the basis of the PCBL as the latest source of reliable land use data covering the entire model domain. The same edits were made to elements representing LCSD and LCWD to remove agricultural land, as described above for ESJWRM Version 2.0 discussed in Section 1.1.5. The land use data for OID area is adjusted to reflect the information consistent with the OID AWMP.

To represent the extent of urban buildout in 2040, the urban areas in 2018 land use dataset were expanded to either the sphere of influence or general plan boundaries and are held constant during the simulation. The areas with urban buildout are shown in Figure 13 and include Lodi, Stockton, Lathrop, Manteca, Ripon, and Escalon. No growth was assumed for the Jenny Lind urban area. While there is agricultural growth anticipated in the eastern areas of the Subbasin and potential conversion of existing agricultural land to permanent irrigated crops, no reliable projections were available to include in the simulation; therefore, no additional agricultural land growth was added to the PCBL. Thus, cropping acreage is reduced only where urban expansion occurs. This means that due to projected urban growth of over 48,000 acres, agricultural acreage is expected to decrease by approximately 34,000 acres and undeveloped acreage decreases by under 15,000 acres. Table 7 shows the differences between the DWR 2018 data and the ultimate baseline acreage once urban buildout was incorporated. Figure 14 is a pie chart of the PCBL Version 2.0 cropping pattern.

Figure 13: 2018 Land Use with Urban Sphere of Influence Boundaries

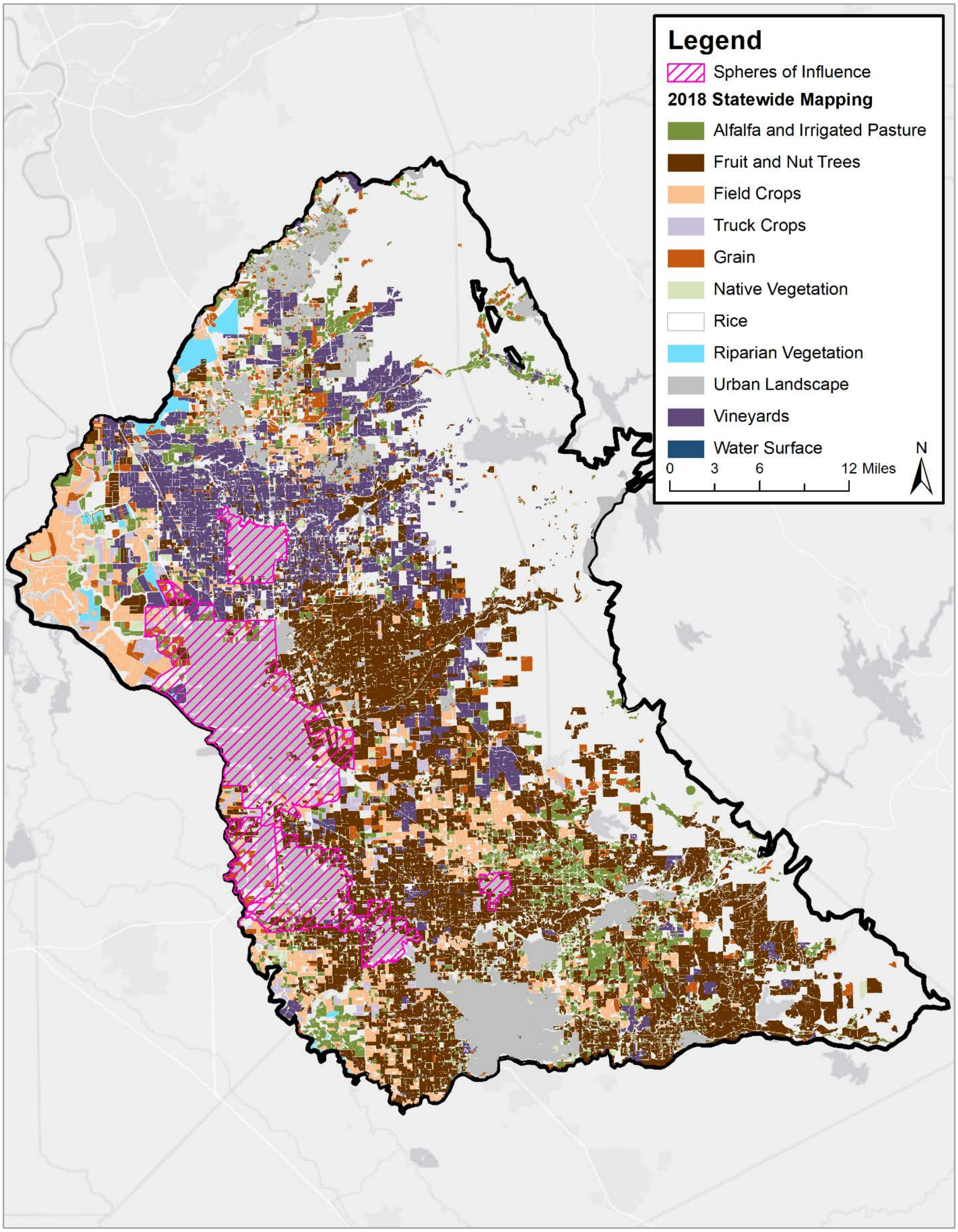
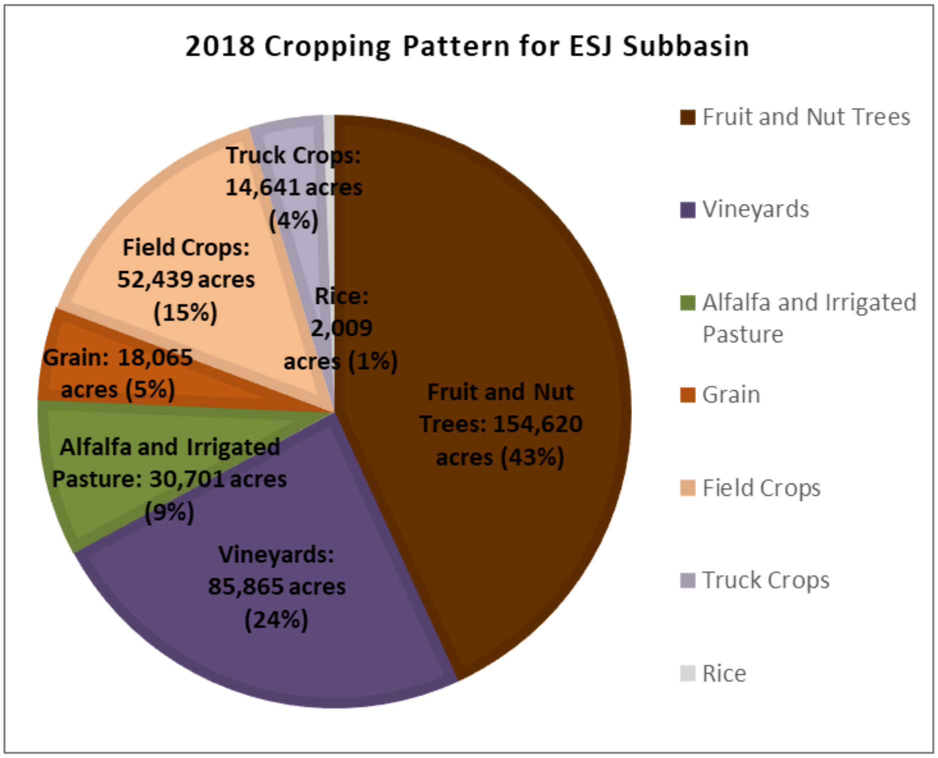


Table 7: ESJ Subbasin Land Use Acreages by Land Use Type

Land Use Type	DWR 2018 Survey	Baseline Model	Change from DWR 2018 Survey
Ag Acreage	392,112	358,340	-33,772
Urban Acreage	104,858	153,484	48,625
Undeveloped Acreage	255,143	240,289	-14,853
Riparian	12,579	12,579	0

Figure 14: 2018 Cropping Pattern for ESJ Subbasin



2.1.3 Water Supply and Demand

Urban water demand in the PCBL Version 2.0 is generally reflective of 2040 conditions. Demand and supply projections were generally available for 2040 or 2045 conditions from urban water management plans (UWMPs). Water demand and supply assumptions are based on the 2020 UWMPs, other planning documents, and the most current information provided by purveyors. Urban demand and supply projections were estimated for three water year types for wet, normal, and dry conditions, with drought periods assumed of critical water supply. Projections for wet years were assumed to be the same as normal conditions when wet year projections were unavailable. After the projected surface water supply and demand were pulled from the planning documents, the projected municipal pumping was calculated as the difference between surface water supply and demand. For the purpose of the modeling, supply was assumed to meet the demand with no surplus.

Agricultural water supply largely used the 11-year averages of grouped water year types from the recent historical data (WY 2010-2020). All PCBL annual average surface water diversion volumes are included in Table 2.

In each of the drought period years in the PCBL, it was assumed that the surface water supply delivered was at the 2015 level of supply, if lower than the dry year supply. Pumping was increased accordingly if not calculated within the model. In this way, the PCBL is based on the most recent critical year actual historical delivery data and simulates periods of extreme stress on the groundwater system.

2.2 Projected Conditions Baseline Results

This section provides a summary of the ESJWRM PCBL Version 2.0 results.

2.2.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
    - Groundwater pumping
    - Surface water deliveries
    - Shortage (if applicable)
- Outflows:
    - Demand (either agricultural or urban)
    - Surplus (if applicable)

The average annual projected water demand for the Subbasin within the 52-year simulation period is 1,258 thousand acre-feet (TAF), consisting of approximately 1,100 TAF expected agricultural demand and 158 TAF expected urban demand. This demand is met by an annual average of 528 TAF of surface water deliveries (453 TAF of agricultural and 76 TAF of urban deliveries) and is supplemented by 743 TAF of groundwater production (661 TAF of agricultural and 82 TAF of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 13 TAF of surplus in the Subbasin scale agricultural water use budget, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 8. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 15 and Figure 16 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

The corresponding average annual agricultural and urban demand figures for the projected conditions baseline are included for each GSA in Appendix B. As in the historical model LCSD and LCWD do not have projected agricultural demand and therefore the figure is not included. At full buildout to the sphere of influence boundaries, City of Stockton GSA, San Joaquin County #2, and City of Manteca GSA do not have agricultural demand and therefore figures for those GSAs are also not included.

Table 8: Eastern San Joaquin Subbasin Land and Water Use Budget Annual Average

Land and Water Use Budget Component	PCBL Version 2.0 Annual Average
Agricultural Area (thousand acres)	359
Agricultural Demand (TAF)	1,100
Agricultural Groundwater Pumping (TAF)	661
Agricultural Surface Water Deliveries (TAF)	453
Agricultural Surplus (TAF)[1]	13
Urban Area (thousand acres)	153
Urban Demand (TAF)	158
Urban Groundwater Pumping (TAF)	82
Urban Surface Water Deliveries (TAF)	76
Urban Shortage (TAF)[1]	0

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 15: Eastern San Joaquin Subbasin Projected Agricultural Demand

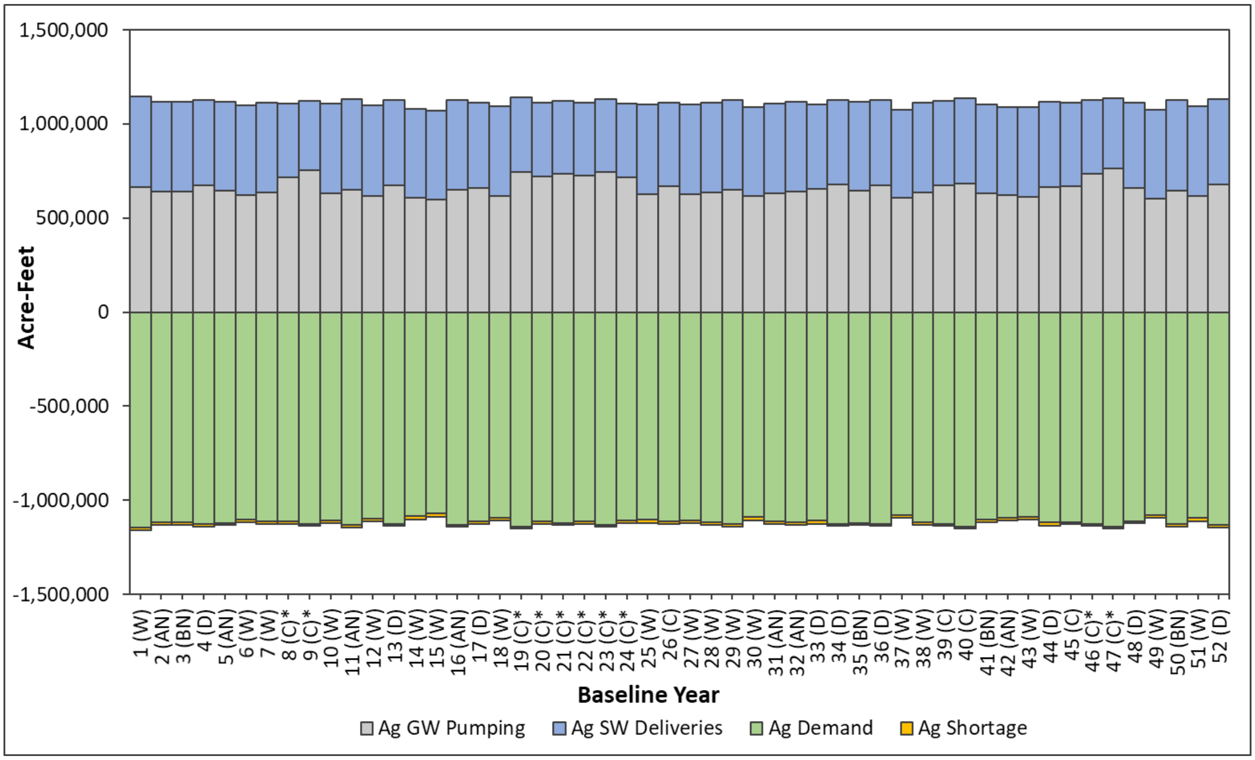
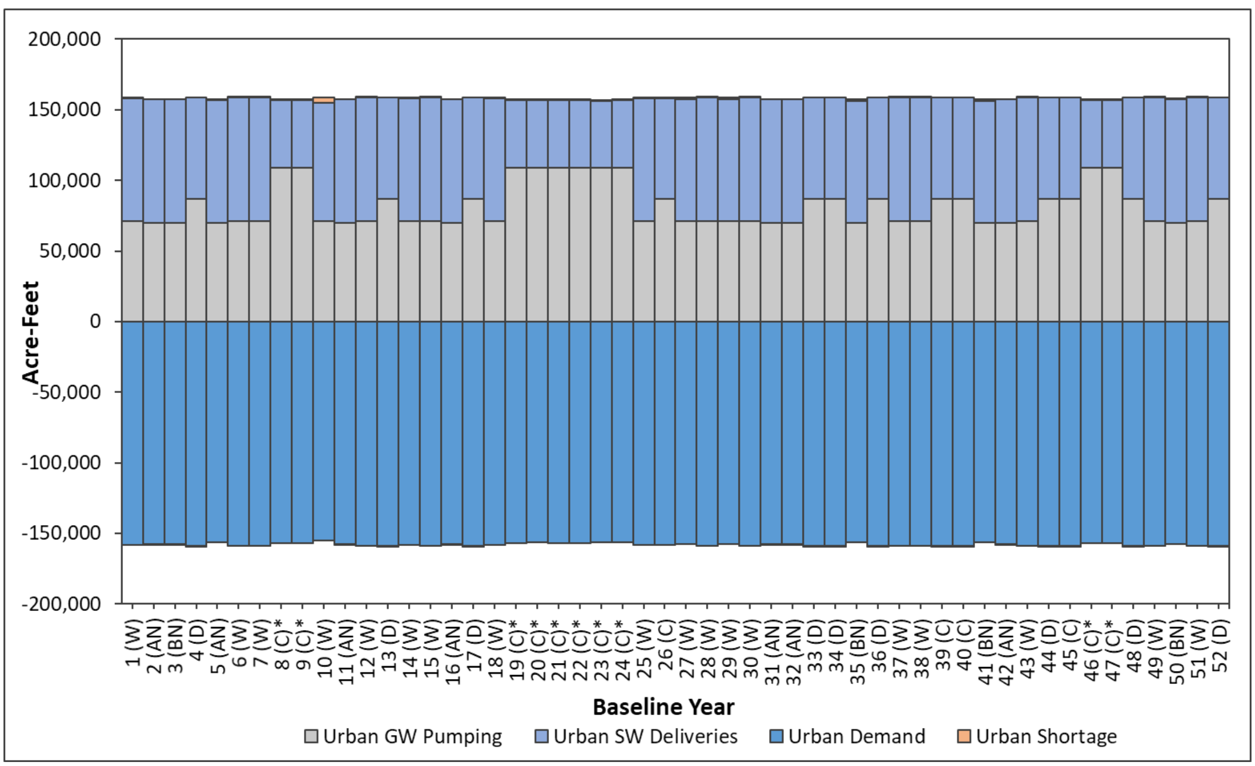


Figure 16: Eastern San Joaquin Subbasin Projected Urban Demand



2.2.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

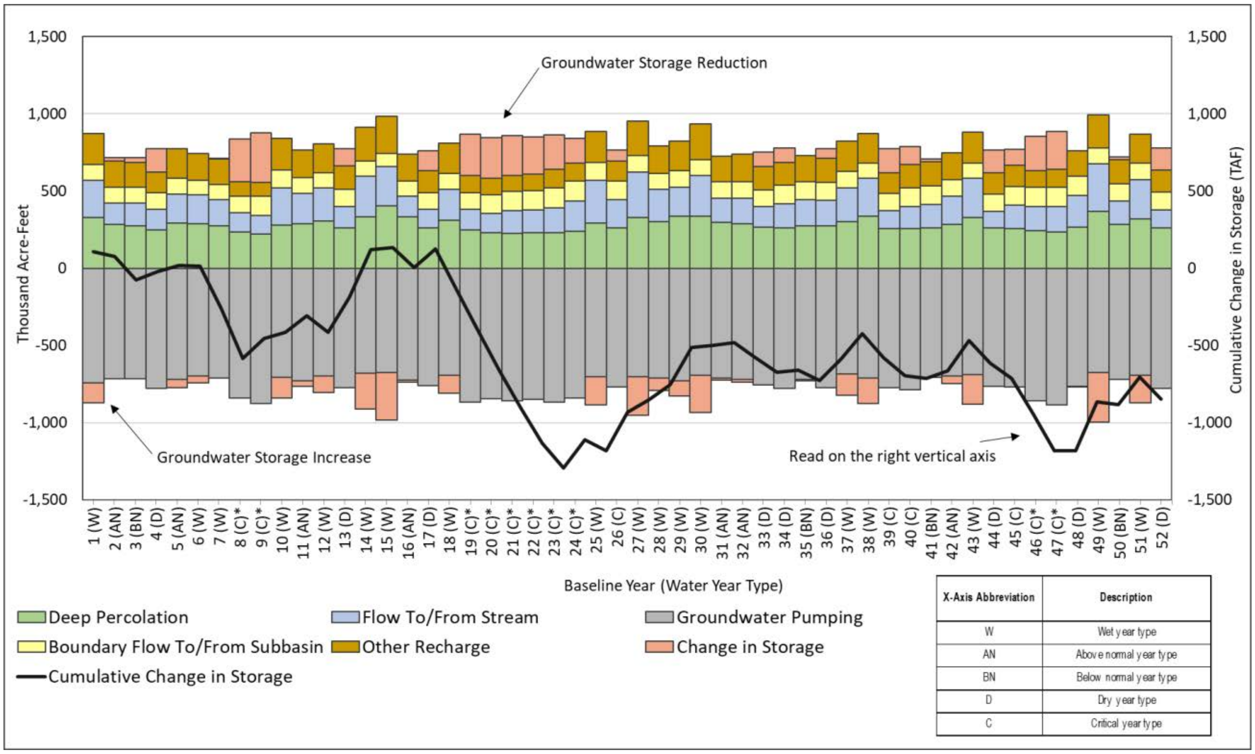
- Inflows:
  - Deep percolation (from rainfall and irrigation applied water)
  - Gain from stream (or recharge due to stream seepage)
  - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
  - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
  - Groundwater pumping
  - Loss to stream (or outflow to streams and rivers)
  - Boundary outflow (to surrounding groundwater subbasins)
  - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL Version 2.0 remains the largest component in the groundwater budget with an annual average 751 TAF. The PCBL offsets this pumping with 282 TAF of deep percolation, a net gain from stream of 181 TAF, 162 TAF of other recharge, and a total subsurface inflow of 110 TAF annually. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL is 16 TAFY. These annual averages are shown in Table 9. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 17.

Table 9: Eastern San Joaquin Subbasin Hydrologic Groundwater Budget Annual Average

Hydrologic Groundwater Budget Component	PCBL Version 2.0 Annual Average
Deep Percolation (TAF)	282
Other Recharge (TAF)	162
Net Stream Seepage (TAF)	181
Net Boundary Inflow (TAF)	110
Groundwater Pumping (TAF)	751
Change in Groundwater Storage (TAF)	16

Figure 17: Eastern San Joaquin Subbasin Projected Hydrologic Groundwater Budget



3 Projected Conditions Baseline Update with Climate Change

With the update of the PCBL Version 2.0, the potential impact of climate change on the Subbasin in the future was also updated. The version of the Projected Conditions Baseline with Climate Change (PCBL-CC) presented in the GSP finalized in November 2019 is called PCBL-CC Version 1.0. The updated version of the PCBL-CC using PCBL Version 2.0 with hydrology perturbation factors is referred to as PCBL-CC Version 2.0. Largely, PCBL-CC Version 1.0 and Version 2.0 use the same perturbation factors, but PCBL-CC Version 2.0 extends the simulation time period by two years. This section presents the climate change methodology, data sources, and assumptions used to develop the PCBL-CC Version 2.0 and provides the model results.

In PCBL-CC Version 1.0, the ESJGWA decided to use 2070 Central Tendency perturbation factors as a reasonable estimation of the impact of climate change. PCBL-CC Version 2.0 also used 2070 Central Tendency climate change conditions.

3.1 Climate Change Background and Methods

SGMA requires taking into consideration uncertainties associated with climate change in the development of GSPs.

Consistent with Section 354.18(d)(3) and Section 354.18(e) of the GSP Regulations, an analysis was performed for the Subbasin evaluating the projected water budget with and without climate change conditions.

Section 354.18(d)(3) of the GSP Regulations states:

"(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:

(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

*(3) Projected water budget information for population, population growth, **climate change** [emphasis added], and sea level rise."*

Section 354.18(e) states:

*"(e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, **climate change** [emphasis added], sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions."*

3.1.1 DWR Guidance

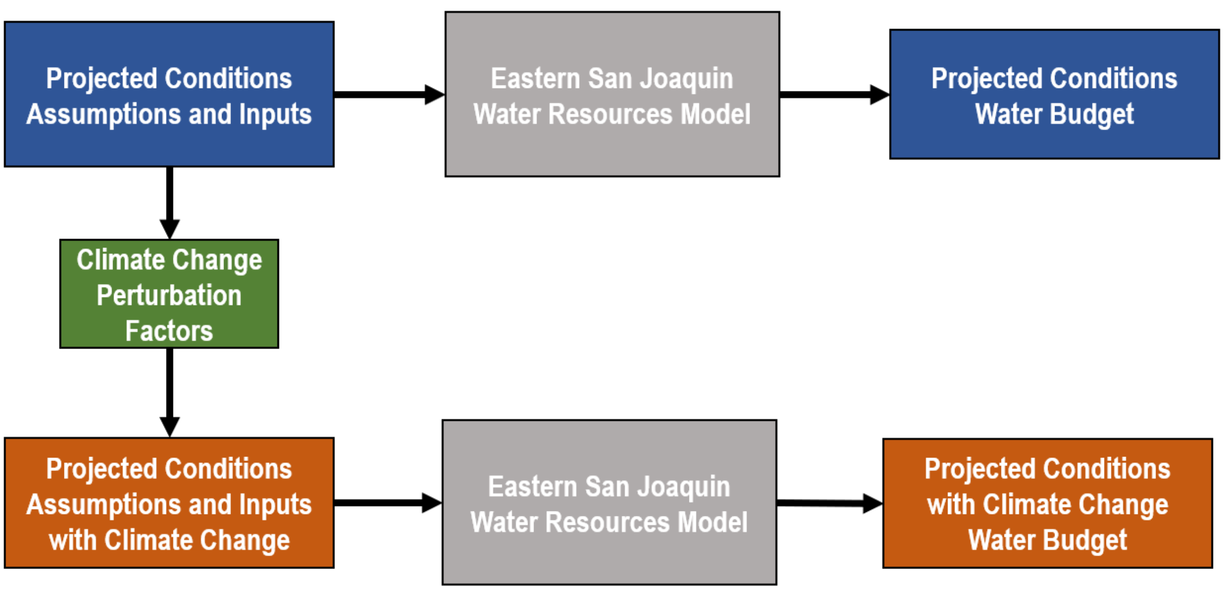
Climate change analysis is an area of continued evolution in terms of methods, tools, forecasted datasets, and the predictions of greenhouse gas concentrations in the atmosphere. The approach developed for this GSP is based on the methodology in DWR's guidance document (CA DWR, 2018b). The "best available information" related to climate change in the Eastern San Joaquin Subbasin was deemed to be the information provided by DWR combined with basin-specific modeling tools. The following resources from DWR were used in the climate change analysis:

- SGMA Data Viewer
- Guidance for Climate Change Data Use During Sustainability Plan Development and Appendices (Guidance Document)
- Water Budget BMP
- Climate Change Desktop IWFM Tools

The SGMA Data Viewer contains climate change forecast datasets for download (CA DWR, 2018c). The guidance document details the approach, development, applications, and limitations of the datasets available from the SGMA Data Viewer (CA DWR, 2018c). The Water Budget BMP describes in greater detail how DWR recommends projected water budgets with climate change be estimated (CA DWR, 2016). The Desktop IWFM Tools are available to estimate the projected precipitation and evapotranspiration inputs under climate change conditions (CA DWR, 2018b).

The methods suggested by DWR in the above resources were used, with modifications where needed, to ensure the results would be reasonable for the Eastern San Joaquin Subbasin and align with the assumptions of the ESJWRM. Figure 18 shows the overall process developed for the Subbasin consistent with the Climate Change Resource Guide (CA DWR, 2018b) and describes workflow beginning with projected conditions inputs and assumptions to perturbed 2070 conditions for the projected conditions.

Figure 18: Eastern San Joaquin Climate Change Analysis Process



The process described in Figure 18 of developing a projected water budget with and without climate change was discussed with DWR staff and is consistent with the regulations. Further, it enables the analysis to account for variability in demand and supply separate from the uncertainty associated with climate change forecasts.

Table 10: DWR-Provided DatasetsTable 10 summarizes the forecasted variable datasets provided by DWR that were used to carry out the climate change analysis (CA DWR, 2018b). The Variable Infiltration Capacity (VIC) model referred to in Table 10 is the fully mechanistic hydrologic model used by DWR to derive hydrographs under standard and climate change conditions.

Table 10: DWR-Provided Datasets

Input Variable	DWR-Provided Dataset
Unimpaired Streamflow	Combined VIC model runoff and baseflow to generate change factors, provided by HUC 8 watershed geometry
Impaired Streamflow (Ongoing Operations)	CalSim II time series outputs
Precipitation	VIC model-generated GIS grid with associated change factor time series for each cell
Reference ETo	VIC model-generated GIS grid with associated change factor time series for each cell

3.1.2 Climate Change Methodology

Accepted methods for estimating climate change impacts on groundwater are based on the assessment of impacts on the individual water resource system elements that directly link to groundwater. These elements include precipitation, streamflow, evapotranspiration and, for coastal aquifers, sea level rise as a boundary condition. For the Eastern San Joaquin Subbasin, sea level rise was not included.

The method for perturbing the streamflow, precipitation, and evapotranspiration input files is described in the following sections. A future scenario of 2070 climate forecasts was evaluated in this analysis, consistent with DWR guidance (CA DWR, 2018b). DWR combined 10 global climate models (GCMs) for two different representative climate pathways (RCPs) to generate the central tendency scenarios in the datasets used in this analysis. The "local analogs" method (LOCA) was used to downscale these 20 different climate projections to a scale usable for California (CA DWR, 2018b). The 2070 central tendency among these projections serves to assess impacts of climate change over the long-term planning and implementation period.

Model simulation results reported in the published GSP have been updated in this section using the updated PCBL Version 2.0 completed as part of the 2021 update of the historical and projected conditions model. This PCBL Version 2.0 has a 52-year simulation baseline period with hydrology from WY 2019 and WY 2020 incorporated. Updates to the PCBL are documented in Section 2. Model results from the updated PCBL-CC are reported in Section 3.3.

3.2 Projected Conditions Baseline with Climate Change Hydrology

This section provides a summary of the data sources, methodology, and summarized results of the updates to the hydrology under climate change conditions.

3.2.1 Streamflow under Climate Change

Hydrologic forecasts for streamflow under various climate change scenarios are available from DWR as either a flow-based timeseries or a series of perturbation factors applicable to local data. DWR simulates volumetric flow in most regional surface water bodies by utilizing the Water Resource Integrated Modeling System (WRIMS, formally named CalSim II). While river flows and surface water diversions in the Calaveras, San Joaquin, and Stanislaus Rivers are simulated in CalSim II, there are significant variations when compared to local historical data. Due to the uncertainty in reservoir operations, flows from CalSim II provided by the state are not used directly. Instead, relative perturbation factors were used to derive surface water inflows and diversions for use in ESJWRM.

Local tributaries and smaller streams within Eastern San Joaquin Subbasin are not simulated in CalSim II and must be simulated using adjustment factors developed by DWR for unregulated stream systems. Dry Creek flows were perturbed using this method. The resolution of these perturbation factors is at the Hydrologic Unit Code 8 watershed scale. CalSim II model runs are not available for the Mokelumne River, according to Appendix B, Table B-2 of DWR's Climate Change Document (CA DWR, 2018b). Therefore, Mokelumne River flows used the perturbation factor method for consistency with the methodology applied to smaller streams. The remaining streams simulated in the ESJWRM utilize the IWFM small watershed package, whose climate change impacts are calculated internally dependent on both precipitation and evapotranspiration refinement. Table 11Table 11: Eastern San Joaquin Stream Inflows presents the impaired and unimpaired streams in the ESJWRM for the Eastern San Joaquin Subbasin.

Table 11: Eastern San Joaquin Stream Inflows

Modeled Stream	Impaired	Unimpaired
Within ESJ Subbasin		
Dry Creek		X
Mokelumne River		X
Calaveras River	X	
San Joaquin River	X	
Stanislaus River	X	
Within Model Area, Outside ESJ Subbasin		
Tuolumne River	x	
Cosumnes River	x	

3.2.1.1 Unimpaired Flows

Change factors for unimpaired streams (Dry Creek and Mokelumne River) were downloaded from SGMA Data Viewer and multiplied by the projected conditions input streamflow data to calculated perturbed flows. DWR change factors are available through 2011; however, the model hydrologic period runs from Water Year 1969-2018. Flows for the remaining model years beyond 2011 were synthesized using the change factor from the most recent matching water year type in the available dataset. Water Year types are designated for each year based on the San Joaquin Valley Runoff WY year type index (CA DWR, 2018a). DWR uses five designations ranging from driest to wettest conditions: Critical, Dry, Below Normal, Above Normal, and Wet. Table 12Table 12: San Joaquin Valley Water Year Type Designations below shows the year type designations used to synthesize the remaining years (2011-2018).

The PCBL with climate change scenario reported in the GSP only used hydrology baseline years through 2018. In the updated PCBL-CC reported in this TM, WY 2019 and WY 2020 are incorporated and added to Table 12 below. The climate change perturbation was carried out for the two additional years of simulation using methods consistent with how the rest of the synthesized years were calculated in the GSP for unimpaired streamflows.

As part of the update to the PCBL, South San Joaquin Irrigation District (SSJID) outflows were incorporated as a new stream inflow to the model. However because these are operationally dependent flows, they were not perturbed in this climate change scenario.

Table 12: San Joaquin Valley Water Year Type Designations

Water Year	Year Type
2003	Below Normal
2004	Dry
2005	Wet
2006	Wet
2007	Critical
2008	Critical
2009	Below Normal
2010	Above Normal
2011	Wet
2012	Dry

2013	Critical
2014	Critical
2015	Critical
2016	Dry
2017	Wet
2018	Below Normal
2019	Wet
2020	Dry

Figure 19 shows the perturbed time series against the projected conditions scenario time series for Dry Creek through the 52-year simulation period and Figure 20 presents the exceedance probability curve. Figure 21 and Figure 22 show the same perturbed time series and exceedance curves, but for Mokelumne River. The exceedance curves are provided because they more clearly show the differences between the projected conditions scenario and the with-climate-change scenario. Generally, flows under the climate change scenario are slightly higher.

Figure 19: Dry Creek Hydrograph

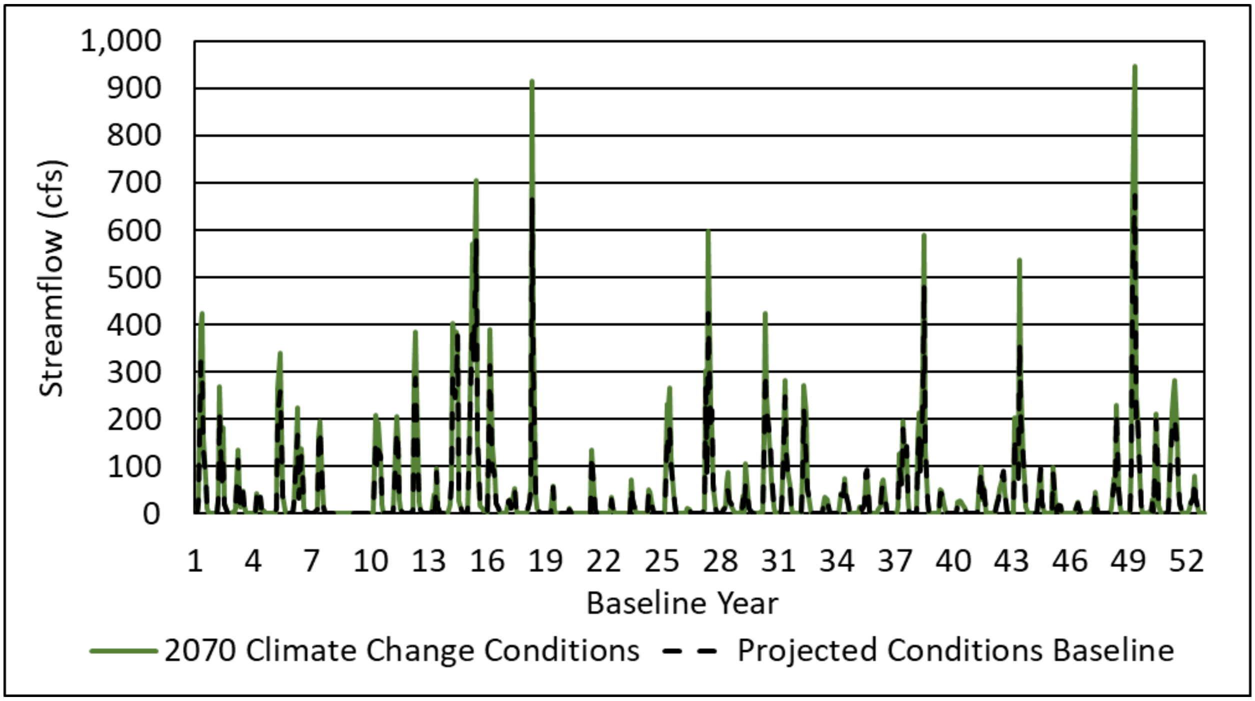


Figure 20: Dry Creek Exceedance Curve

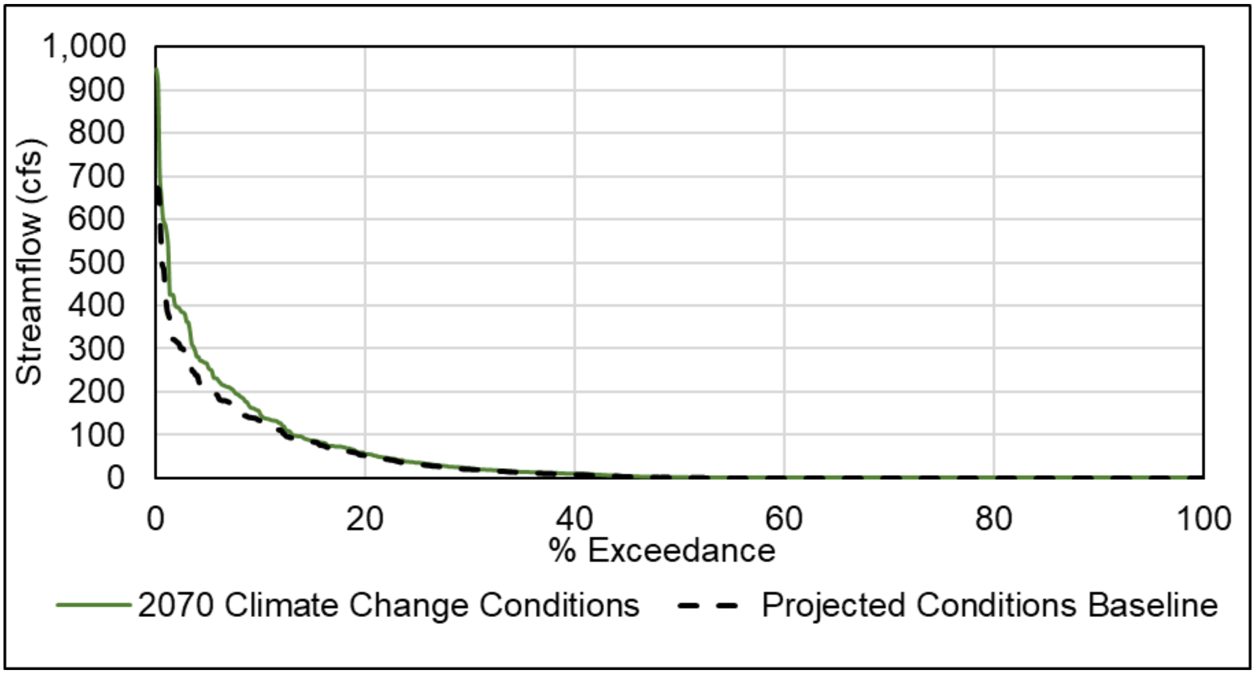


Figure 21: Mokelumne River Hydrograph

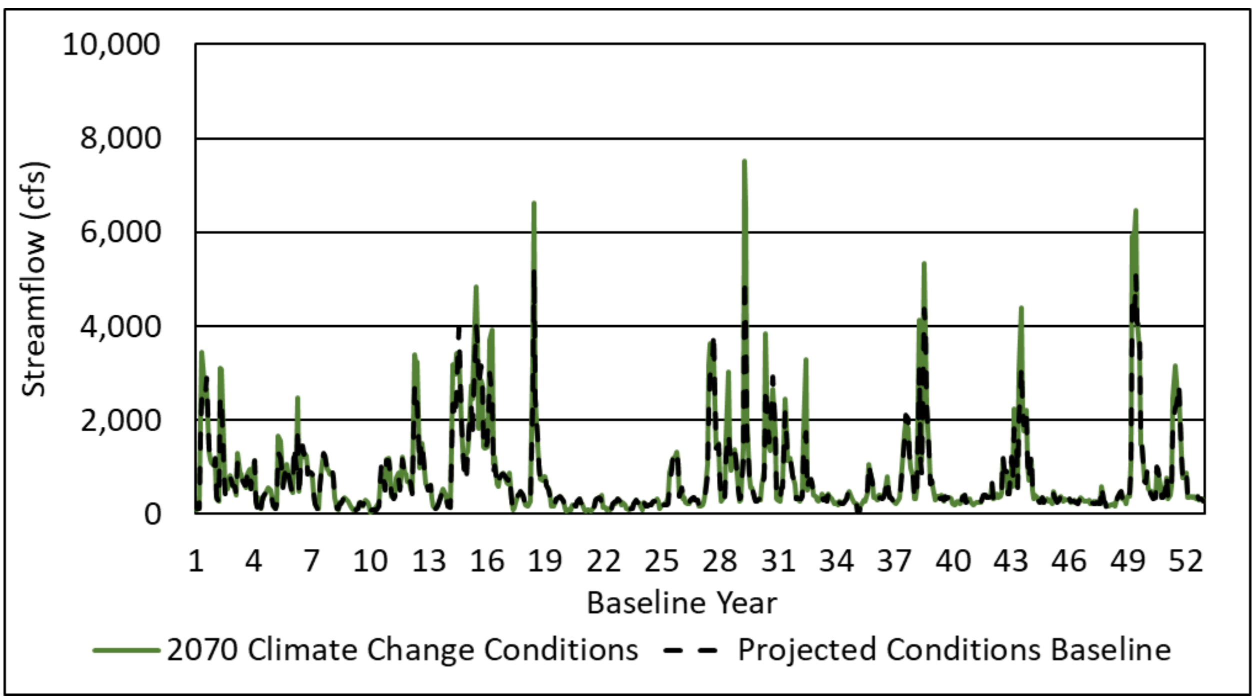
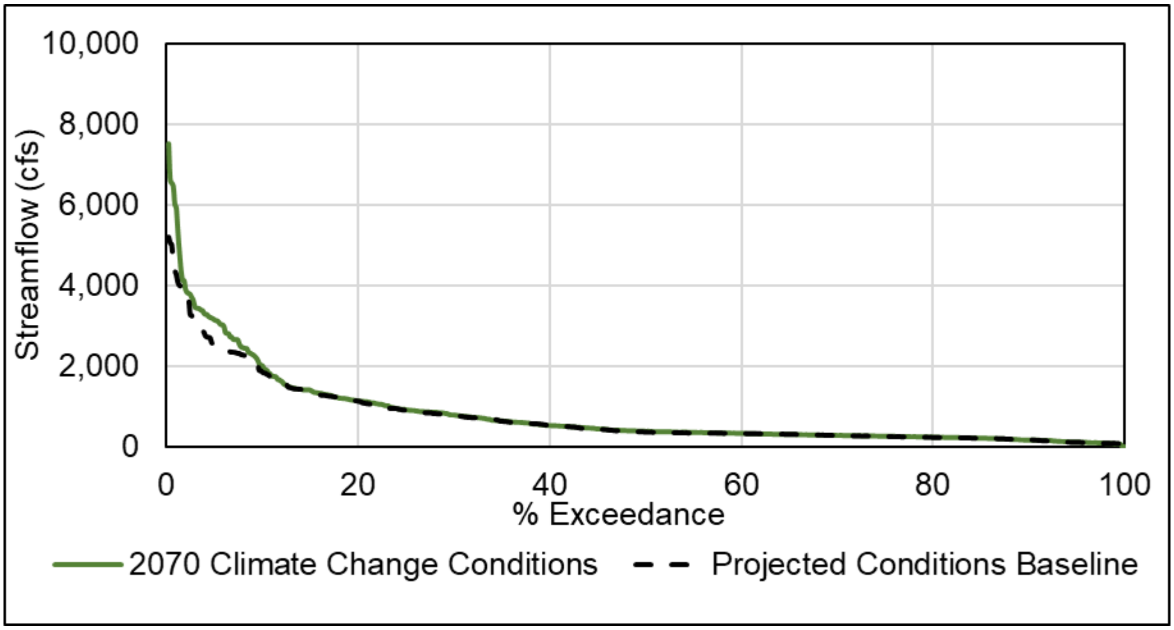


Figure 22: Mokelumne River Exceedance Curve



3.2.1.2 Impaired Flows

CalSim II-estimated flows for point locations on the Calaveras River, San Joaquin River, and Stanislaus River were downloaded from DWR. These points obtained from CalSim II include:

- Calaveras River: New Hogan Reservoir Outflow
- San Joaquin River: San Joaquin River at Vernalis
- Stanislaus River: New Melones Reservoir Outflow

These flows represent projected hydrology based on reservoir outflow, operational constraints, and diversions and deliveries of water for the State Water Project and the Central Valley Project. CalSim II data from WY 1969-2003 were available. For the years 2003-2018, streamflow was synthesized based on flows from WY 1969-2003 and the DWR year type index shown in Table 12 (CA DWR, 2018a). For example, the total monthly streamflow for October 2003 was calculated as the average of the monthly streamflows from October 1966 and October 1971 because they are the same water year type.

CalSim II simulated flows were compared with flows generated using the DWR-provided unimpaired perturbation factors. Streamflows simulated in CalSim II and those derived using the unimpaired adjustment factors did not present similar trends, particularly in dry years, due to CalSim II's simulation of reservoir operations. DWR-provided unimpaired change factors do not account for variations in the operation of the reservoirs that would result from climate change conditions. Therefore, CalSim II outputs were considered a more appropriate starting dataset for regulated streams given that downstream flow is driven by surface water demand rather than natural flow.

The team explored a hybrid approach to improve upon the discrepancy between flows produced using CalSim II and perturbation factors, while accounting for some change in reservoir operations. In this approach, change factors are generated from the difference between the simulated future climate change CalSim II scenario for 2070 climate conditions and a "without climate change" CalSim II run. This "without climate change" run is the CalSim II 1995 Historical Detrended simulation run. The generated change factors from these two runs were then used to perturb the regulated river inflows simulated in the ESJWRM projected conditions scenario. For the purposes of simplicity, this method is referred to throughout the rest of the document as CalSim II Generated Perturbation Factors (CGPF). The CGPF method presents limitations given that the resulting flows are not directly obtained from an operations model. The actual mass balance on the reservoirs is not tracked in the estimates of the flows and, instead, the method relies on CalSim II tracking storage and managing the reservoir based on the appropriate rule curves.

The climate change perturbation was carried out for the two additional years of simulation using methods consistent with how the rest of the synthesized years were calculated in the GSP for impaired streamflows.

Figure 23 through Figure 28 provide a comparison of project baseline condition and the results of the CGPF method described above for each stream within the ESJ Subbasin, updated for the 52-year simulation.

Figure 29 through Figure 32 show the same hydrographs for streams within the model area, but outside of the ESJ Subbasin. Exceedance curves are included for each of the CGPF flows against the project baseline flows.

Figure 23: Calaveras River Hydrograph

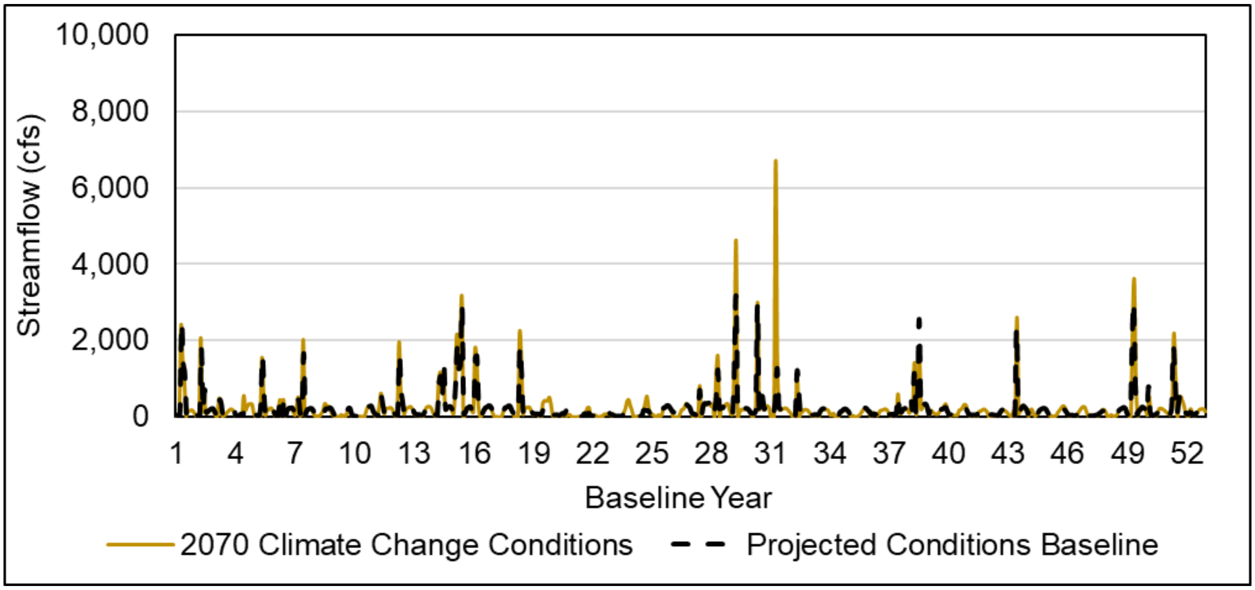


Figure 24: Calaveras River Exceedance Curve

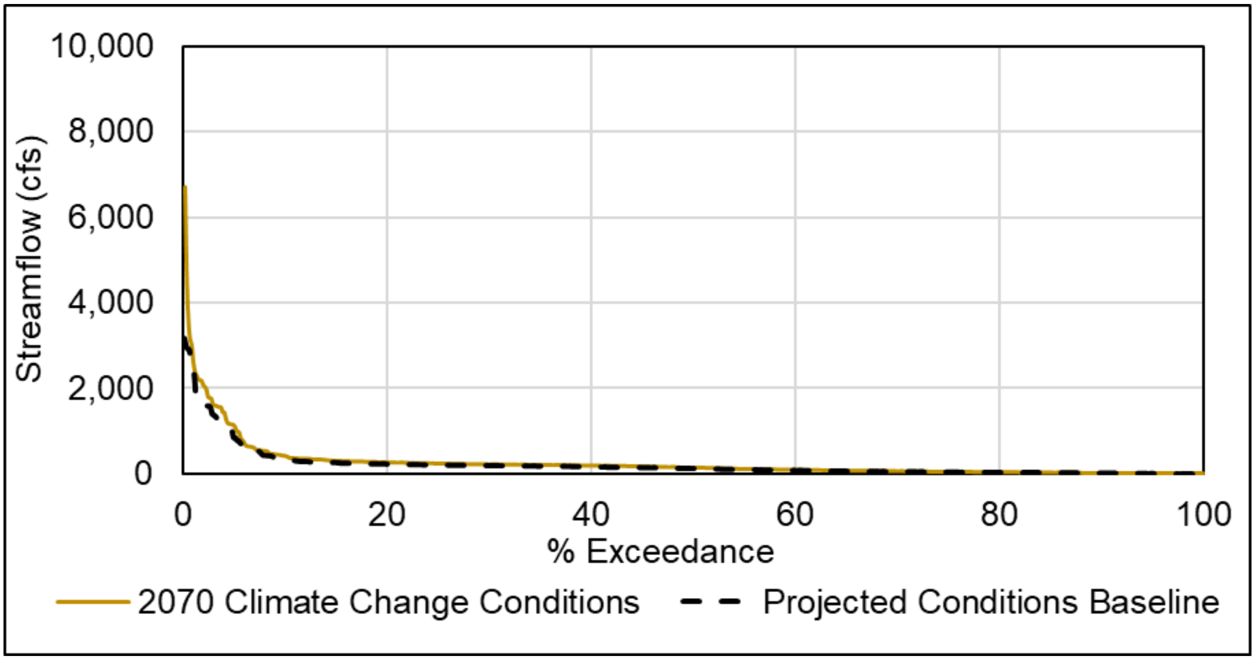


Figure 25: Stanislaus River Hydrograph

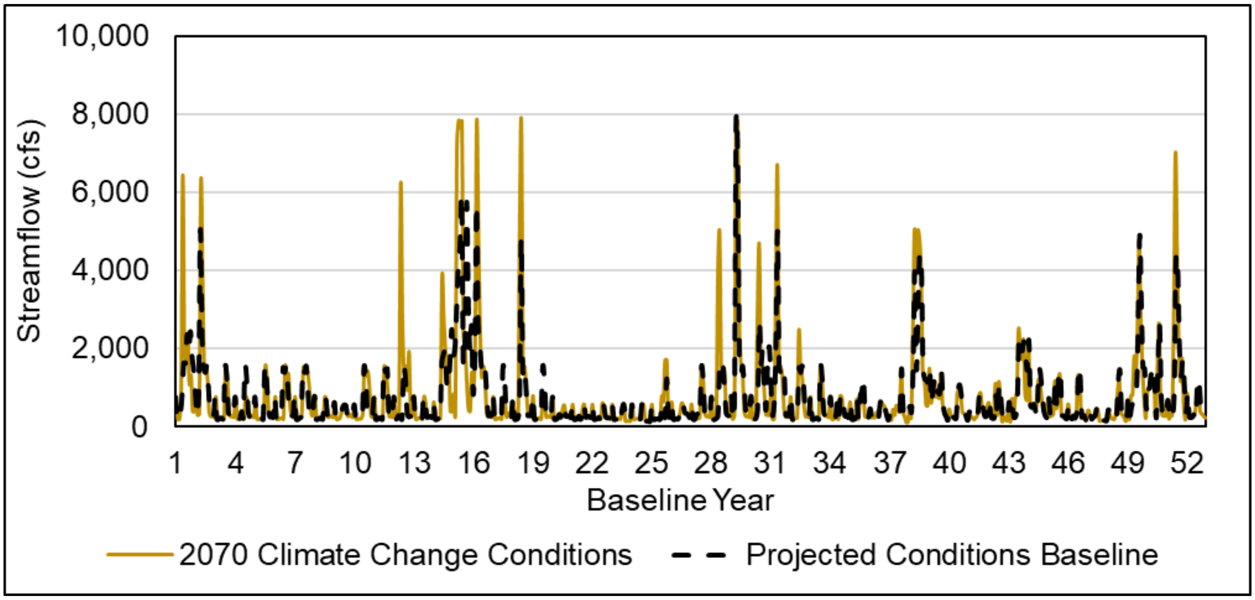


Figure 26: Stanislaus River Exceedance Curve

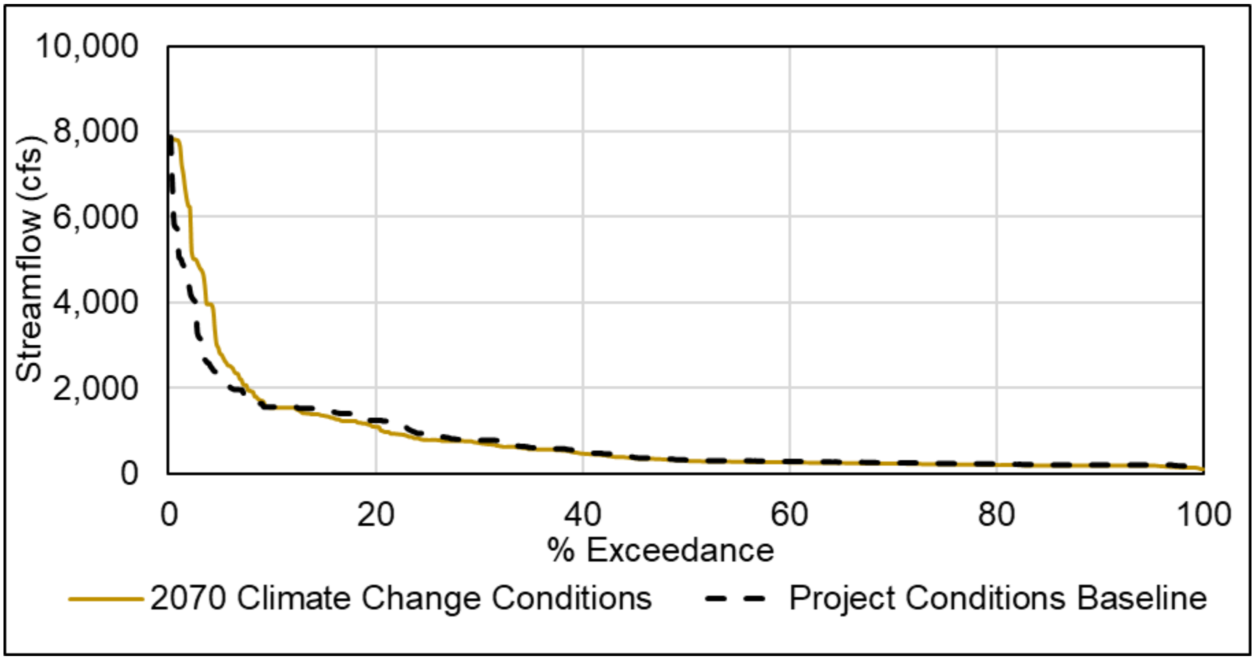


Figure 27: San Joaquin River Hydrograph

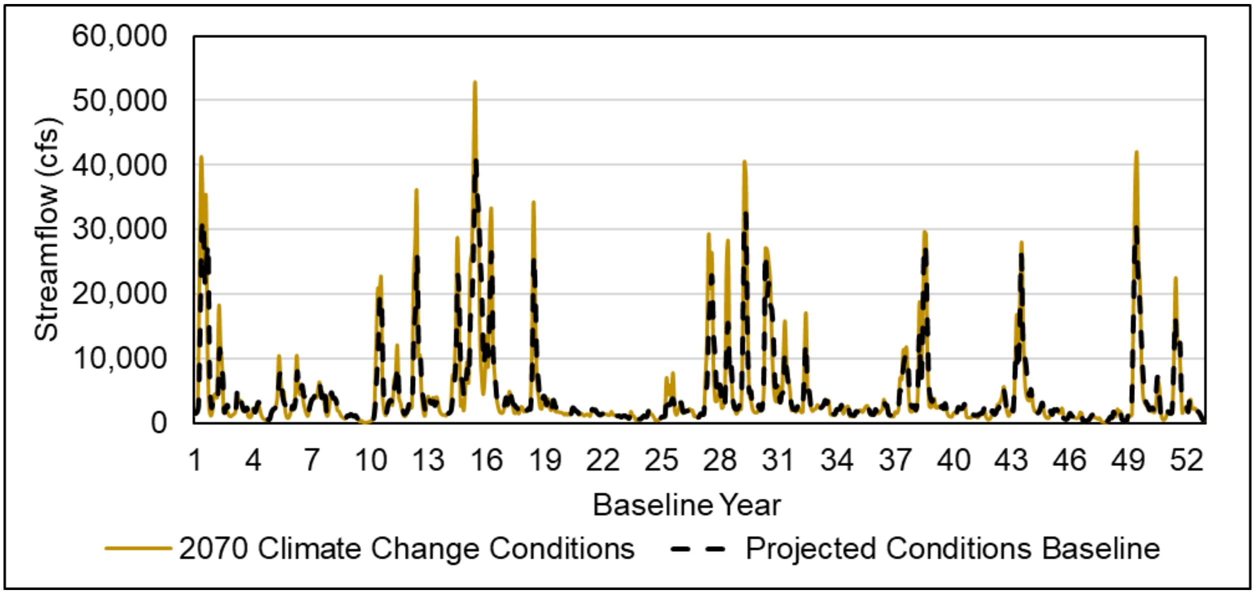


Figure 28: San Joaquin River Exceedance Curve

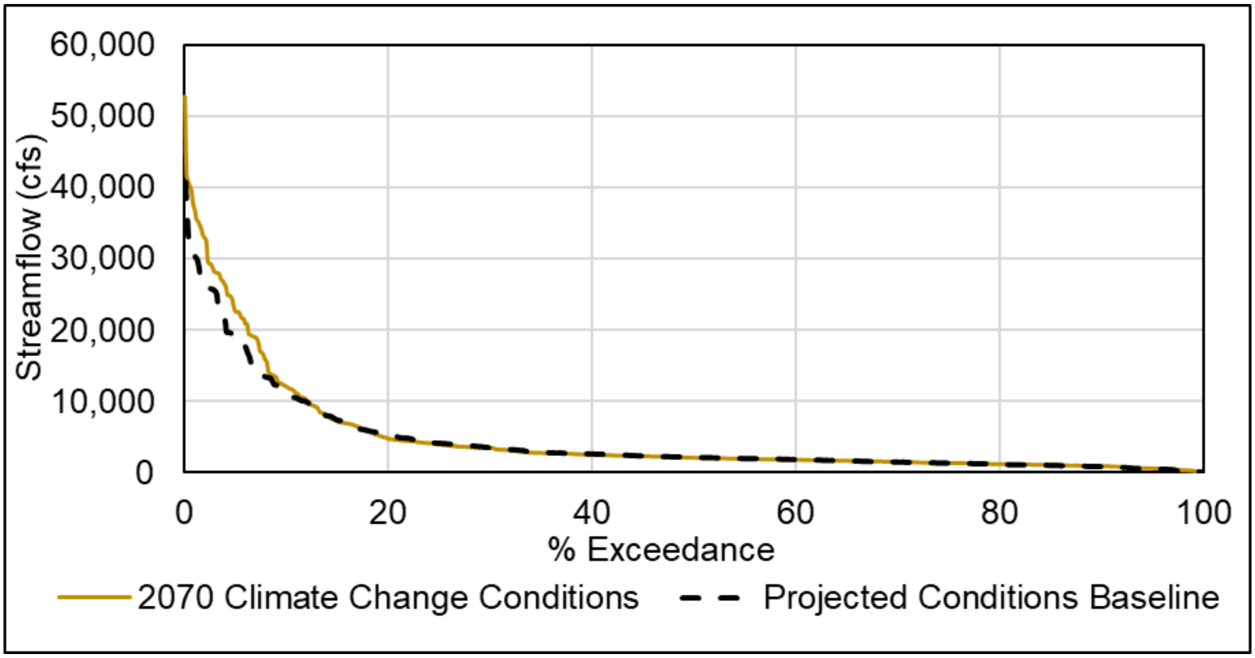


Figure 29: Tuolumne River Hydrograph

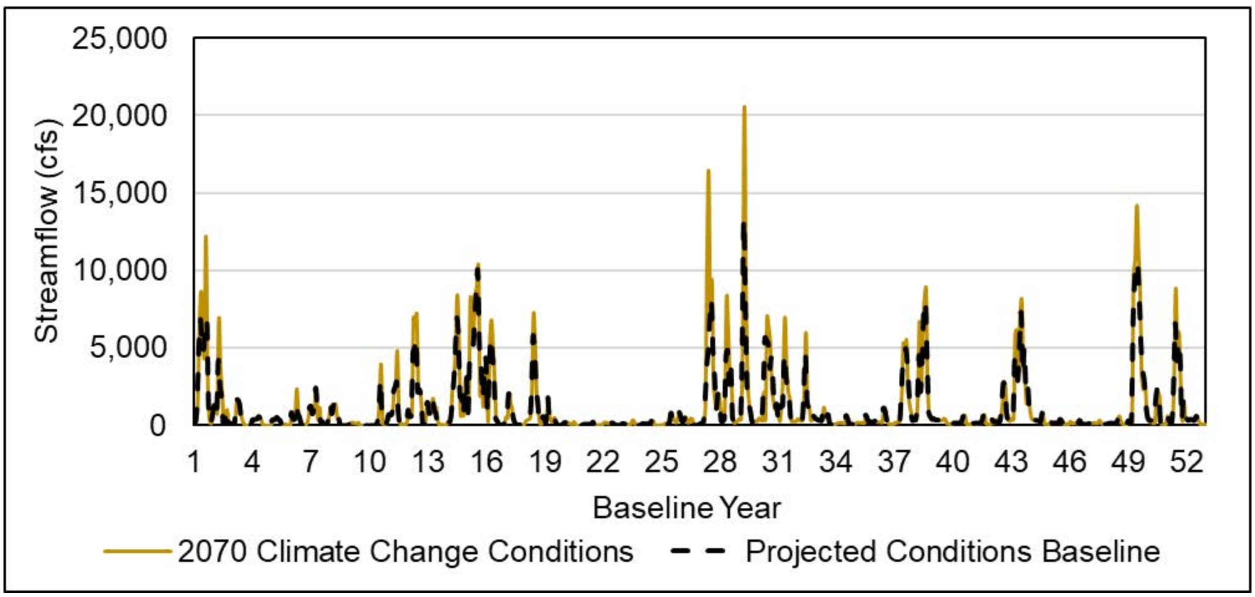


Figure 30: Tuolumne River Exceedance Curve

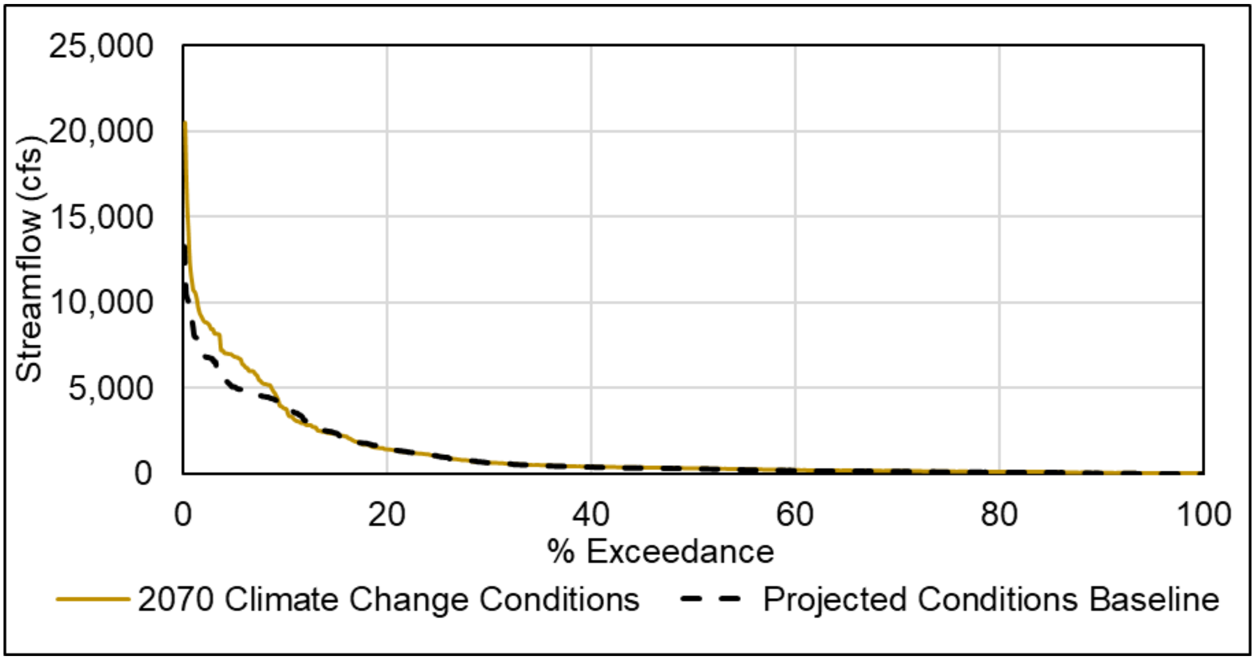


Figure 31: Cosumnes River Hydrograph

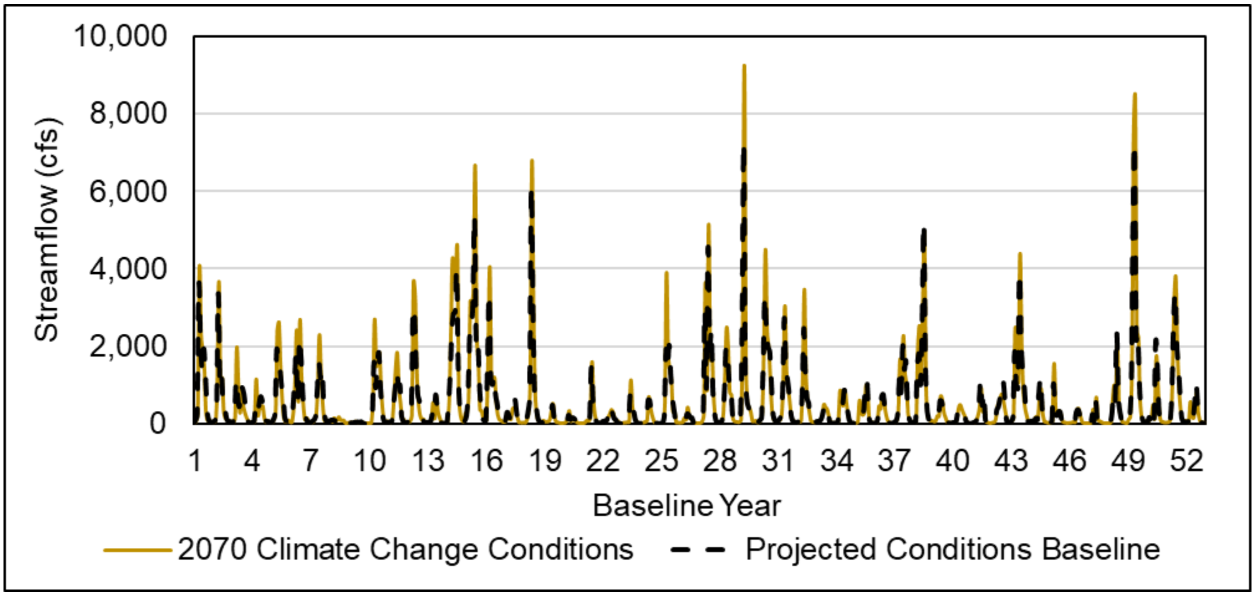
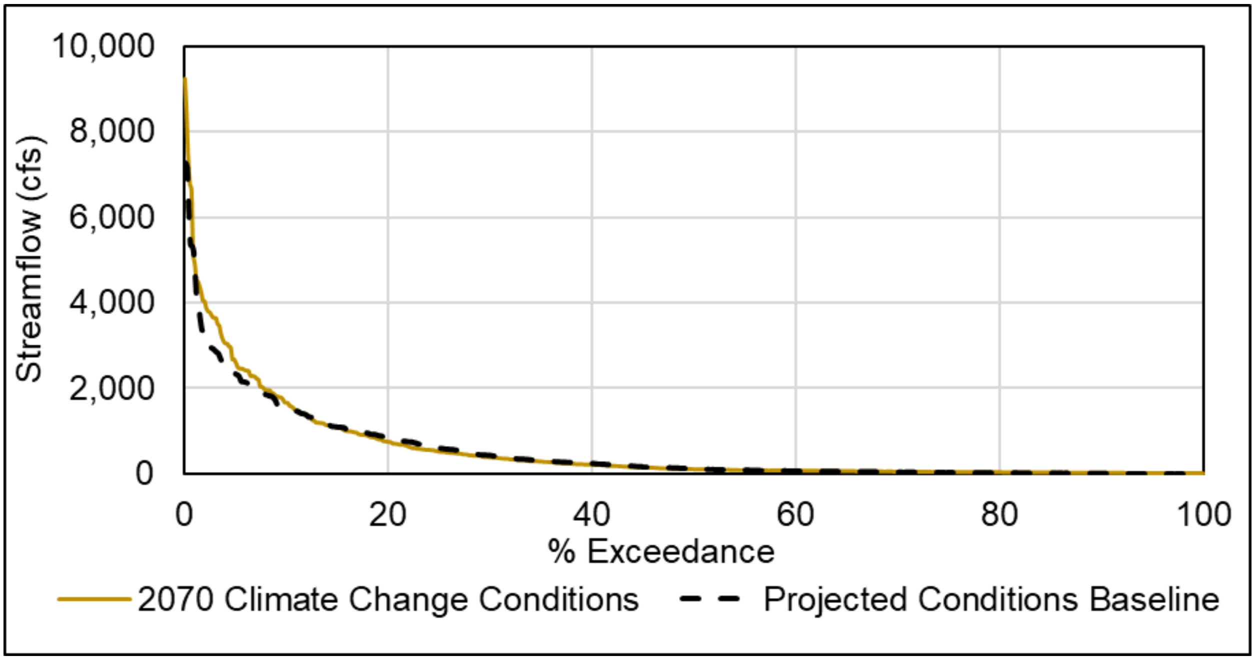


Figure 32: Cosumnes River Exceedance Curve



3.2.2 Precipitation and Evapotranspiration under Climate Change

Projected precipitation and evapotranspiration (ETo) change factors were calculated using a climate period analysis based on historical precipitation and ETo from January 1915 to December 2011 (CA DWR, 2018b). DWR used a macroscale hydrologic model that solves the water balance of a watershed, called the VIC Model. Change factors provided by DWR were calculated as a ratio of the value of a variable under a "future scenario" divided by a baseline. That baseline data is the 1995 Historical Temperature Detrended scenario downscaled from GCM climate data. The "future scenario" corresponds to VIC outputs of the simulation of future conditions using GCM forecasted hydroclimatic variables as inputs. These change factors are thus a simple perturbation factor that corresponds to the ratio of a future with climate change divided by the past without it. Change factors are available on a monthly time step and are spatially defined by the VIC model grid. Supplemental tables with the time series of perturbation factors are available from DWR for each grid cell. DWR has made accessible a Desktop GIS tool for both IWFM and MODFLOW to process these change factors (CA DWR, 2018c).

3.2.2.1 Applying Change Factors to Precipitation

DWR change factors were multiplied by historical precipitation to generate projected precipitation under the 2070 central tendency future scenario using the Desktop IWFM GIS tool (CA DWR, 2018c). The tool calculates an area weighted precipitation change factor for each model grid geometry. This model grid geometry was based on polygons generated around the PRISM nodes within the model region used to specify rainfall depths.

However, the DWR tool only includes change factors through 2011. The remaining 6 years of the time series were synthesized according to historically comparable water years. The perturbation factor from the corresponding month of the comparable year was applied to the baseline of the missing years (2012-2018) to generate projected values. Months with no precipitation in the baseline were assumed to have a monthly precipitation of 1 mm under climate change to account for increased precipitation that cannot be calculated from a baseline of 0 mm for these synthesized years. The comparable years that were used can be found in Table 13. These comparable years were determined by comparing total San Joaquin Valley runoff, DWR year type index, and total annual Subbasin precipitation.

The same approach reported in the GSP to synthesizing years that are not included in the DWR dataset was used to extend the simulation for two additional years. The comparable water years used to represent WY 2019 and WY 2020 hydrology have been added to Table 13 below.

Table 13: Comparable Water Years (based on Precipitation)

Water Year Not Available in DWR Tool	Comparable Water Year
2012	2001
2013	1991
2014	1987
2015	1977
2016	2002
2017	1983
2018	1983
2019	2016
2020	2013

The resulting perturbed precipitation values and the baseline precipitation values for the representative historical period can be found in Figure 33. The exceedance plot for these two times series can be found in Figure 34, both updated for 52 years of projected conditions simulation. The absolute difference between the PCBL-CC and the PCBL are shown in Figure 35.

Figure 33: Perturbed Precipitation Under Climate Change

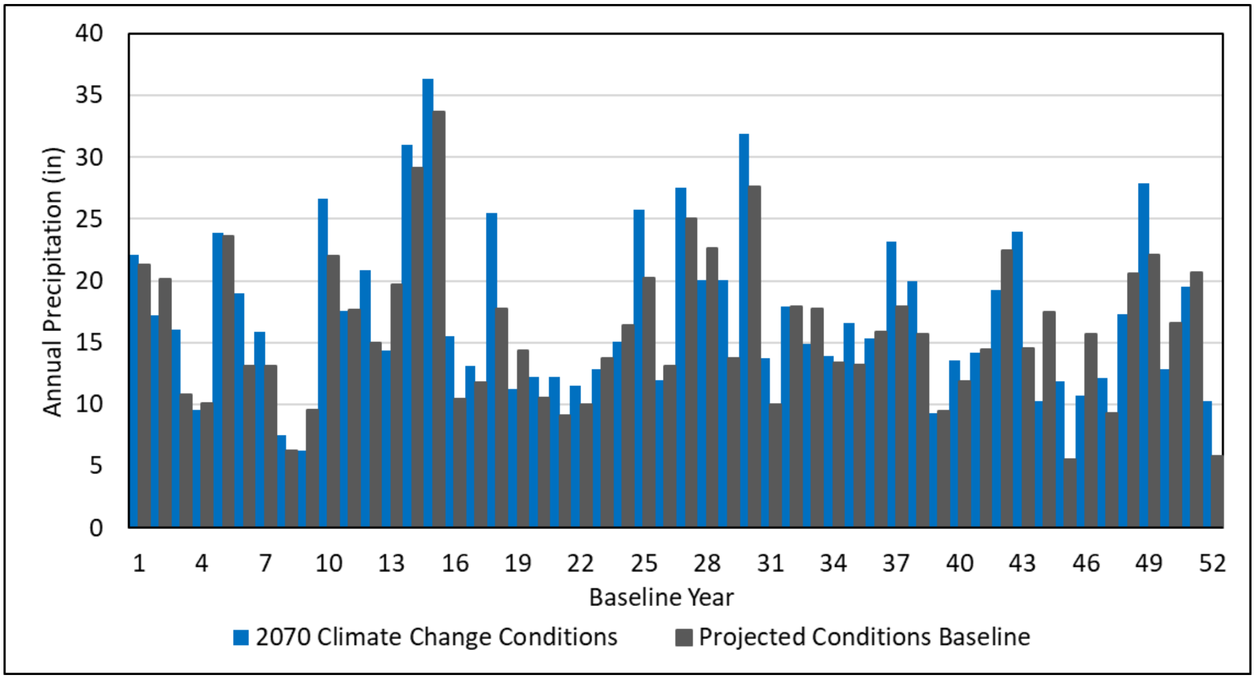


Figure 34: Perturbed Precipitation Exceedance Curve

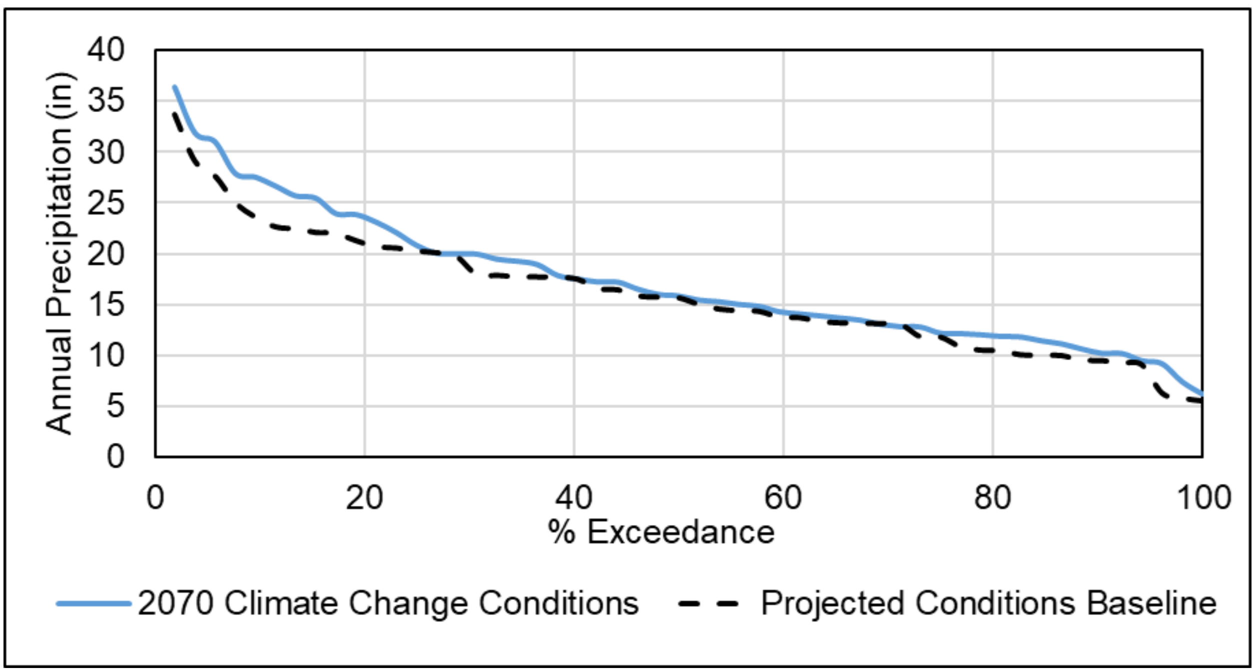
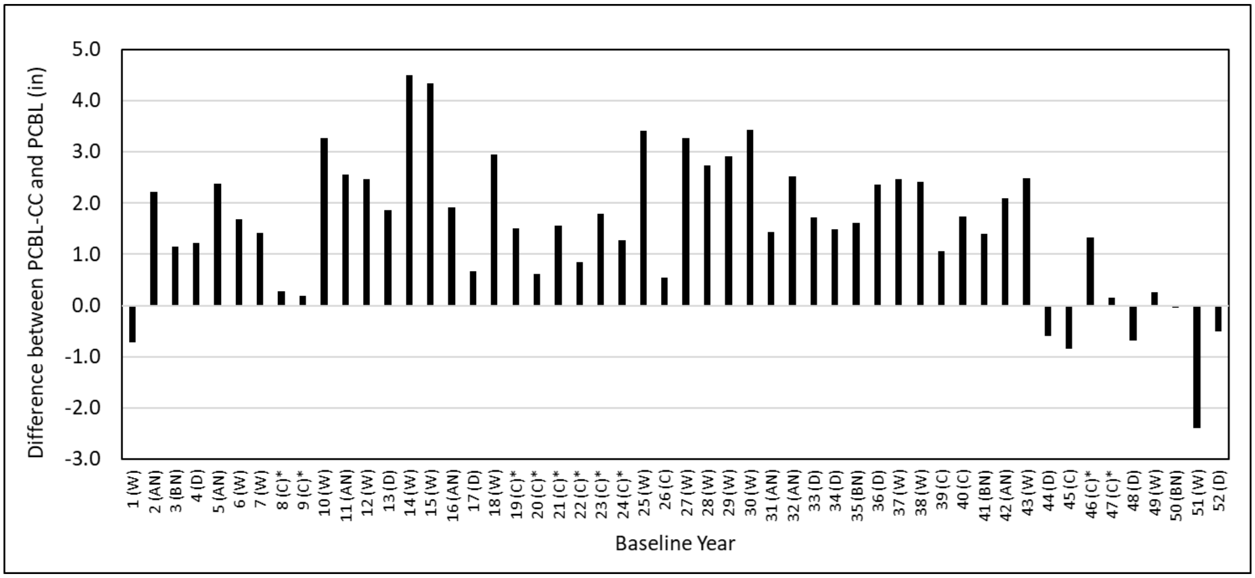


Figure 35: Subbasin Precipitation Difference with Climate Change Conditions



3.2.2.2 Applying Change Factors to Evapotranspiration

Potential ETo in the Subbasin varies geographically and by land use. The tool provided by DWR to process ETo was not used because of the minimal spatial variation in ETo in the Subbasin. DWR provides change factors for ETo that vary spatially based on the VIC model grid as described above. Change factors for November 1, 1964 through December 1, 2011 were averaged. For the purposes of this analysis, a localized averaged change factor of 1.082 or 1.084 was used depending on the crop type and where in the Subbasin that crop can be found. All ETo in the Subbasin is expected to increase. However, almonds, pistachios, walnuts, cherries, pasture, corn, and rice ETo are expected to increase more with climate change in the South of the Subbasin in comparison to the North. All land uses in the South and the remaining crops in the North are perturbed with a single average change factor of 1.084, as shown for vineyards in Error! Reference source not found..

This average ETo change factor was then applied to the historical ETo time series for each crop type. Because there is currently no interannual variability in ETo in ESJWRM, the same perturbed time series was applied across all simulation years. Refinement to the simulated evapotranspiration of almonds, walnuts, and cherries under 2070 climate conditions is shown in Figure 36 through Figure 38.

There were no changes made to the projected conditions simulation for evapotranspiration in the PCBL model update. Additionally, as is currently set up in the model, there is no variation by year, only by month. Therefore, there were no adjustments made to the evapotranspiration model input under the projected conditions with climate change scenario while extending the model through the 52 year simulation.

Figure 36: Monthly Evapotranspiration Variability for Almonds

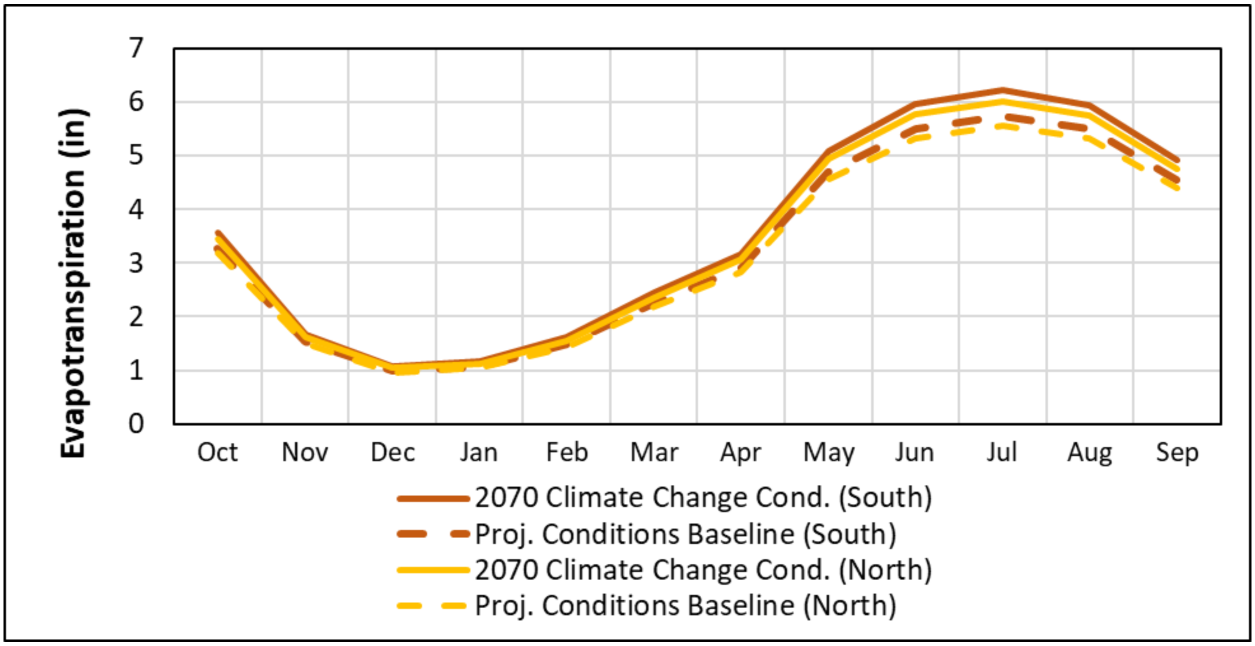


Figure 37: Monthly Evapotranspiration Variability for Walnuts

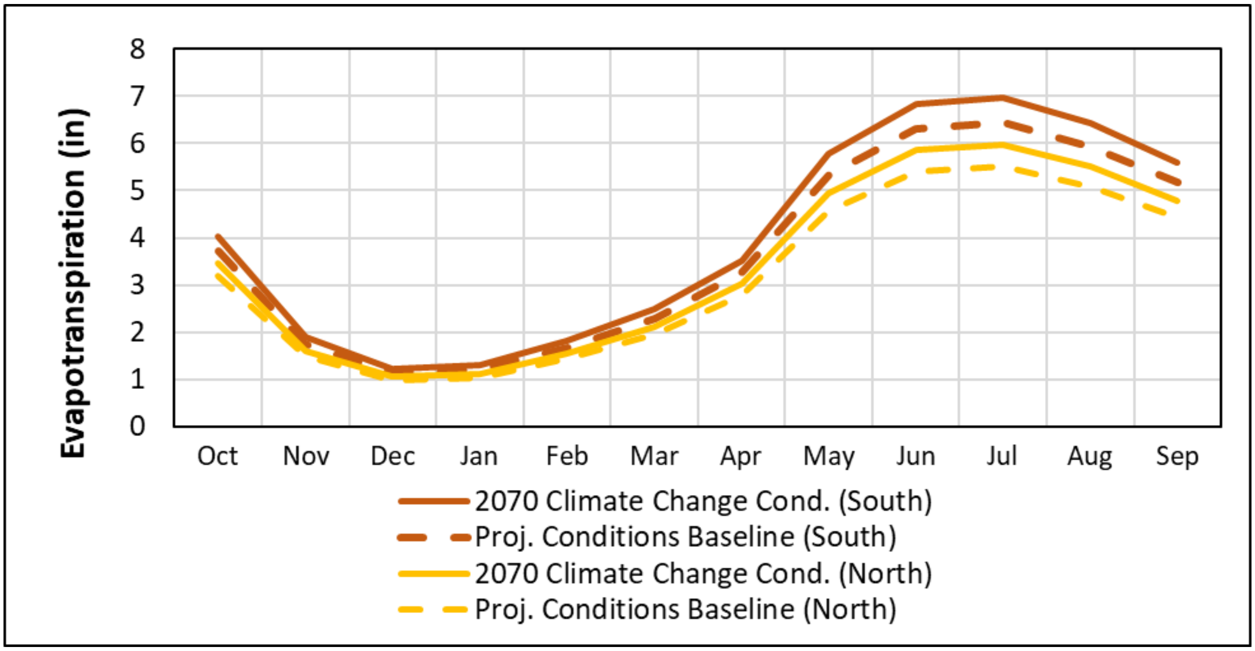


Figure 38: Monthly Evapotranspiration Variability for Cherries

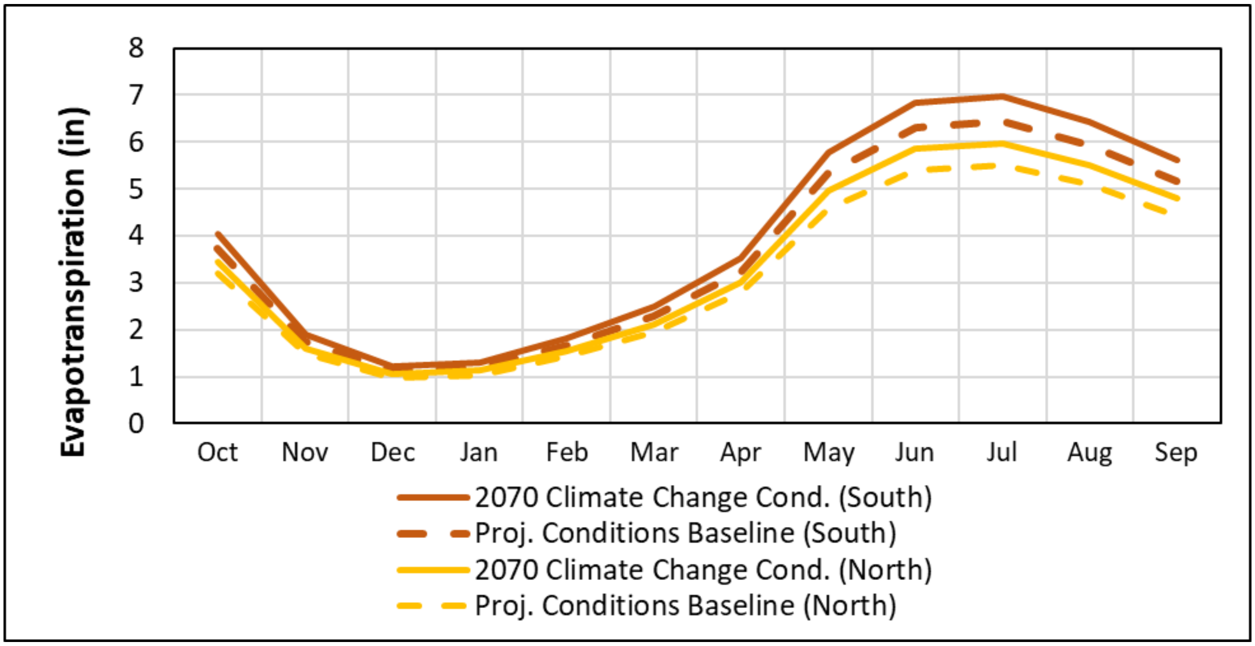
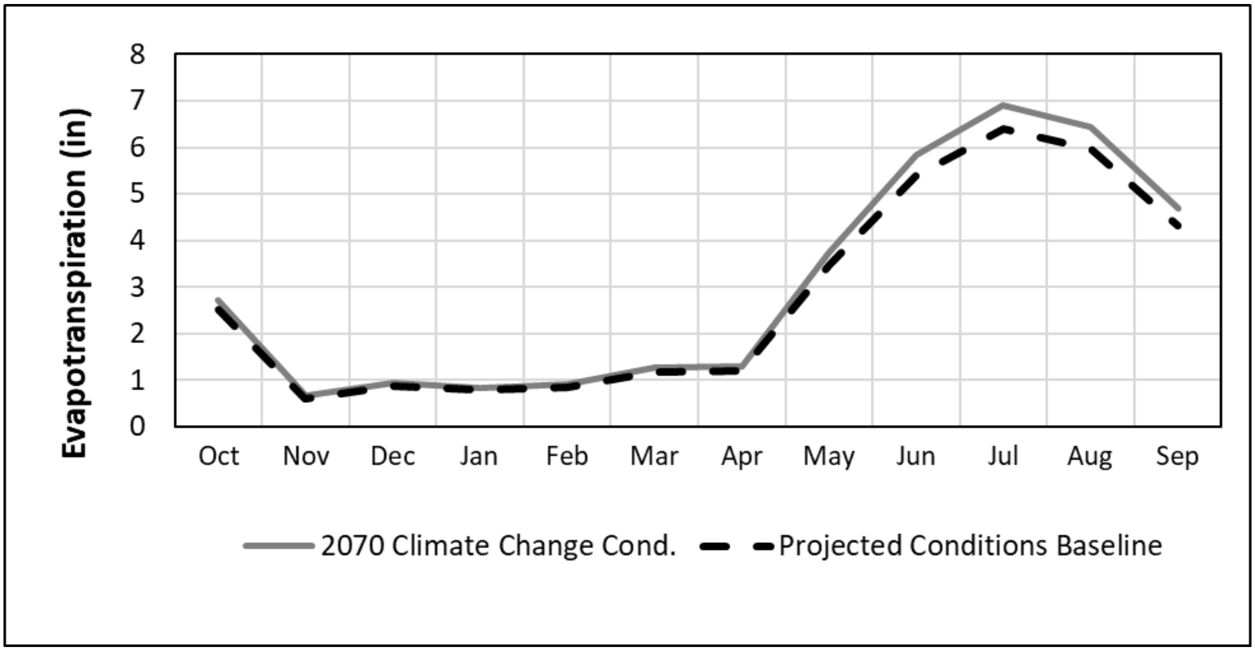


Figure 39: Monthly Evapotranspiration Variability for Vineyards



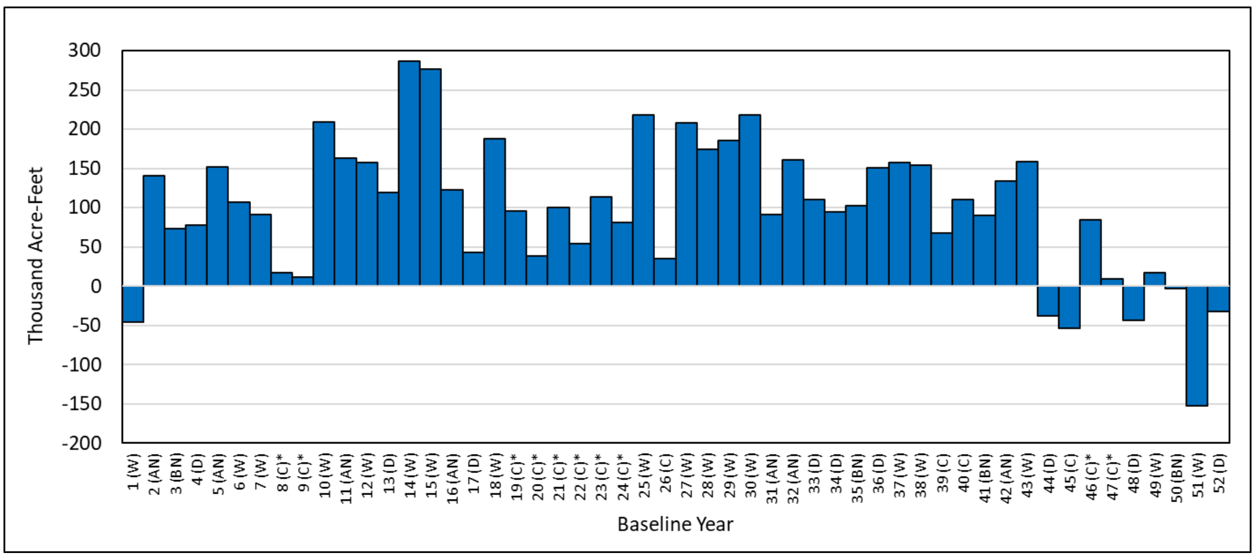
3.3 Projected Conditions Baseline with Climate Change Results

This section provides a summary of the ESJWRM PCBL-CC Version 2.0 results.

3.3.1 Differences in Precipitation, Evapotranspiration, and Streamflow under Climate Change

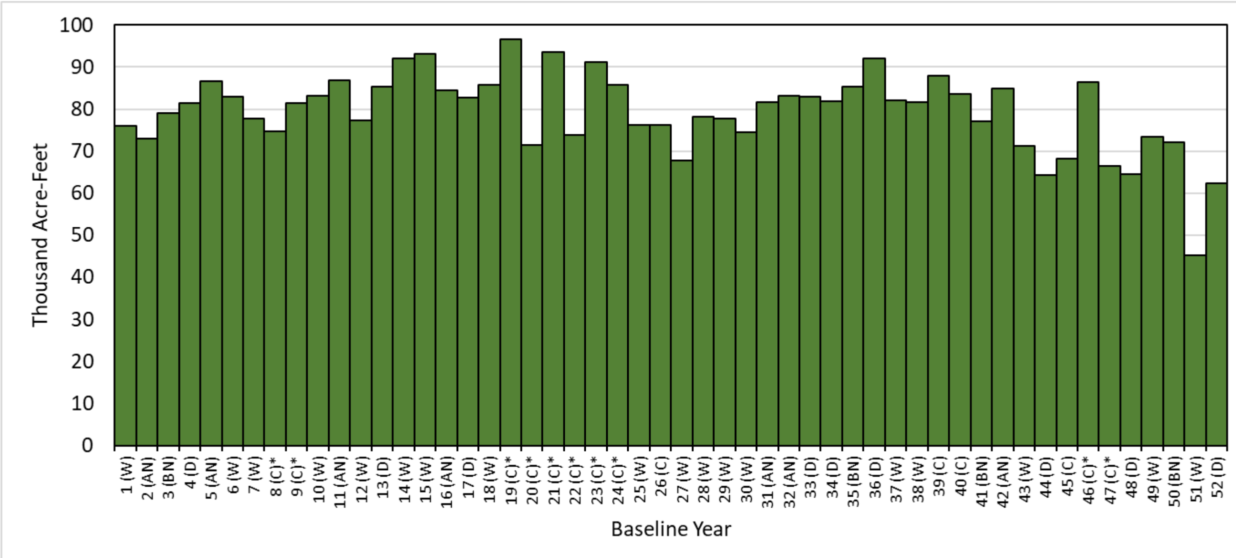
Under the climate change scenario (PCBL-CC), the average annual precipitation is overall 10 percent higher than the projected conditions scenario (PCBL), increasing from 985,000 AFY to 1,082,000 AFY or from about 15.5 in/year to 17.0 in/year. Similarly, the average annual volume of evapotranspiration in PCBL-CC is 8 percent higher than the PCBL, increasing to 1,441,000 AFY from 1,362,000 AFY. Despite there being higher flows in streams in PCBL-CC, the anticipated surface water diversions were not expected to change in PCBL-CC due to both availability of water in the stream and water rights agreements limiting diversion months. With a similar surface water supply and increased water demands under the PCBL-CC, private groundwater production is simulated to increase by approximately 10 percent, from 751,000 AFY to 833,000 AFY. Under climate change conditions, due to increased groundwater use driven by higher agricultural demands, the depletion in aquifer storage is expected to increase by about 134 percent to an average annual storage change of 38,000 AFY in the PCBL-CC, from 16,000 AFY in the PCBL. A graphical representation of simulated changes to precipitation, evapotranspiration, and groundwater pumping are presented in **Error! Reference source not found.** though **Error! Reference source not found.**. Full water budgets for the land surface and groundwater systems are discussed in Sections 3.3.2 and 3.3.3.

Figure 40: Simulated Changes in Precipitation due to Climate Change



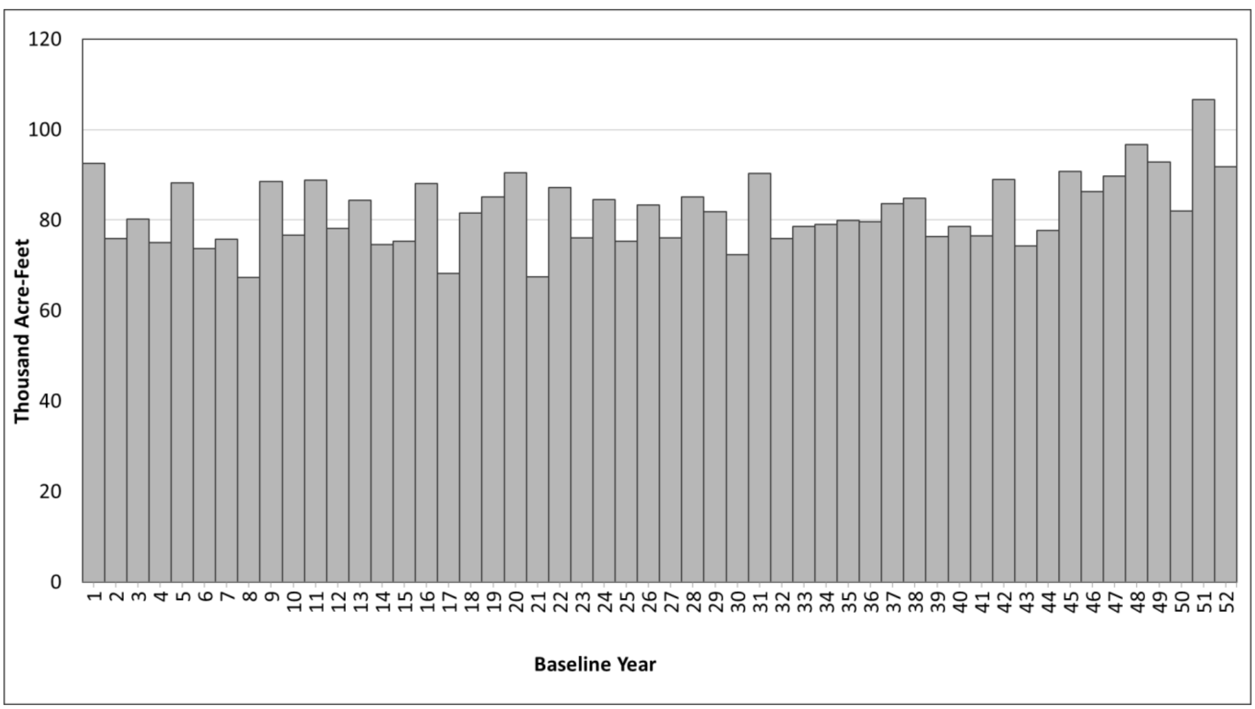
Note: Negative indicates PCBL value was larger and positive indicates PCBL-CC was larger. The climate change scenario largely has more precipitation than the projected conditions scenario.

Figure 41: Simulated Changes in Evapotranspiration due to Climate Change



Note: PCBL-CC evapotranspiration is always larger than the PCBL for all simulated years.

Figure 42: Simulated Changes in Groundwater Pumping due to Climate Change



Note: PCBL-CC groundwater pumping is always larger than the PCBL for all simulated years.

3.3.2 Land and Water Use Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
    - Groundwater pumping
    - Surface water deliveries
    - Shortage (if applicable)
- Outflows:
    - Demand (either agricultural or urban)
    - Surplus (if applicable)

The average annual projected water demand for the Subbasin within the 52-year simulation period is 1,339 thousand acre-feet (TAF), consisting of approximately 1,181 TAF expected agricultural demand and 158 TAF expected urban demand. This demand is met by an annual average of 528 TAF of surface water deliveries (452 TAF of agricultural and 76 TAF of urban deliveries) and is supplemented by 825 TAF of groundwater production (742 TAF of agricultural and 82 TAF of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 13 TAF of surplus in the Subbasin scale agricultural water use budget, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 14. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 43 and Figure 44 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

A comparison between the PCBL and the PCBL-CC is included in

Table 15. As shown in Section 3.3.1 and Figure 41, evapotranspiration is higher in the PCBL-CC compared to the PCBL in every year of the simulation. This higher evapotranspiration translates to a higher agricultural demand in the PCBL-CC of 81,400 AFY, which must be met by increased groundwater pumping of 81,800 AFY. The slight difference between the demand increase and the groundwater pumping increase is due to a decrease in 400 AFY of agricultural surface water deliveries. Small changes in surface water availability in streams occurred in the PCBL-CC compared to the PCBL due to the impact of perturbation factors on monthly stream flows. On the urban demand side, there were no differences built into the assumptions for climate change for urban entities, so there were no changes to the urban areas in the PCBL-CC versus the PCBL, aside from a minor difference in surface water diversions that was balanced by a small increase in urban shortage.

Table 14: Eastern San Joaquin Subbasin Land and Water Use Budget Annual Average for PCBL-CC

Land and Water Use Budget Component	PCBL-CC Annual Average
Agricultural Area (thousand acres)	359
Agricultural Demand (TAF)	1,181
Agricultural Groundwater Pumping (TAF)	742
Agricultural Surface Water Deliveries (TAF)	452
Agricultural Surplus (TAF)	13
Urban Area (thousand acres)	153
Urban Demand (TAF)	158
Urban Groundwater Pumping (TAF)	82
Urban Surface Water Deliveries (TAF)	76
Urban Shortage (TAF)	0

Table 15: Eastern San Joaquin Subbasin Land and Water Use Budget Annual Average Comparison Between the PCBL and the PCBL-CC

	Annual Average		
Land and Water Use Budget Component	PCBL	PCBL-CC	Climate Change Impact (PCBL-CC minus PCBL)
Agricultural Area (acres)	358,600	358,600	0
Agricultural Demand (AF)	1,099,900	1,181,300	81,400
Agricultural Groundwater Pumping (AF)	660,600	742,400	81,800
Agricultural Surface Water Deliveries (AF)	452,800	452,400	-400
Agricultural Surplus (AF)	13,500	13,500	0
Urban Area (acres)	153,400	153,400	0
Urban Demand (AF)	158,100	158,100	0
Urban Groundwater Pumping (AF)	82,200	82,200	0
Urban Surface Water Deliveries (AF)	75,600	75,500	-100
Urban Shortage (AF)	300	400	100

Figure 43: Eastern San Joaquin Subbasin Projected Agricultural Demand in the PCBL-CC

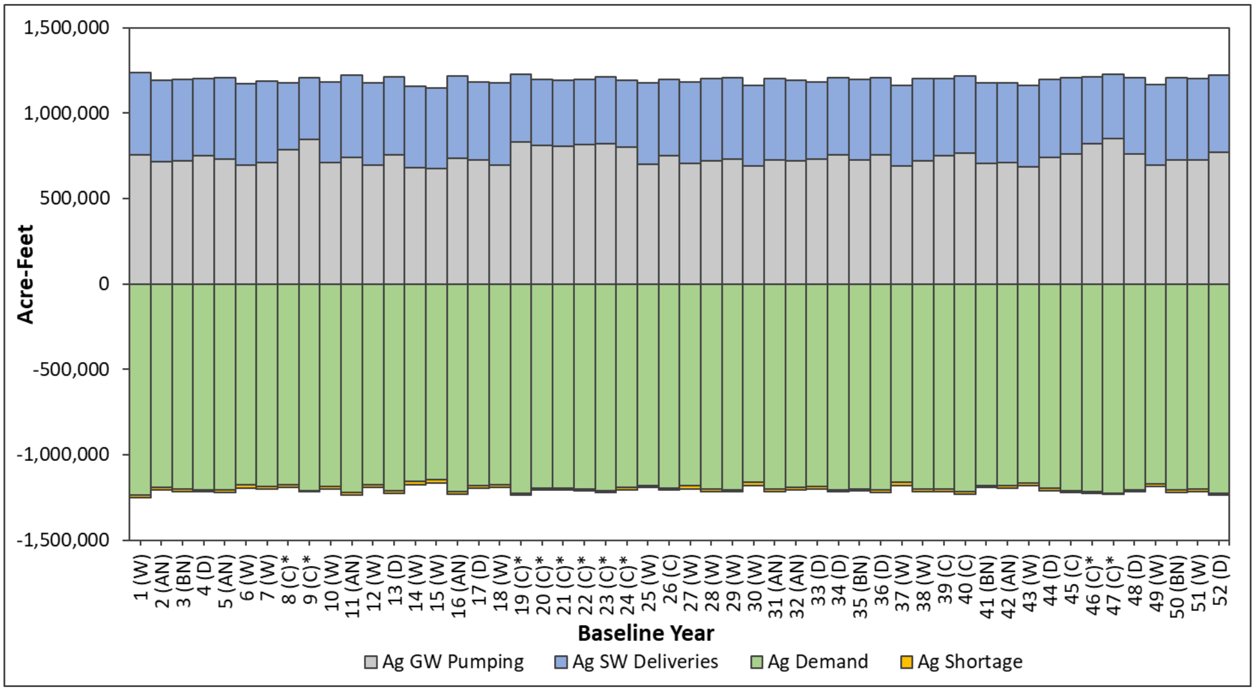
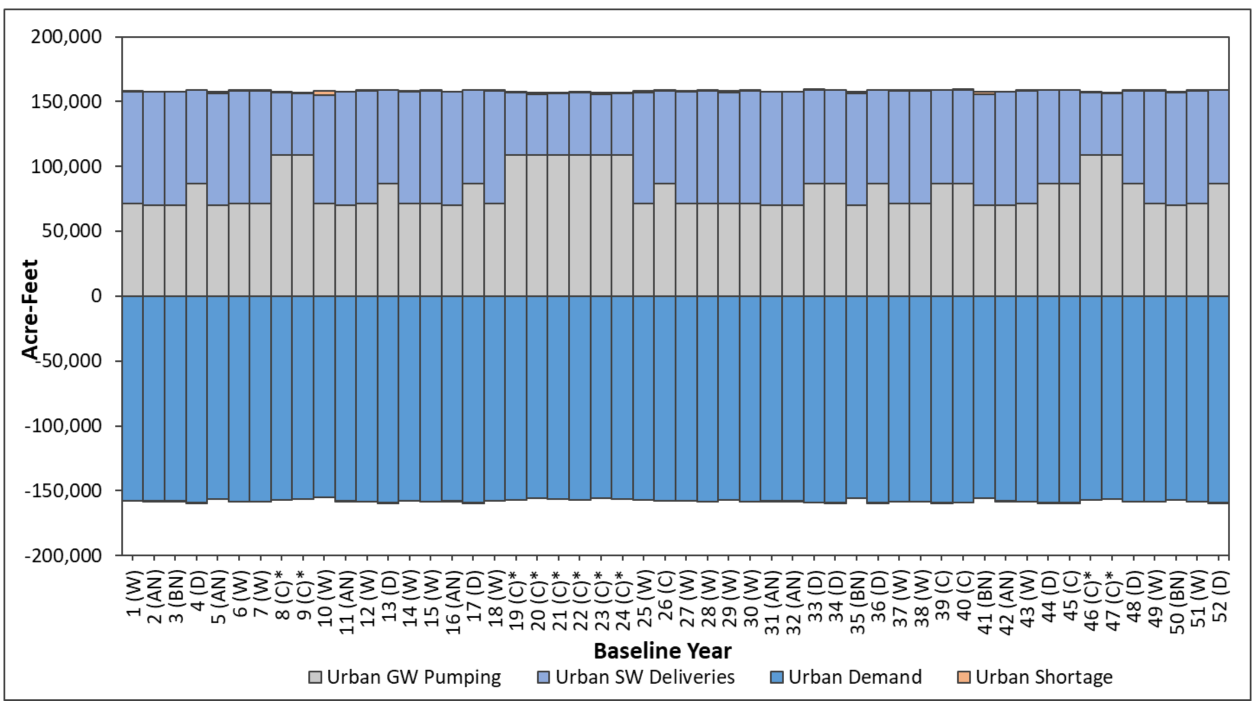


Figure 44: Eastern San Joaquin Subbasin Projected Urban Demand in the PCBL-CC



3.3.3 Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
  - Deep percolation (from rainfall and irrigation applied water)
  - Gain from stream (or recharge due to stream seepage)
  - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
  - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
  - Groundwater pumping
  - Loss to stream (or outflow to streams and rivers)
  - Boundary outflow (to surrounding groundwater subbasins)
  - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL-CC remains the largest component in the groundwater budget with an annual average 833 TAF. The PCBL-CC offsets this pumping with 286 TAF of deep percolation, a net gain from stream of 218 TAF, 165 TAF of other recharge, and a total subsurface inflow of 126 TAF annually. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-CC is 38 TAFY. These annual averages are shown in Table 16. The groundwater budget, with cumulative change in storage, is shown for the ESJ Subbasin in Figure 45.

A comparison of the PCBL and the PCBL-CC is shown in Table 17. The increase in groundwater pumping of 81,800 AFY is due to the increase in evapotranspiration and therefore increased agricultural demand as discussed above in Section 3.3.2 and

Table 15. Additionally, increased precipitation in most years as shown in **Error! Reference source not found.** and discussed in Section 3.3.1, leads to overall increased deep percolation from precipitation and other recharge (specifically the ungauged watershed drainage component). The increased groundwater pumping causes groundwater levels to be lower, which then causes increased stream seepage, boundary inflow, and change in groundwater storage. The streamflow is overall higher in the PCBL-CC, which may also allow for more stream seepage into the groundwater system.

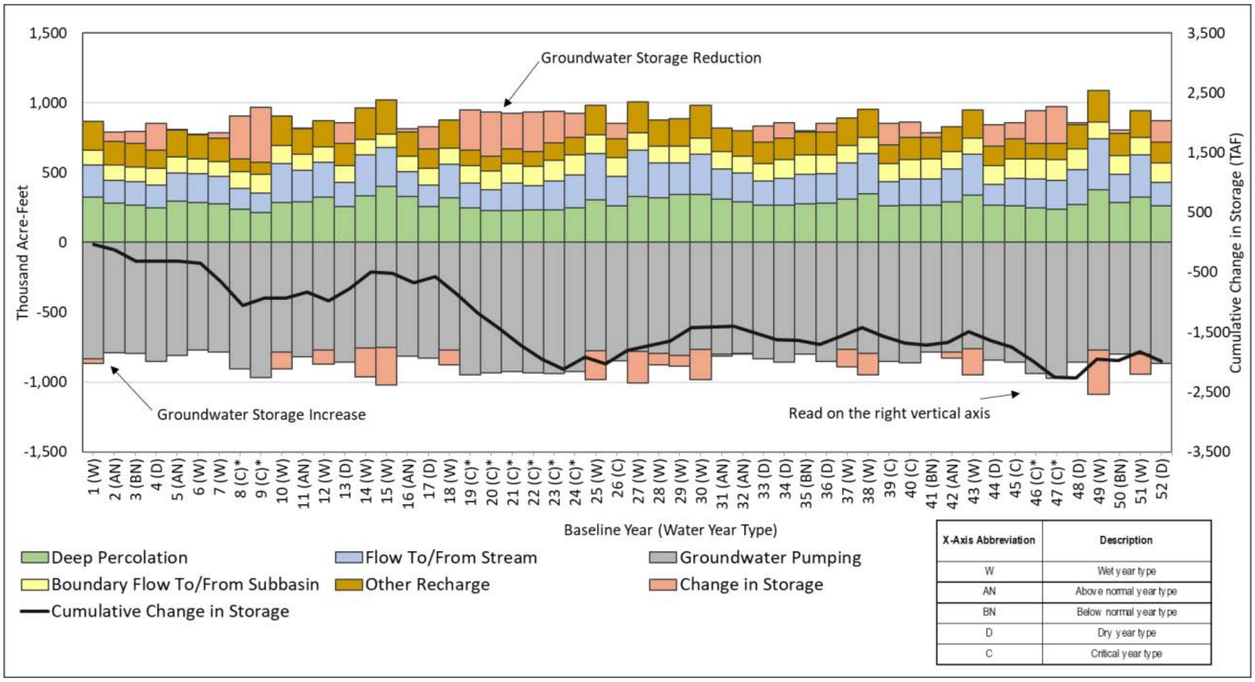
Table 16: Eastern San Joaquin Subbasin Hydrologic Groundwater Budget Annual Average

Hydrologic Groundwater Budget Component	PCBL-CC Annual Average
Deep Percolation (TAF)	286
Other Recharge (TAF)	165
Net Stream Seepage (TAF)	218
Net Boundary Inflow (TAF)	126
Groundwater Pumping (TAF)	833
Change in Groundwater Storage (TAF)	38

Table 17: Eastern San Joaquin Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL and the PCBL-CC

	Annual Average		
Hydrologic Groundwater Budget Component	**PCBL**	**PCBL-CC**	**Climate Change Impact (PCBL-CC minus PCBL)**
Deep Percolation (AF)	282,100	285,600	3,500
Other Recharge (AF)	161,700	165,300	3,600
Net Stream Seepage (AF)	180,700	218,100	37,400
Net Boundary Inflow (AF)	110,400	126,000	15,700
Groundwater Pumping (AF)	751,300	833,100	81,800
Change in Groundwater Storage (AF)	16,300	38,100	21,800

Figure 45: Eastern San Joaquin Subbasin Projected Hydrologic Groundwater Budget



4 Conclusions and Recommendations

The updated ESJWRM Version 2.0 is a robust, comprehensive, defensible, and well-established model for assessing the water resources in the ESJ Subbasin under historical and projected conditions using PCBL Version 2.0. The following recommendations are to be considered for further refinements and enhancements of the model:

- **Continue engagement with local groundwater users and managers**. Continue working with local agencies and groundwater users in ESJ Subbasin to further understand the local operations of the groundwater system and improve representation of groundwater users in the ESJWRM.
- **Enhance variability of potential evapotranspiration**. The current version of the IDC used for estimation of the consumptive use of crops in the ESJWRM uses monthly potential ET values that are the same for all years during the model period. Given that there may be annual variability in the potential ET data with possible effects on the annual estimation of crop water demand, it is recommended to use more detailed data with temporal variability to develop a full time series of ET values for use in the model.
- **Refine infiltration of precipitation**. The current version of the IDC is based on parameters from the DWR C2VSim model. Further refinements can be made to reflect the local soil conditions and rainfall runoff patterns.
- **Refine surface water deliveries in Cosumnes Subbasin.** The surface water deliveries in the Cosumnes Subbasin are currently at the subregion level and do not have the detailed spatial resolution of other areas within the ESJ Subbasin. This data may be verified and updated with modeling in that subbasin completed to meet the requirements of SGMA.
- **Update land use as needed.** As part of the statewide SGMA support, the DWR prepares statewide land use surveys every other year. It is recommended that the appropriate land use surveys be incorporated in the historical model, as well as the projected baseline as necessary and needed.
- **Integration with GRAT.** ESJGWA is in the process of developing a Groundwater Recharge Assessment Tool (GRAT). It is recommended to integrate the ESJWRM with the GRAT to better assess the implications of any water recharge on the state of the basin and distribution of benefits.
- **Climate change refinement.** The approach developed for the GSP and used in the PCBL-CC Version 2.0 update is based on the methodology in DWR's guidance document (CA DWR, 2018b) and uses "best available information" related to climate change in the Eastern San Joaquin Subbasin. There are limitations and uncertainties associated with the analysis. One important limitation is that CalSim II does not fully simulate local surface water operations. Thus, the analysis conducted for this GSP may not fully reflect how surface and groundwater basin operations would respond to the changes in water demand and availability caused by climate change. Mokelumne River flows are simulated in PCBL-CC as unimpaired despite the potential of changes to operations for Pardee and Camanche Reservoirs under climate change conditions. This presents an opportunity in future efforts to improve the analysis to better project streamflow. Use of a local model and the perturbation factor approach were deemed appropriate given the uncertainties in the climate change analysis.

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APPENDIX A: LAND AND WATER USE BUDGETS BY GSA FOR HISTORICAL MODEL (ESJWRM 2.0)

FIGURES

Figure 1: San Joaquin County #1 GSA Agricultural Demand

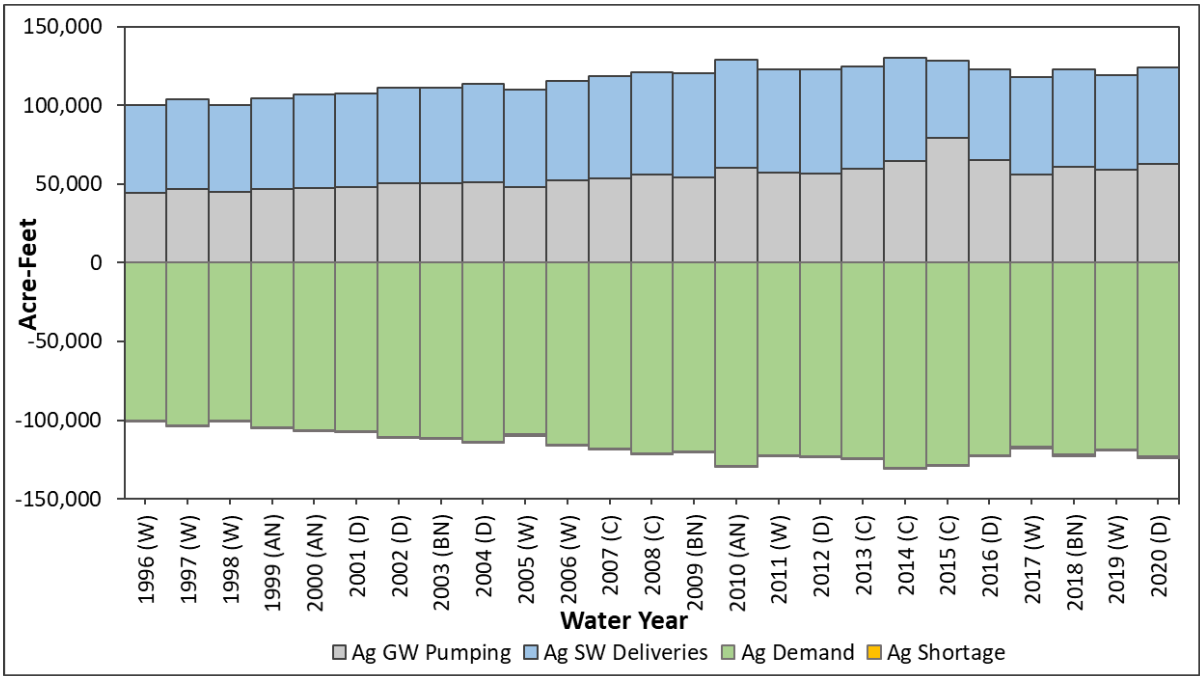


Figure 2: San Joaquin County #1 GSA Urban Demand

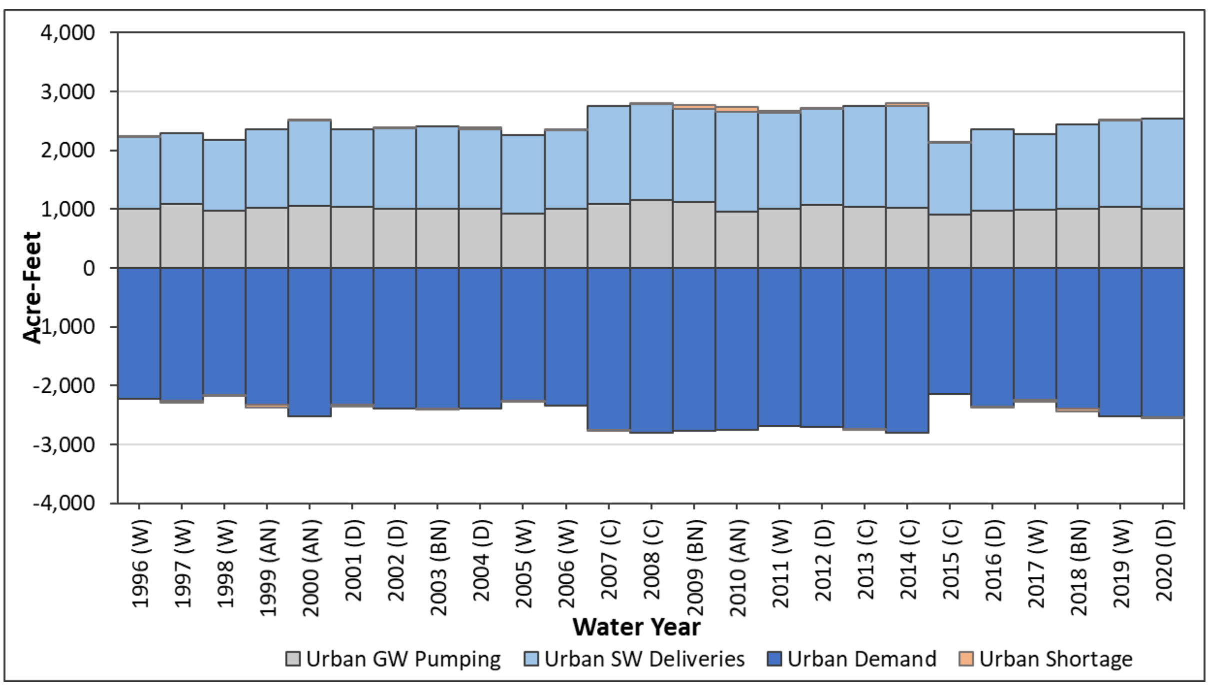


Figure 3: Central Delta Water Agency GSA Agricultural Demand

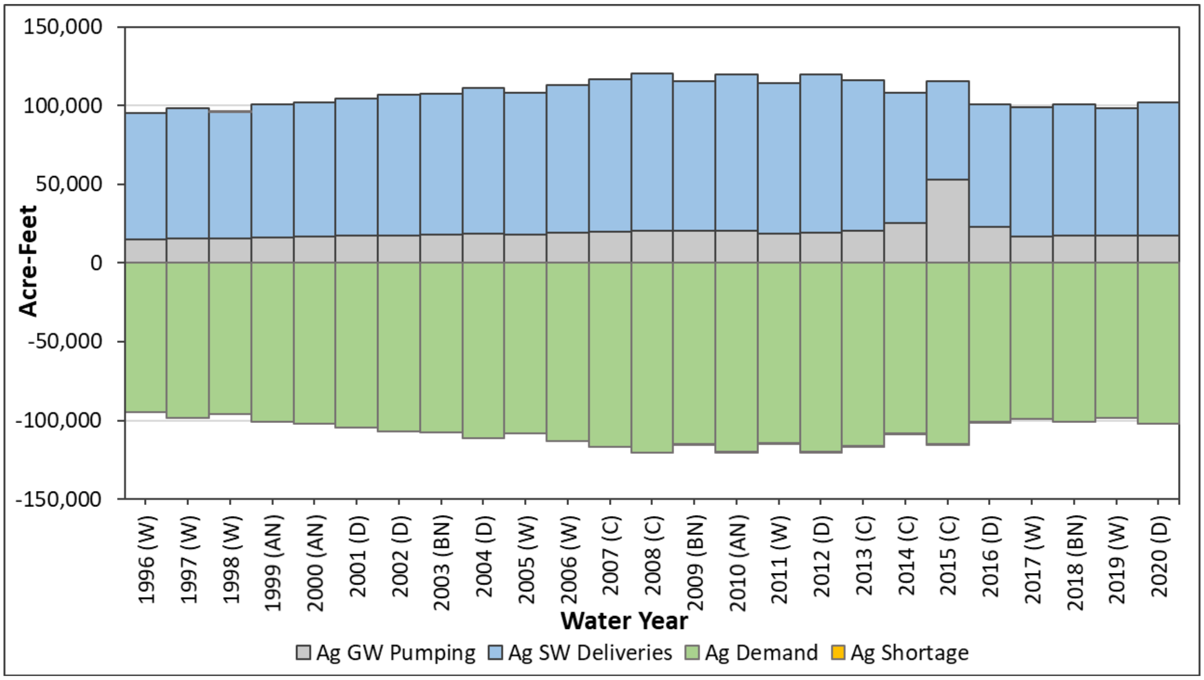


Figure 4: Central Delta Water Agency GSA Urban Demand

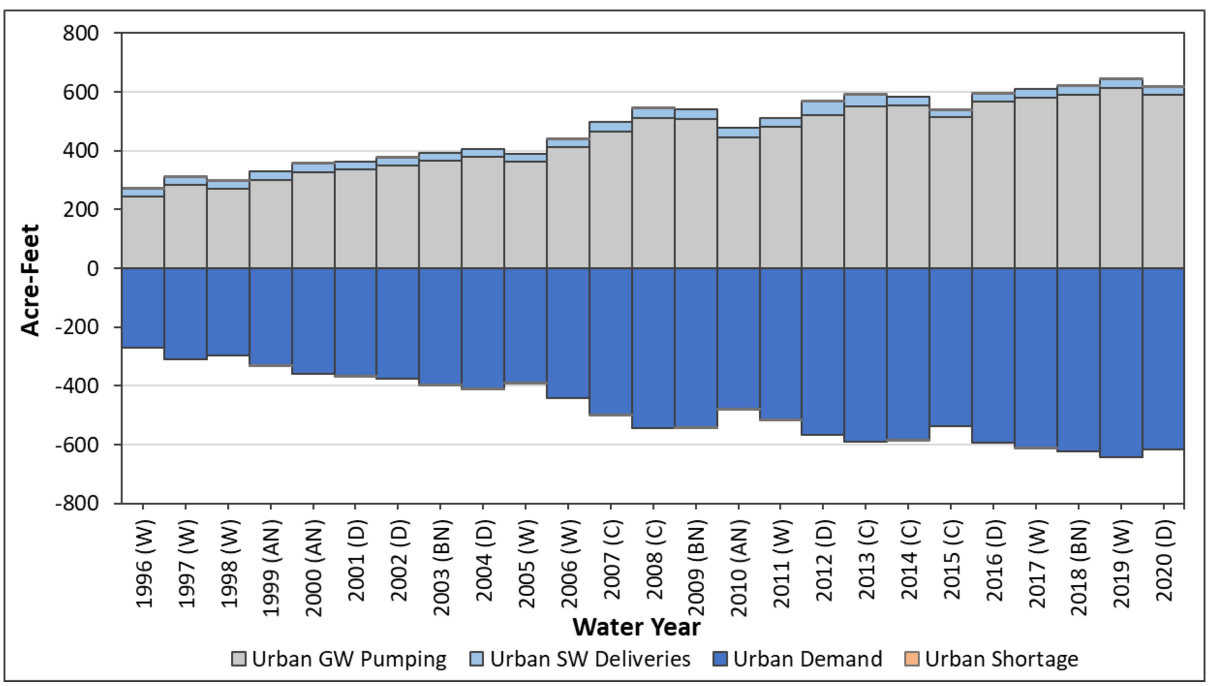


Figure 5: Woodbridge Irrigation District GSA Agricultural Demand

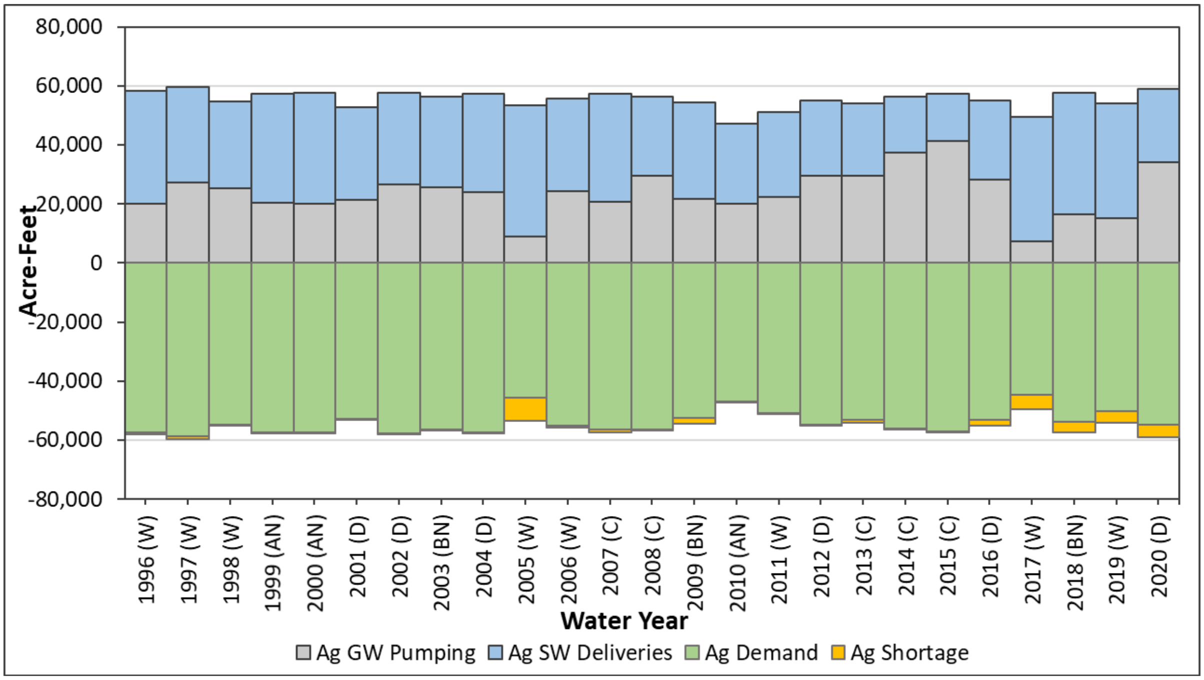


Figure 6: Woodbridge Irrigation District GSA Urban Demand

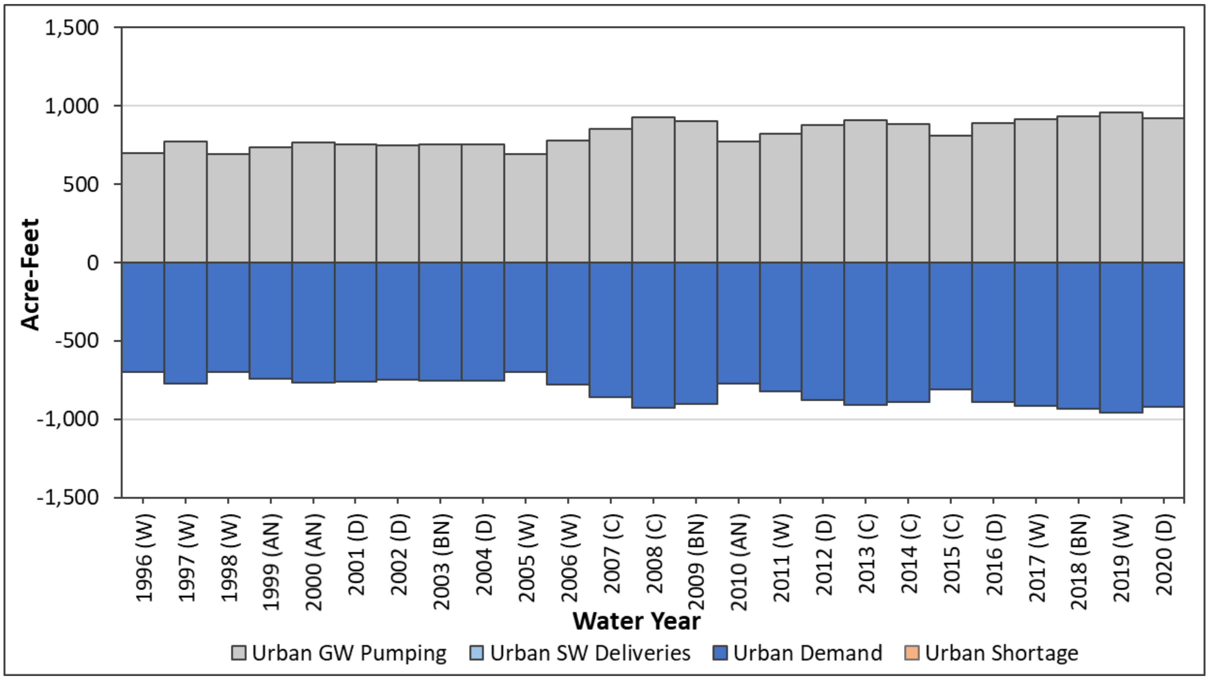


Figure 7: City of Lodi GSA Agricultural Demand

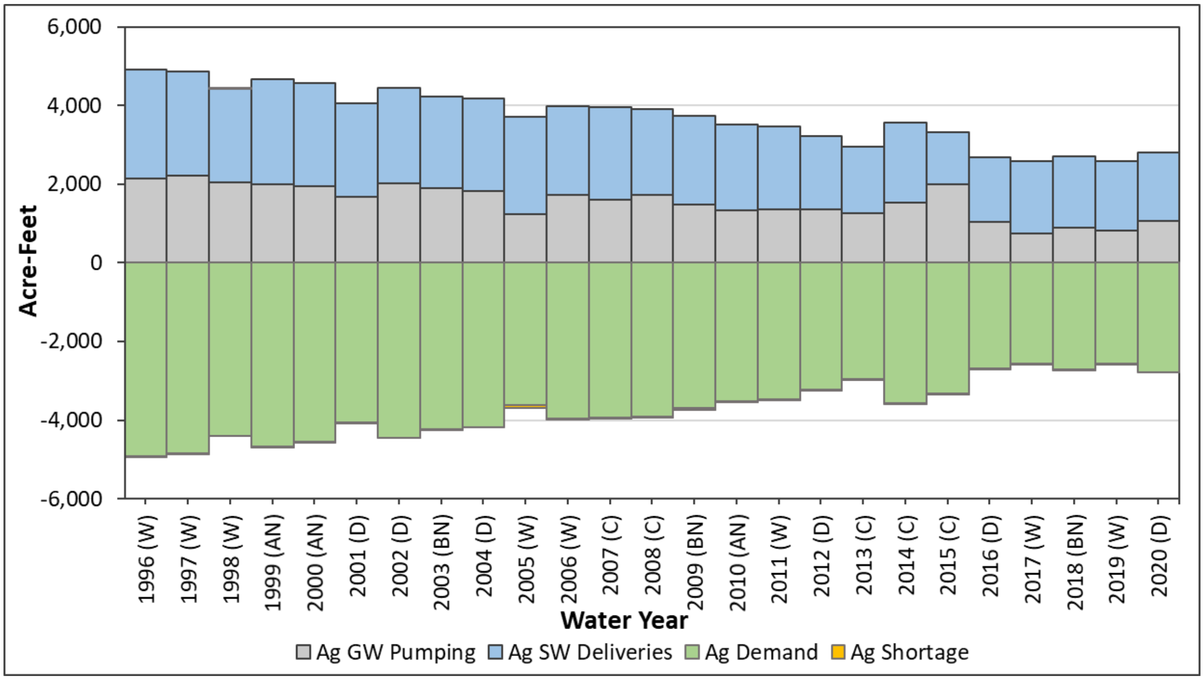


Figure 8: Cit of Lodi GSA Urban Demand

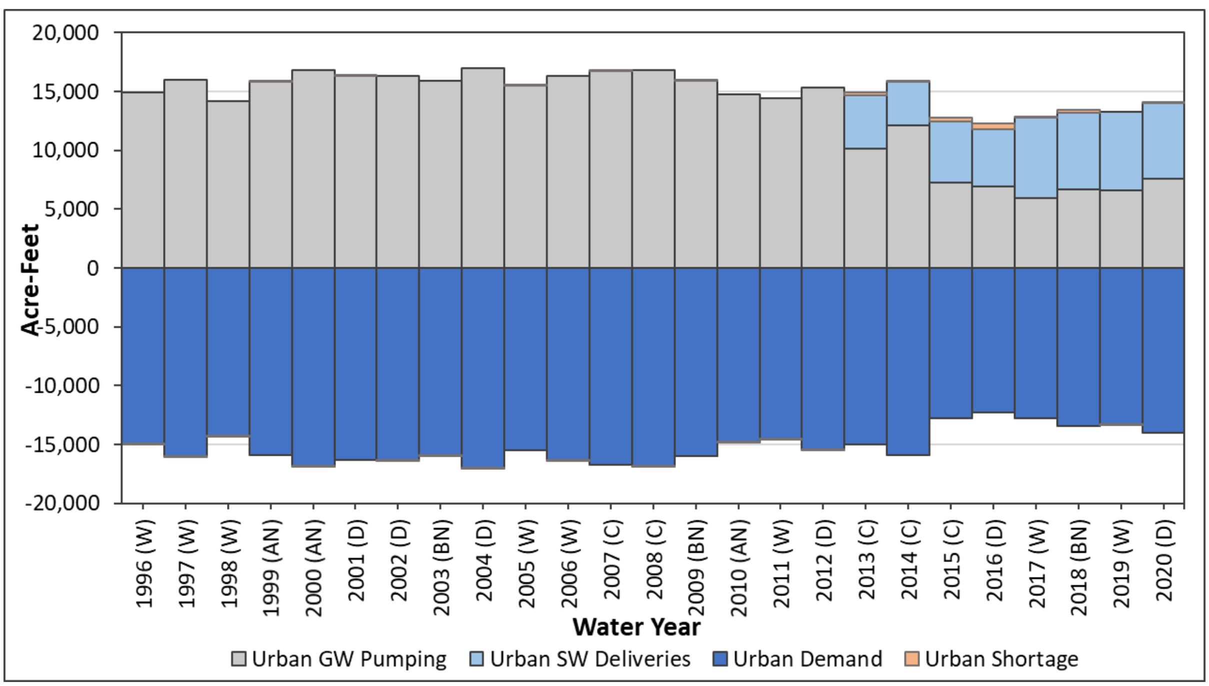


Figure 9: North San Joaquin Water Conservation District GSA Agricultural Demand

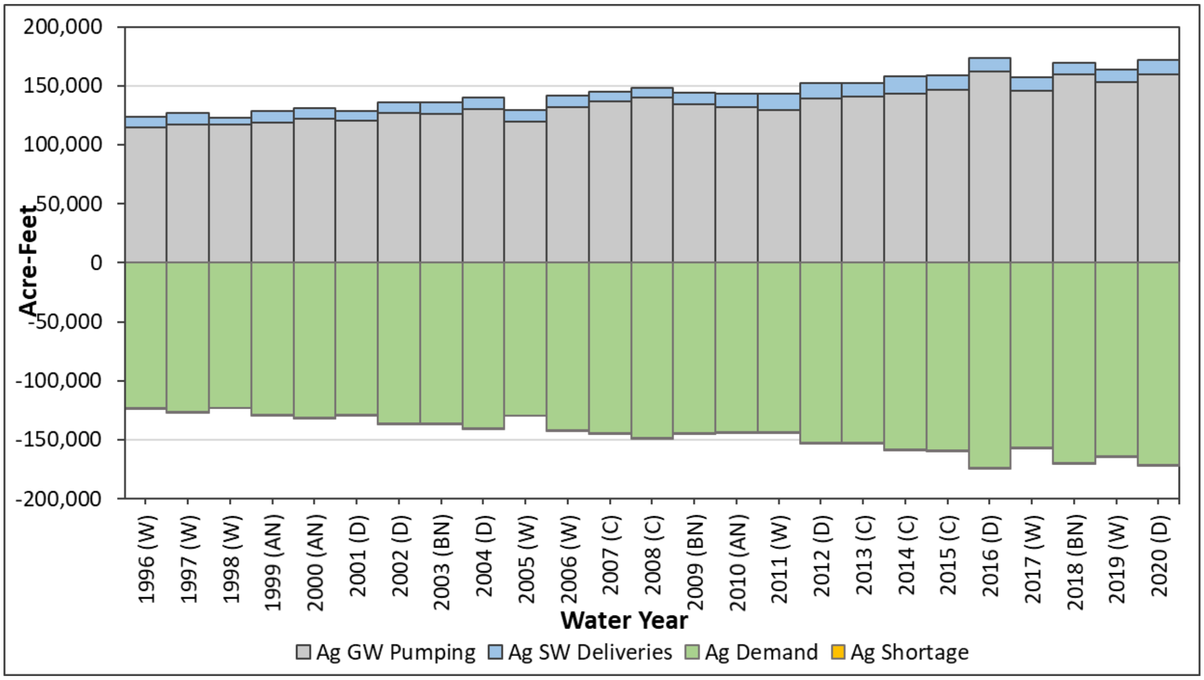


Figure 10: North San Joaquin Water Conservation District GSA Urban Demand

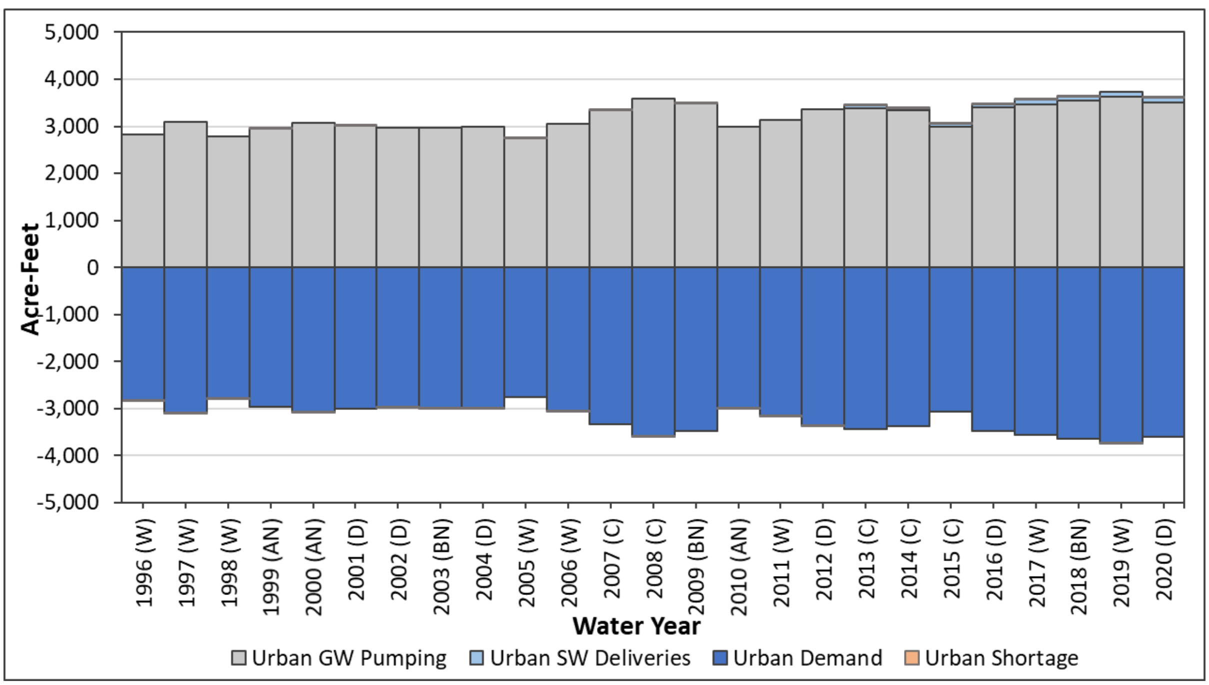


Figure 11: Lockeford Community Services District GSA Urban Demand

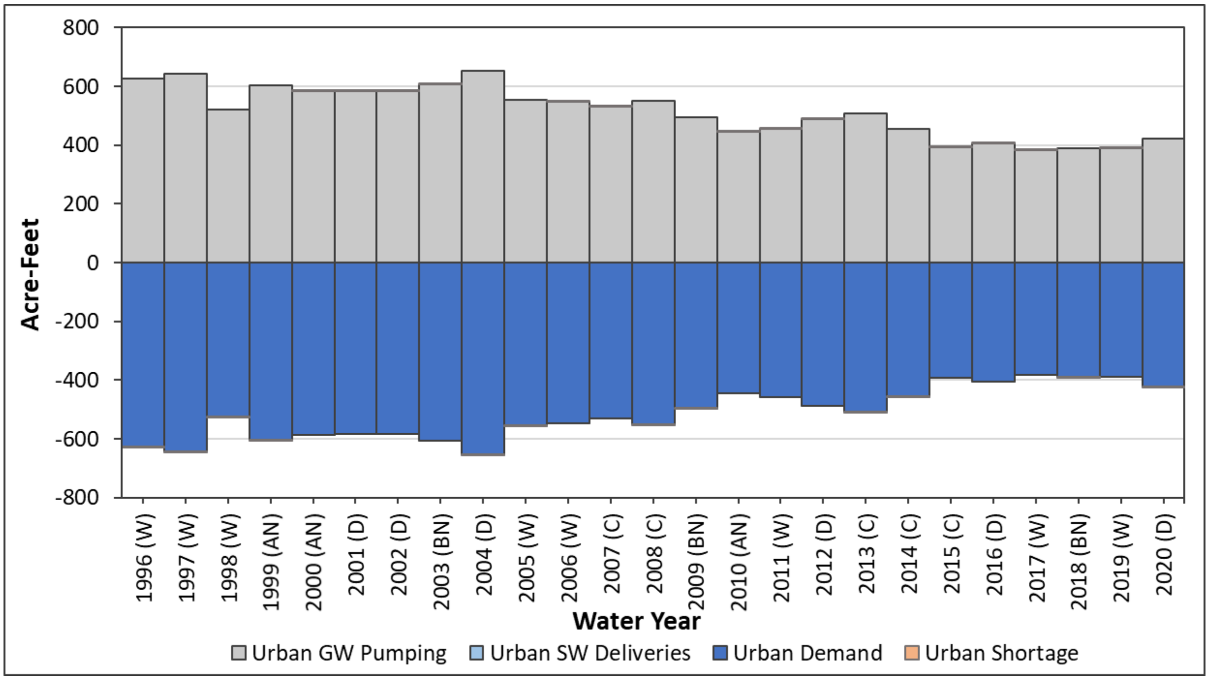


Figure 12: City of Stockton GSA Agricultural Demand

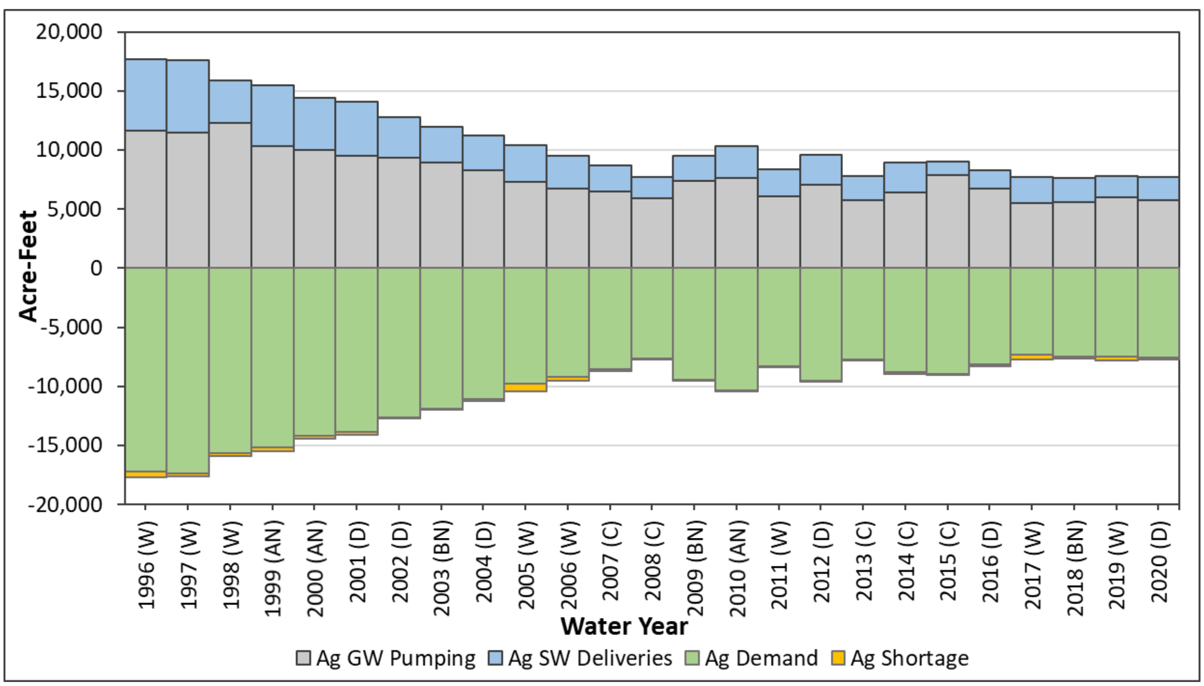


Figure 13: City of Stockton GSA Urban Demand

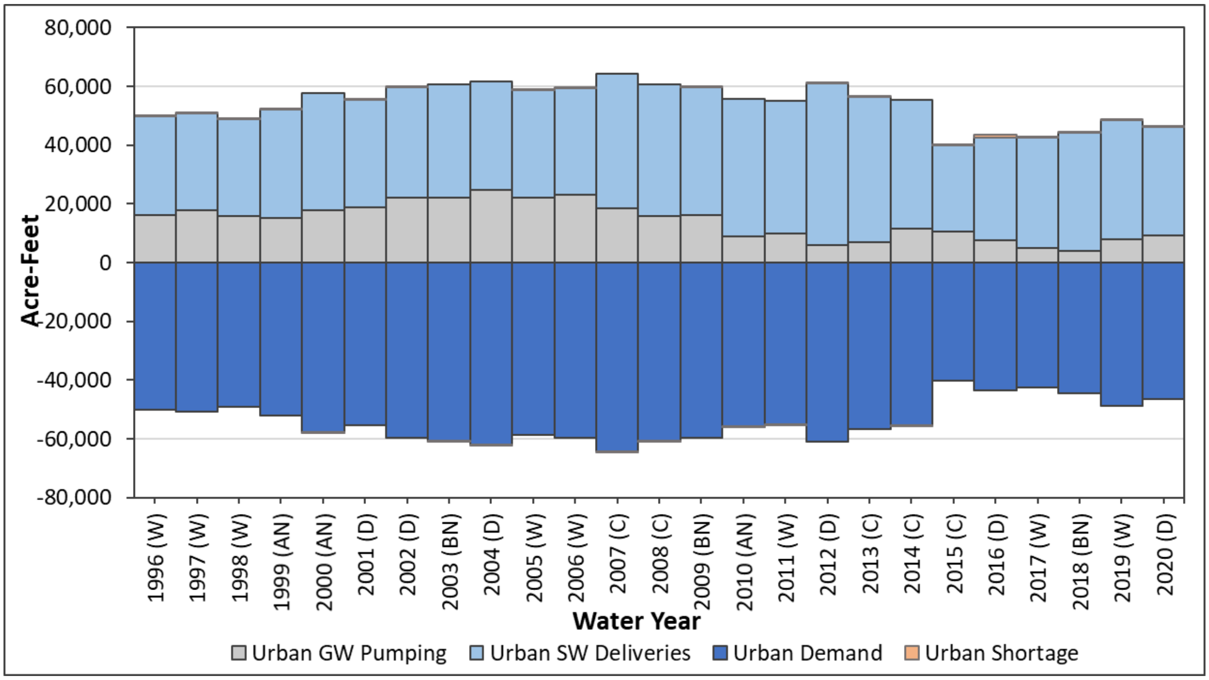


Figure 14: San Joaquin County #2 GSA Agricultural Demand

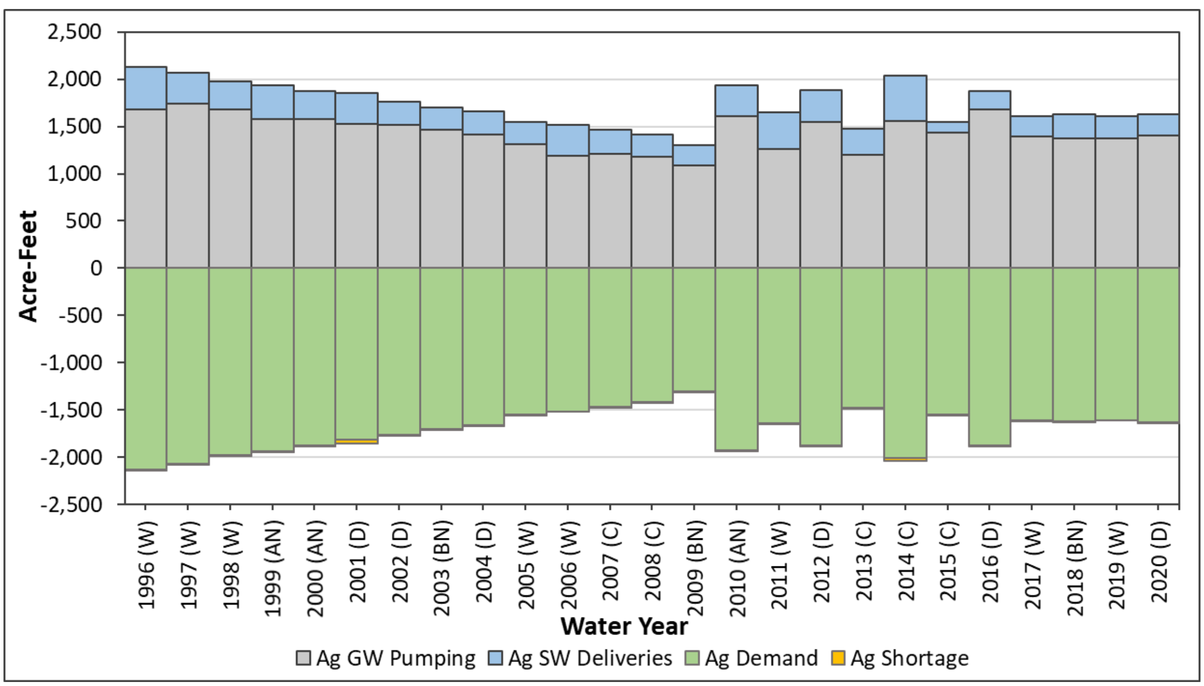


Figure 15: San Joaquin County #2 GSA Urban Demand

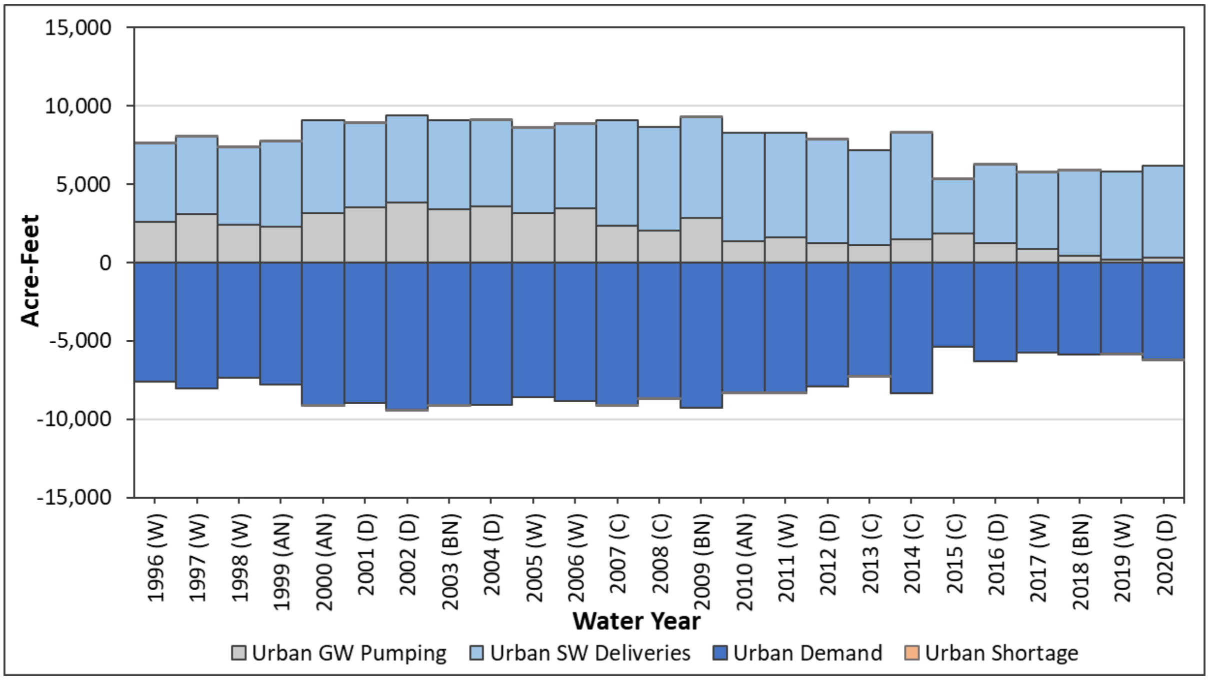


Figure 16: Stockton East Water District GSA Agricultural Demand

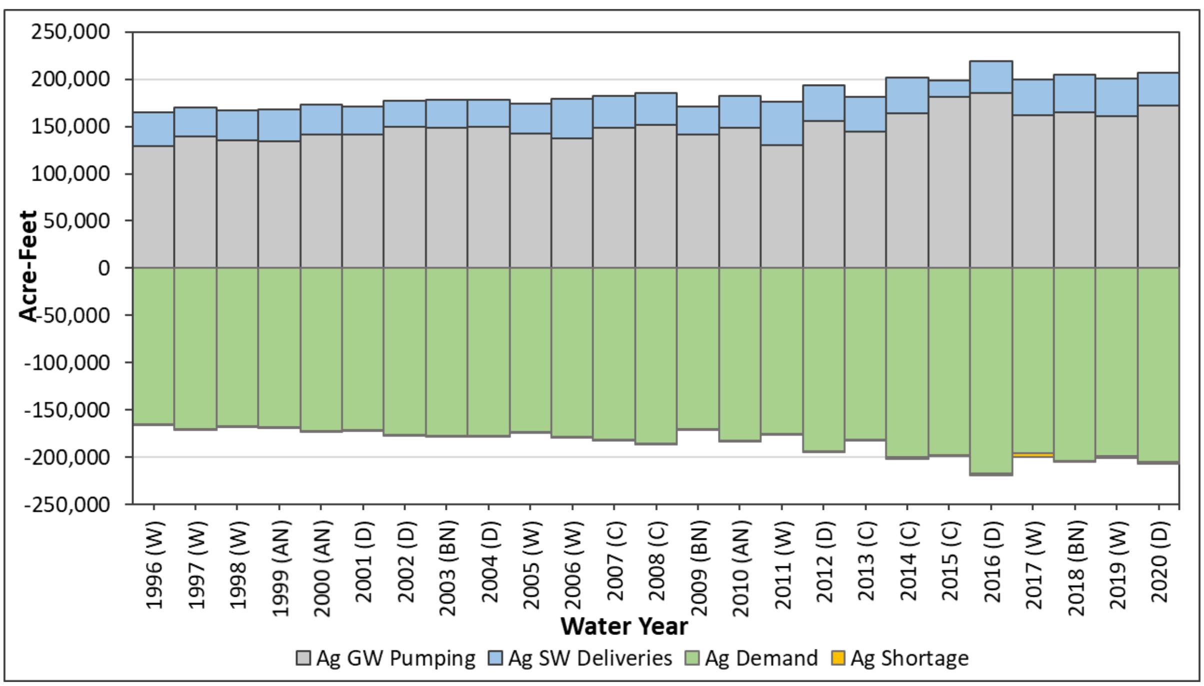


Figure 17: Stockton East Water District GSA Urban Demand

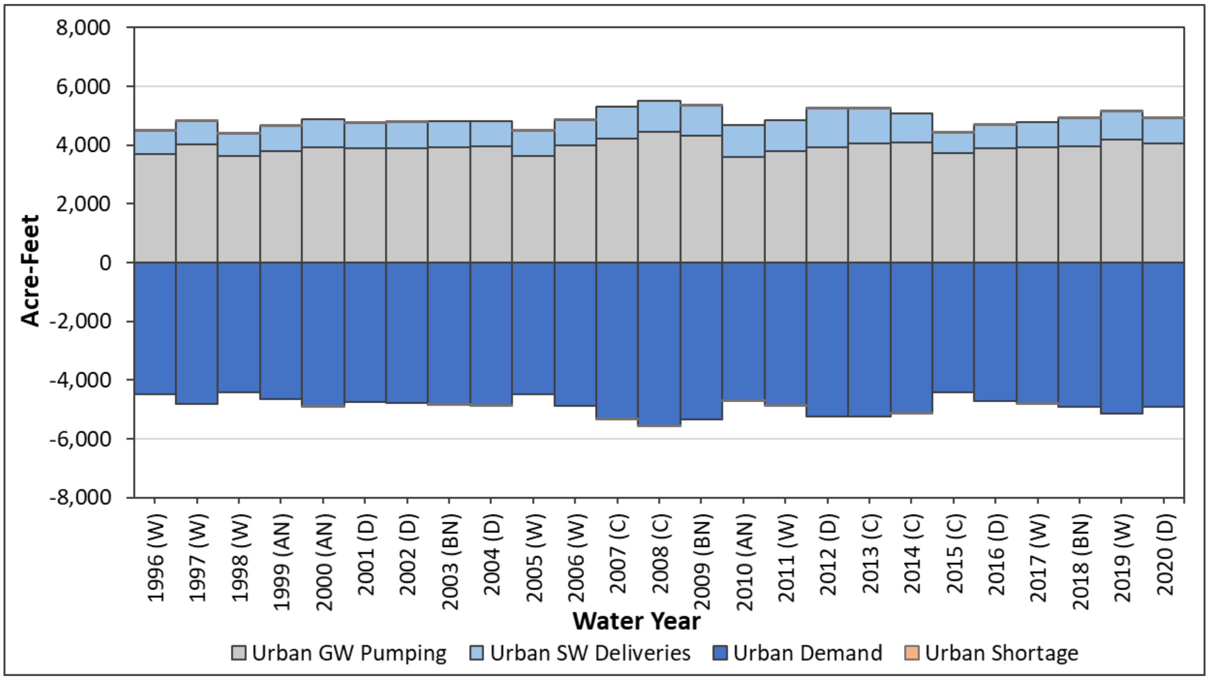


Figure 18: Linden County Water District GSA Urban Demand

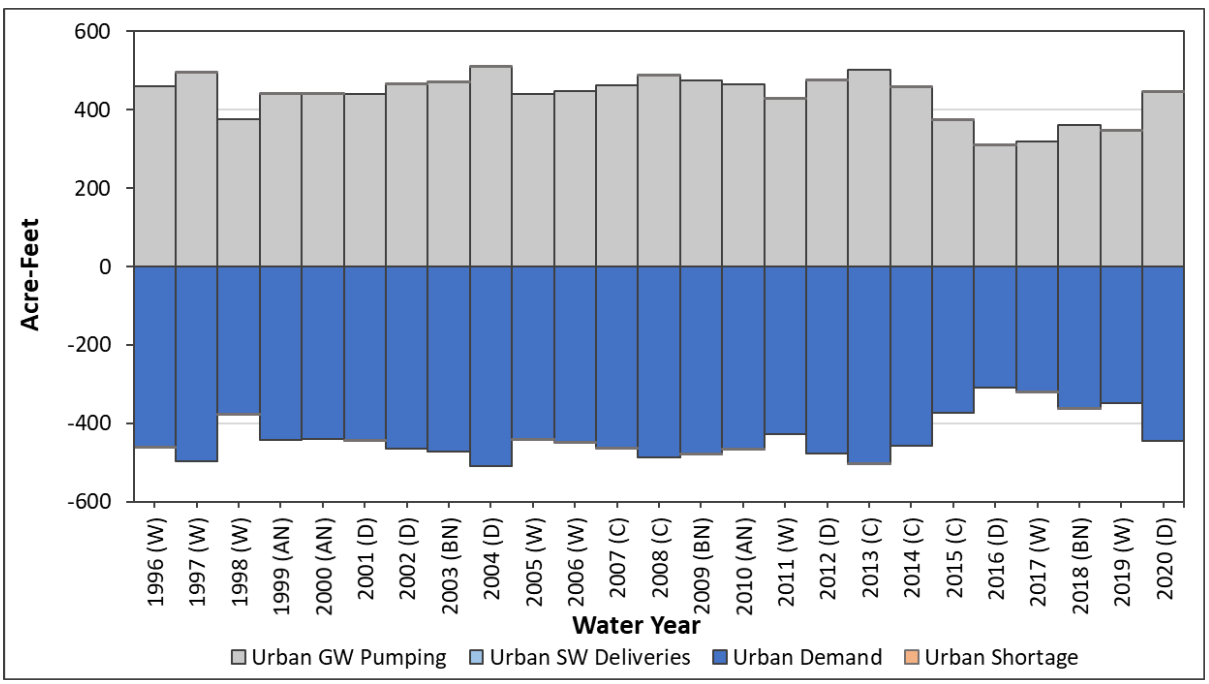


Figure 19: Central San Joaquin Water Conservation District GSA Agricultural Demand

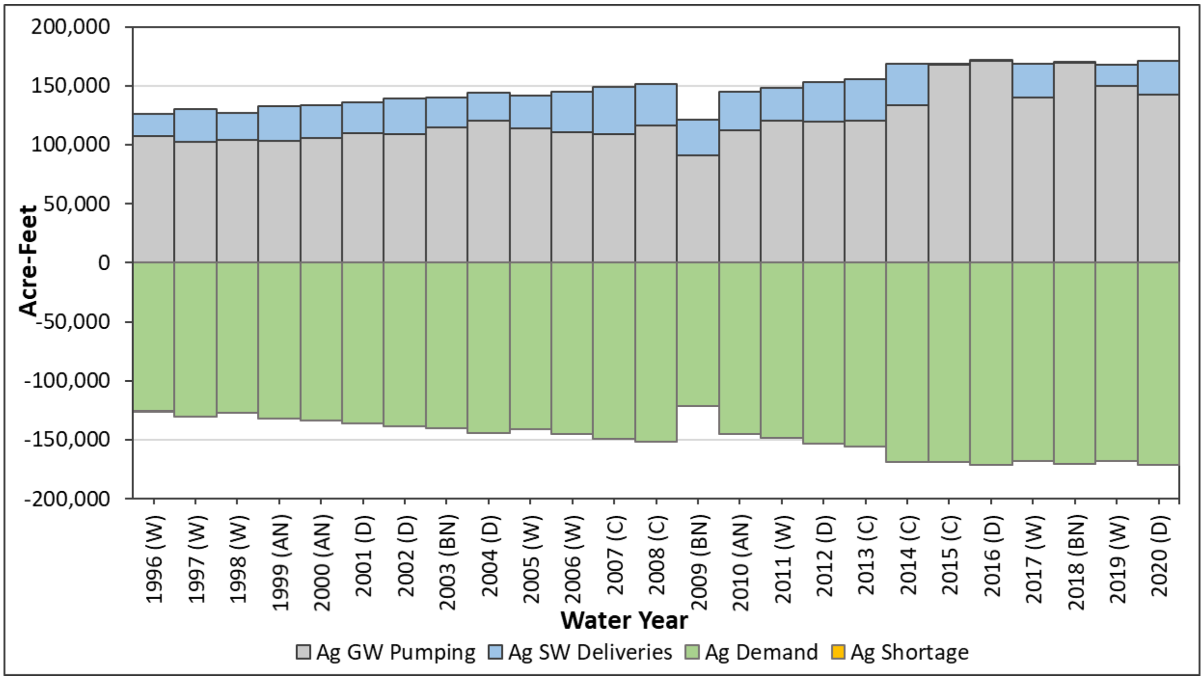


Figure 20: Central San Joaquin Water Conservation District GSA Urban Demand

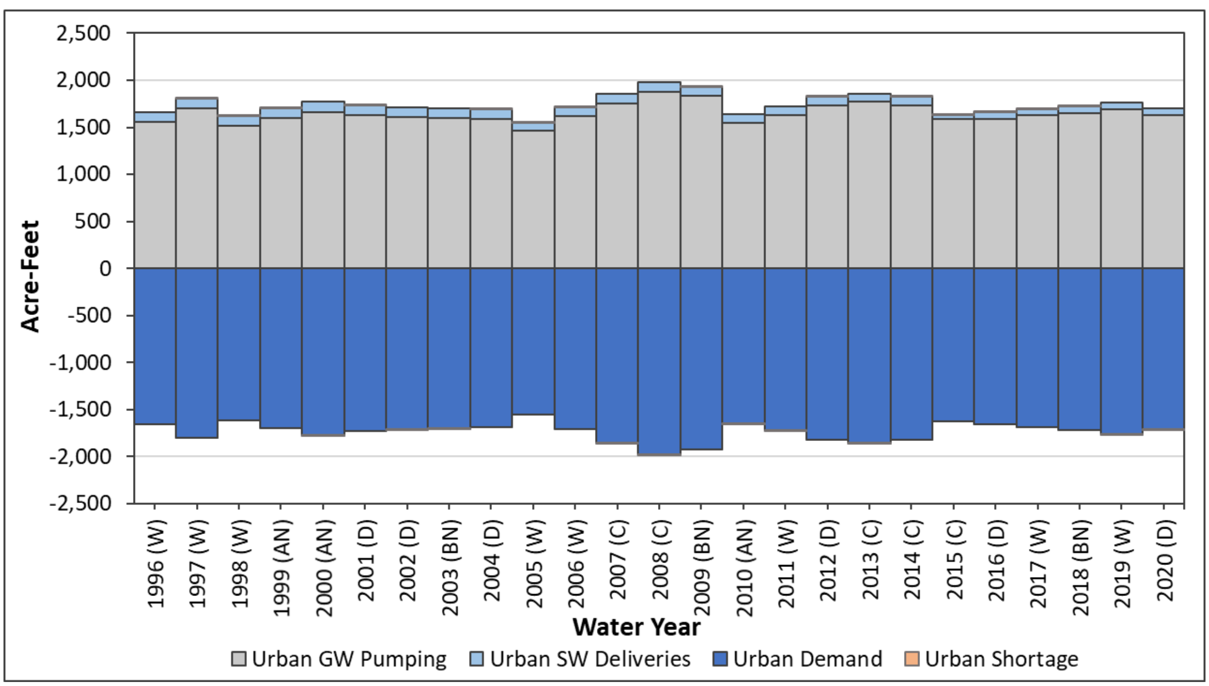


Figure 21: South Delta Water Agency GSA Agricultural Demand

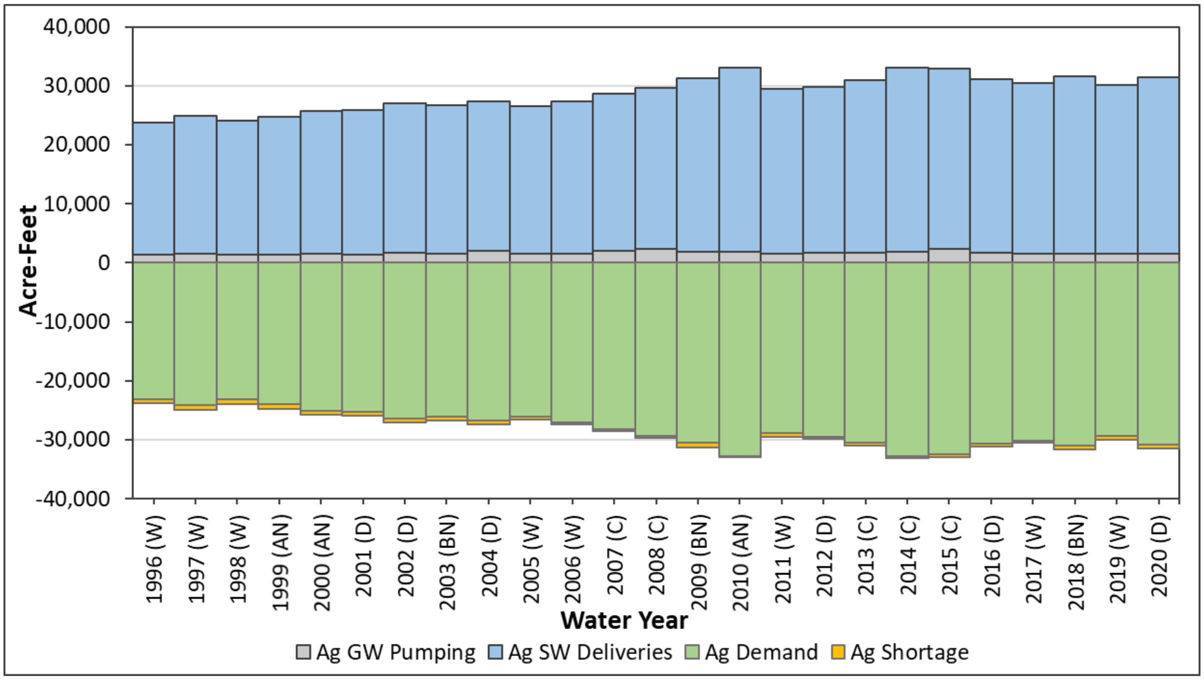


Figure 22: South Delta Water Agency GSA Urban Demand

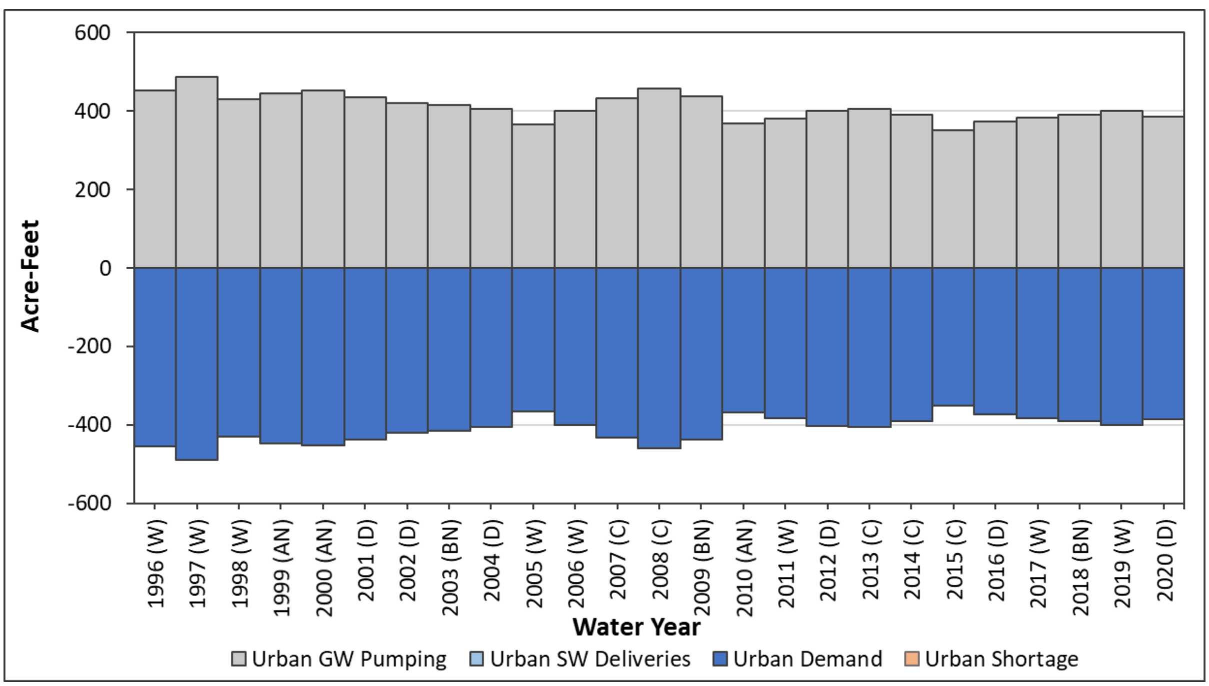


Figure 23: City of Manteca GSA Agricultural Demand

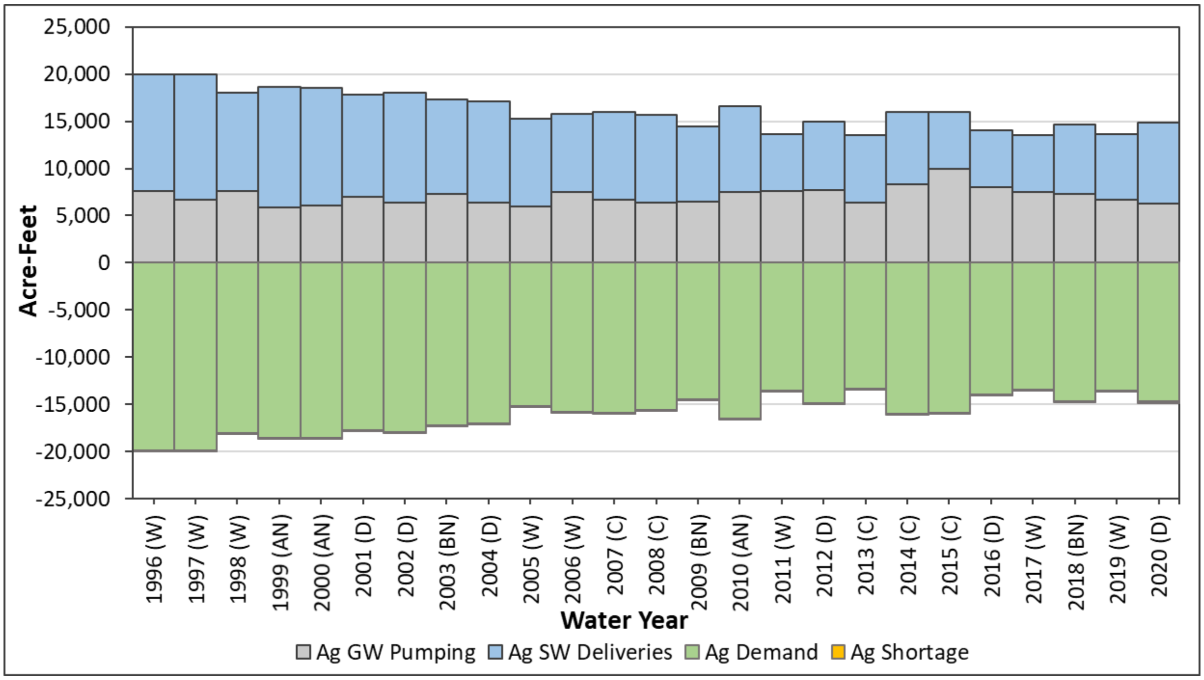


Figure 24: City of Manteca GSA Urban Demand

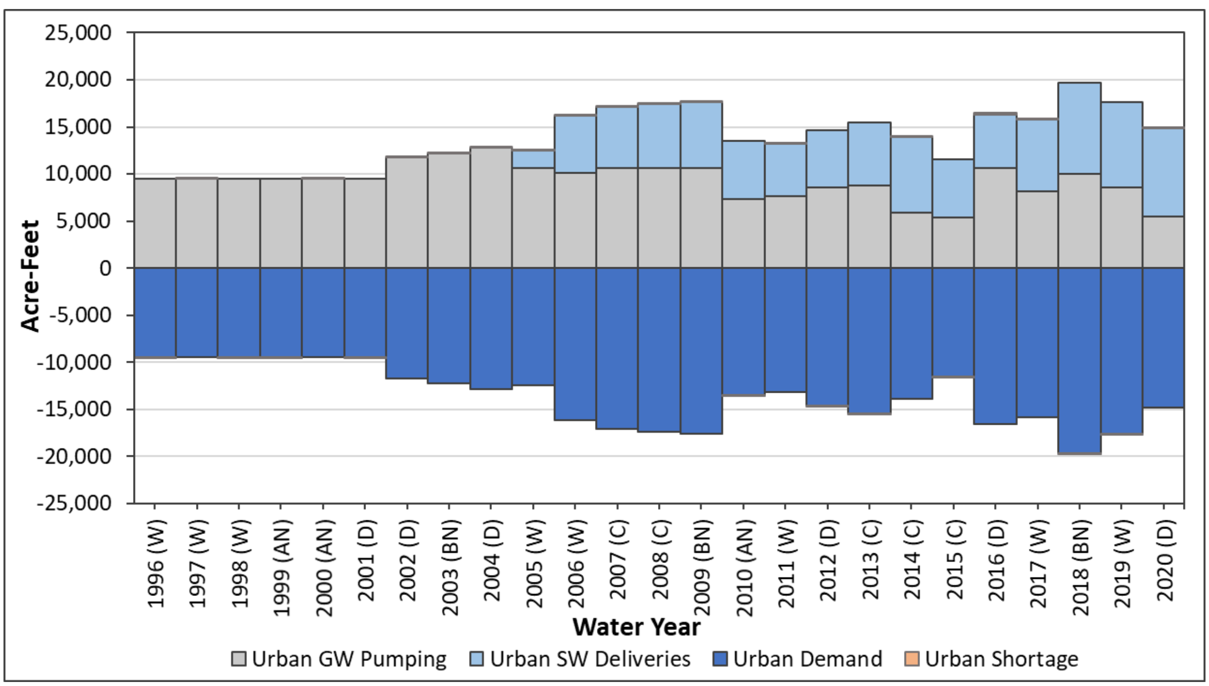


Figure 25: South San Joaquin Irrigation District GSA Agricultural Demand

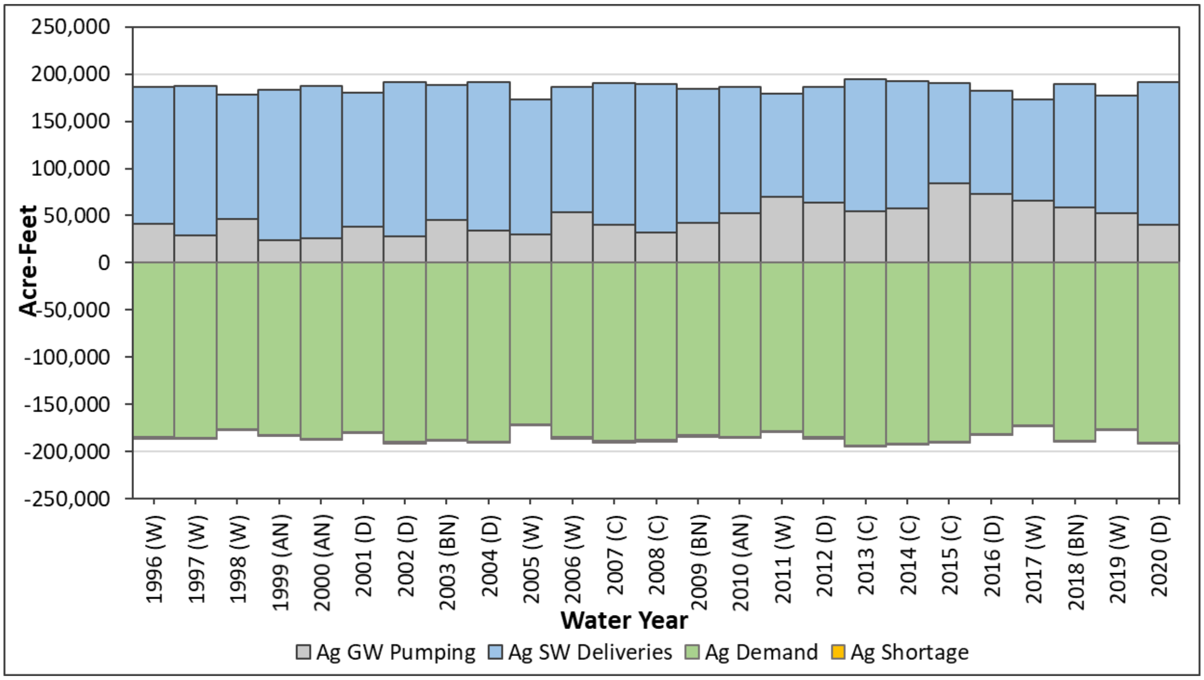


Figure 26: South San Joaquin Irrigation District GSA Urban Demand

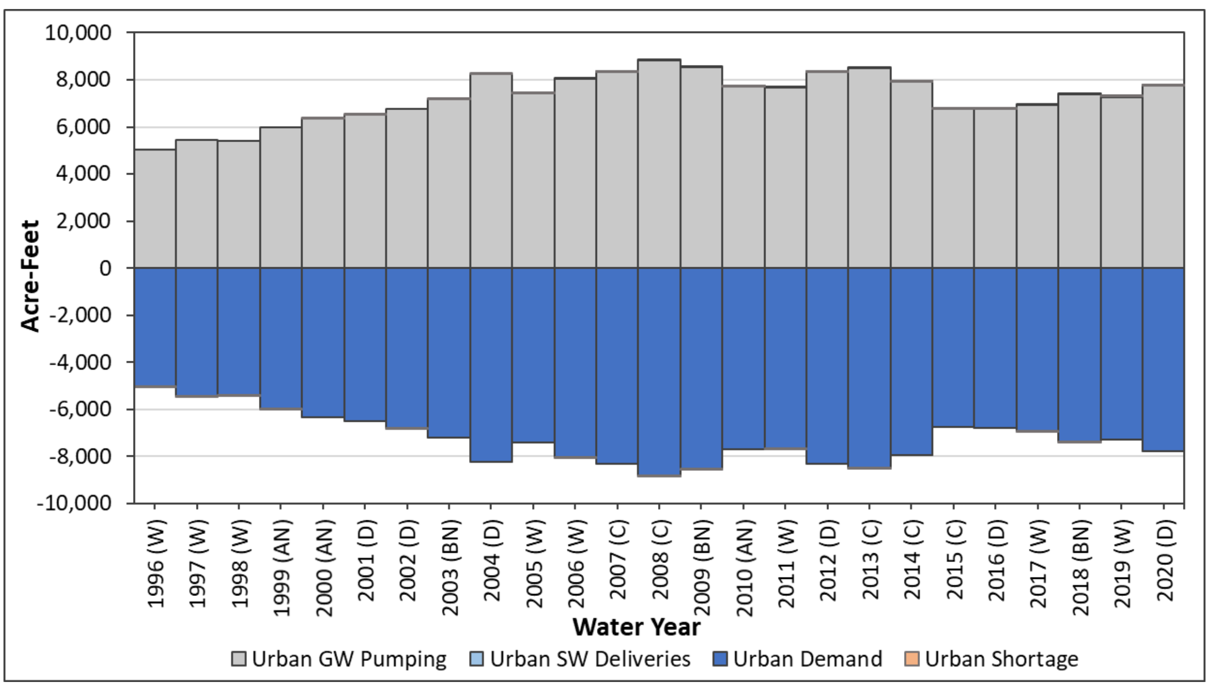


Figure 27: Oakdale Irrigation District GSA (North) Agricultural Demand

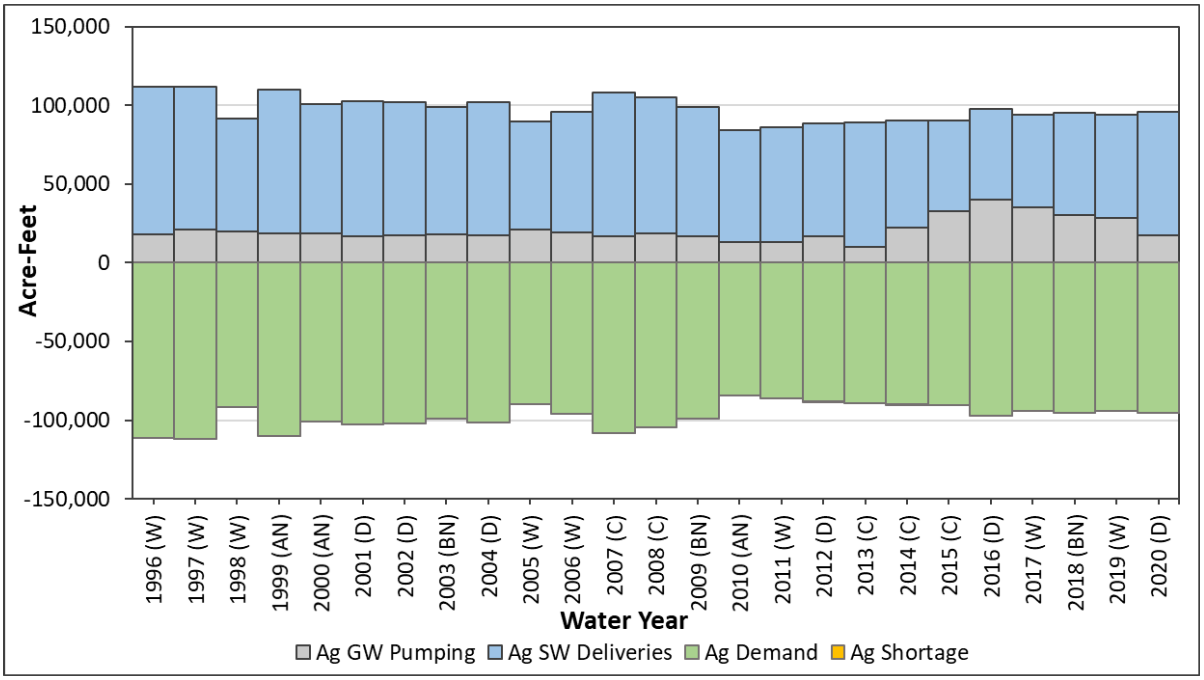
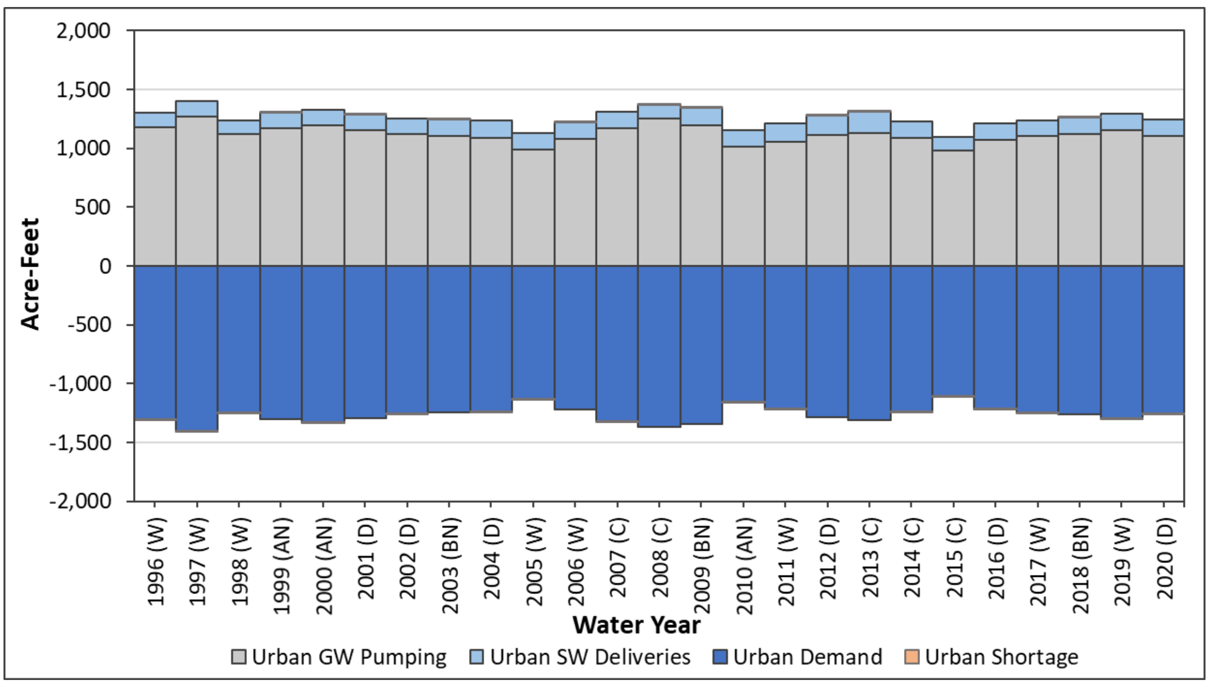


Figure 28: Oakdale Irrigation District GSA (North)Urban Demand



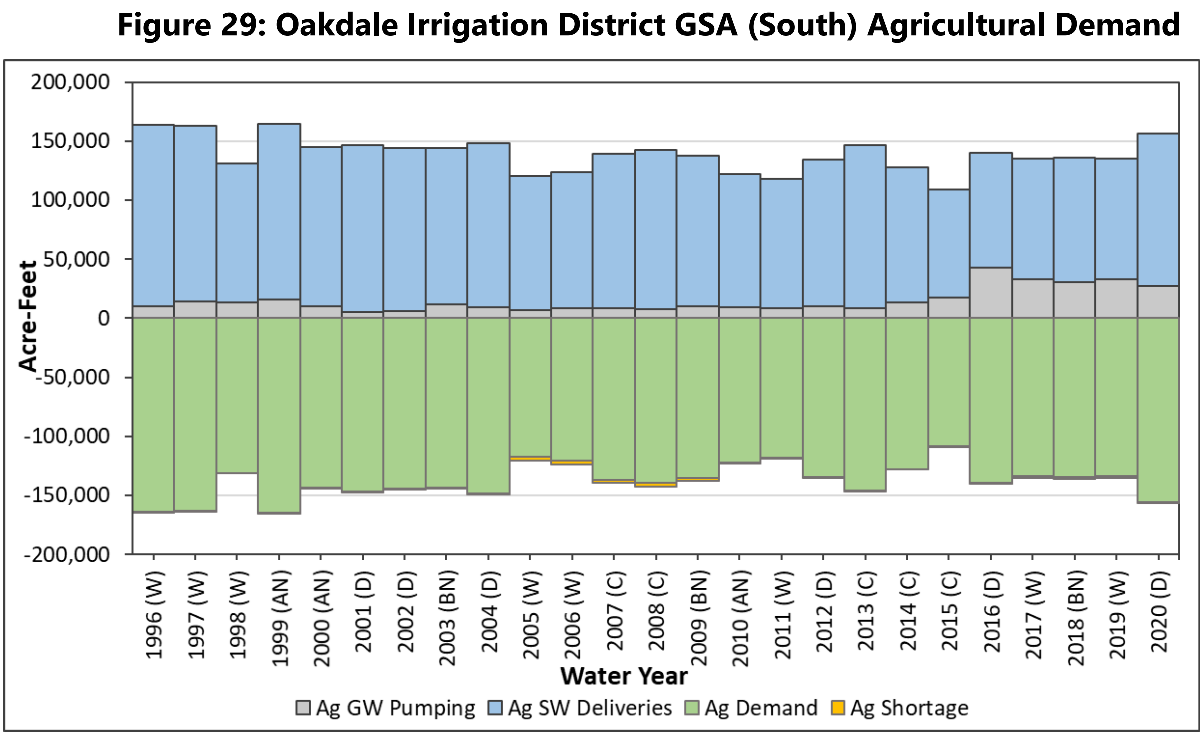


Figure 29: Oakdale Irrigation District GSA (South) Agricultural Demand
200,000
150,000
100,000
50,000
0
-50,000
-100,000
-150,000
-200,000
Acre-Feet
1996 (W)
1997 (W)
1998 (W)
1999 (AN)
2000 (AN)
2001 (D)
2002 (D)
2003 (BN)
2004 (D)
2005 (W)
2006 (W)
2007 (C)
2008 (C)
2009 (BN)
2010 (AN)
2011 (W)
2012 (D)
2013 (C)
2014 (C)
2015 (C)
2016 (D)
2017 (W)
2018 (BN)
2019 (W)
2020 (D)
Water Year
Ag GW Pumping
Ag SW Deliveries
Ag Demand
Ag Shortage

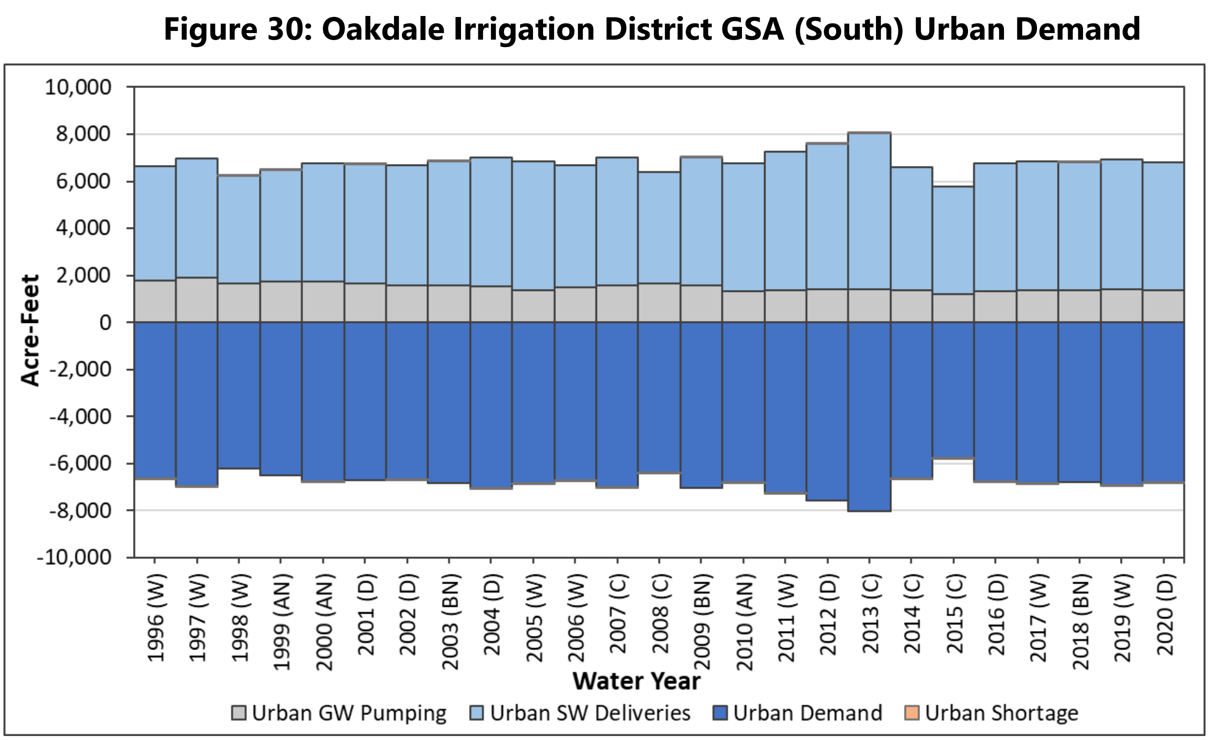


Figure 30: Oakdale Irrigation District GSA (South) Urban Demand
10,000
8,000
6,000
4,000
2,000
0
-2,000
-4,000
-6,000
-8,000
-10,000
Acre-Feet
1996 (W)
1997 (W)
1998 (W)
1999 (AN)
2000 (AN)
2001 (D)
2002 (D)
2003 (BN)
2004 (D)
2005 (W)
2006 (W)
2007 (C)
2008 (C)
2009 (BN)
2010 (AN)
2011 (W)
2012 (D)
2013 (C)
2014 (C)
2015 (C)
2016 (D)
2017 (W)
2018 (BN)
2019 (W)
2020 (D)
Water Year
Urban GW Pumping
Urban SW Deliveries
Urban Demand
Urban Shortage

Figure 31: Eastside San Joaquin GSA Agricultural Demand

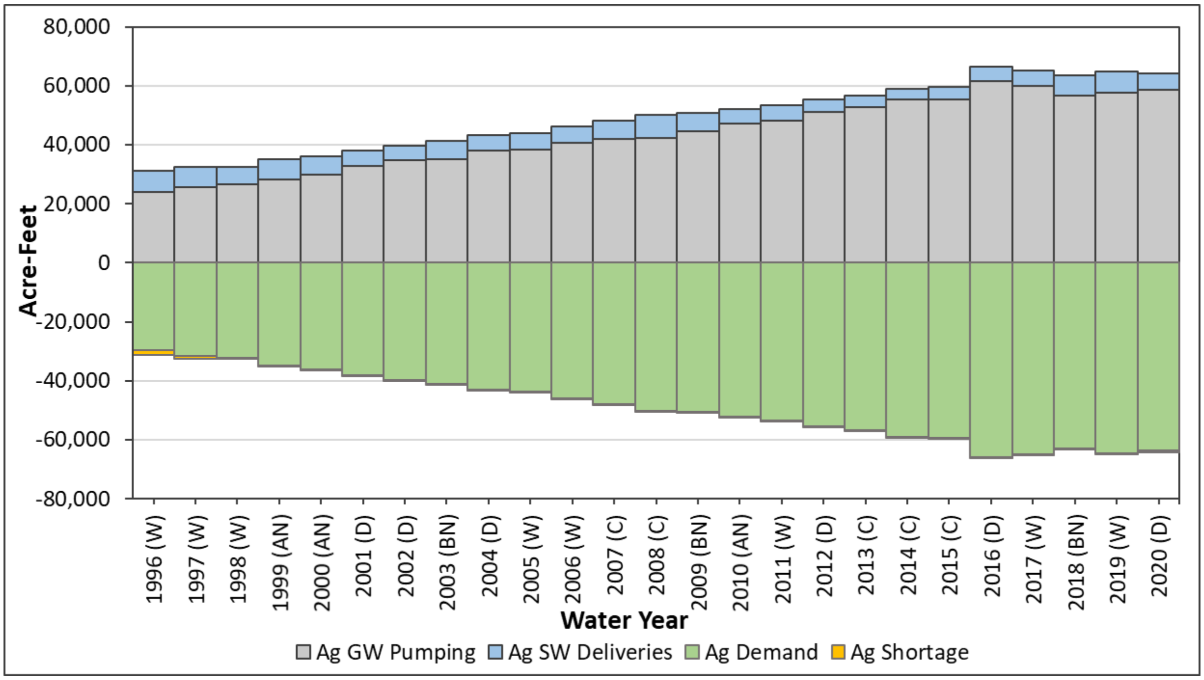
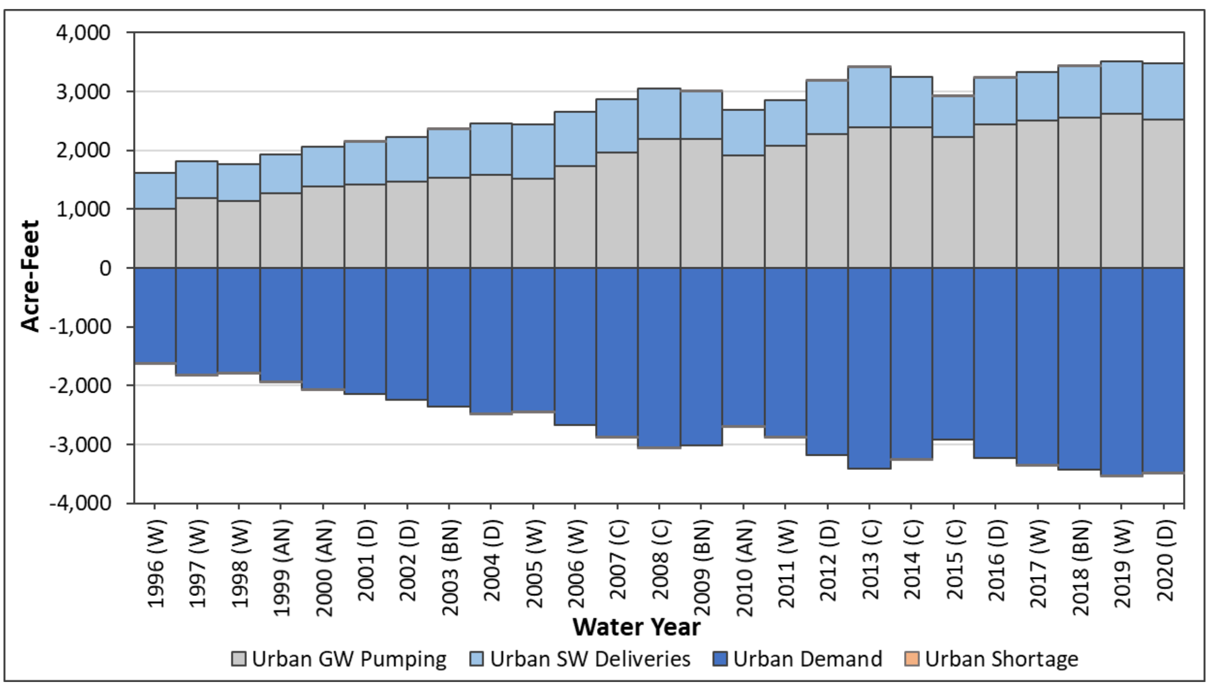


Figure 32: Eastside San Joaquin GSA Urban Demand



APPENDIX B: LAND AND WATER USE BUDGETS BY GSA FOR PROJECTED CONDITIONS BASELINE MODEL (PCBL VERSION 2.0)

FIGURES

Figure 1: San Joaquin County #1 GSA Projected Agricultural Demand

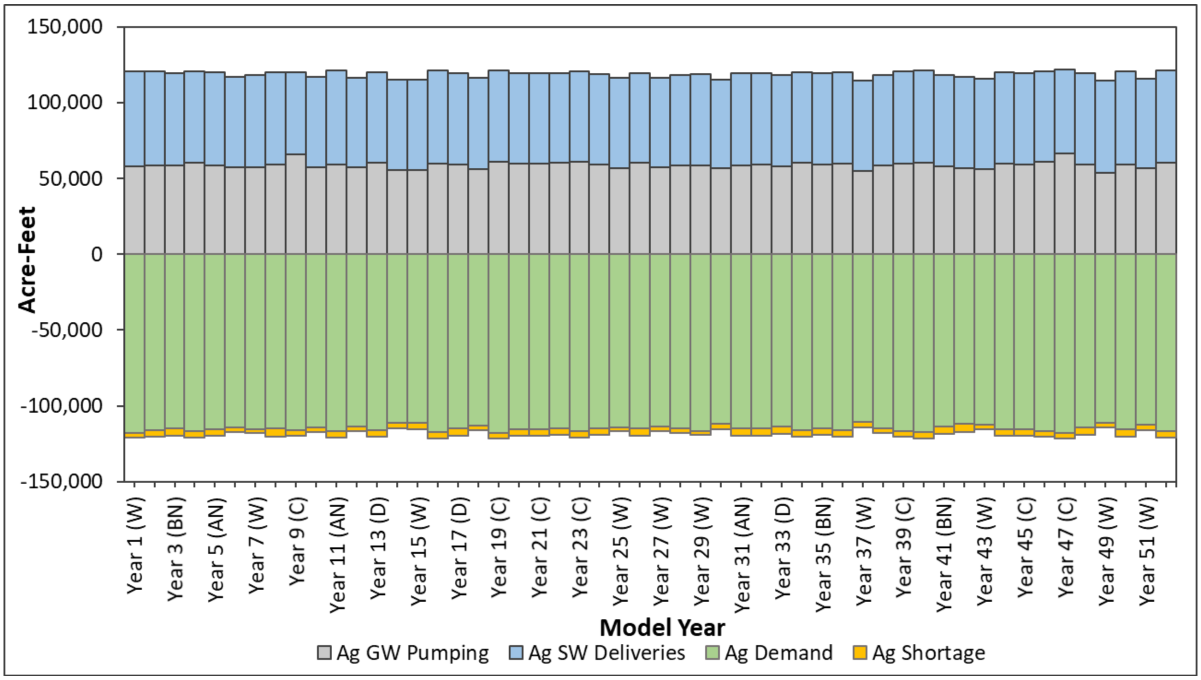


Figure 2: San Joaquin County #1 GSA Projected Urban Demand

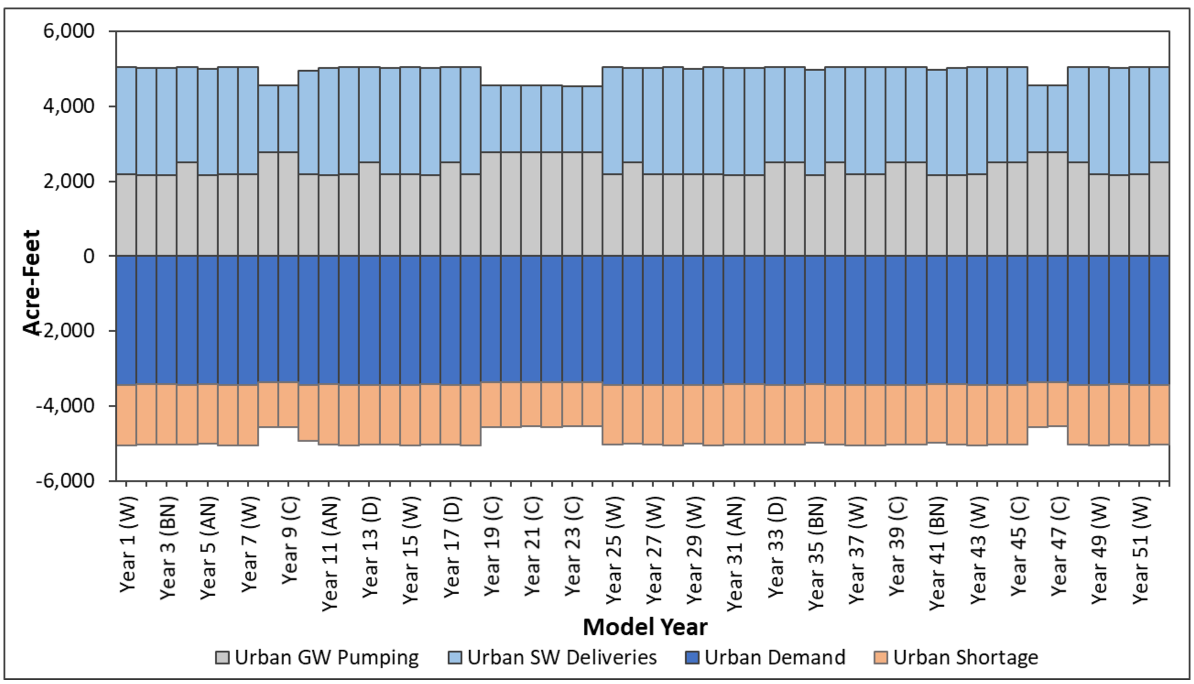


Figure 3: Central Delta Water Agency GSA Projected Agricultural Demand

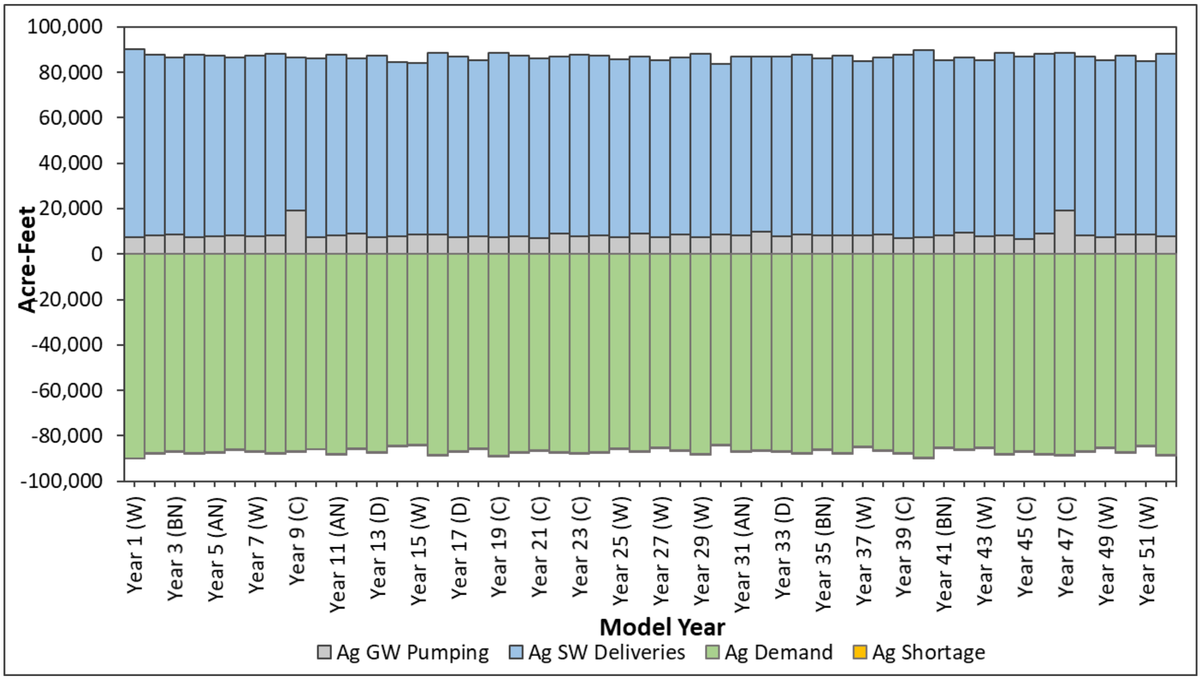


Figure 4: Central Delta Water Agency GSA Projected Urban Demand

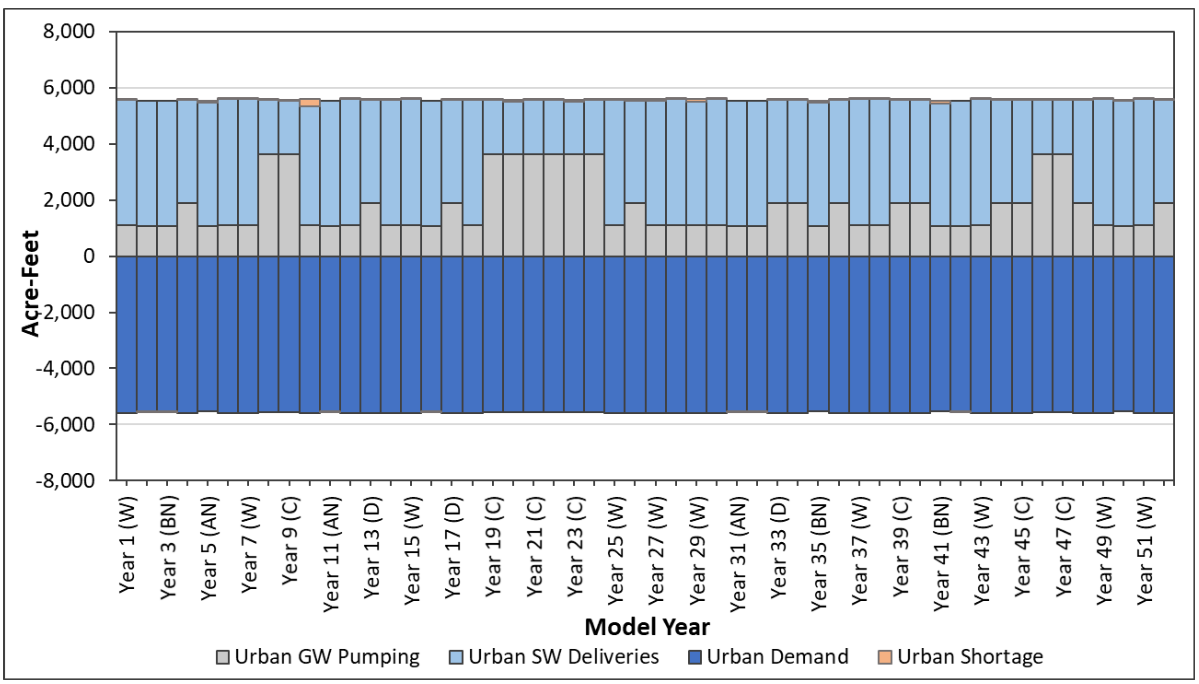


Figure 5: Woodbridge Irrigation District GSA Projected Agricultural Demand

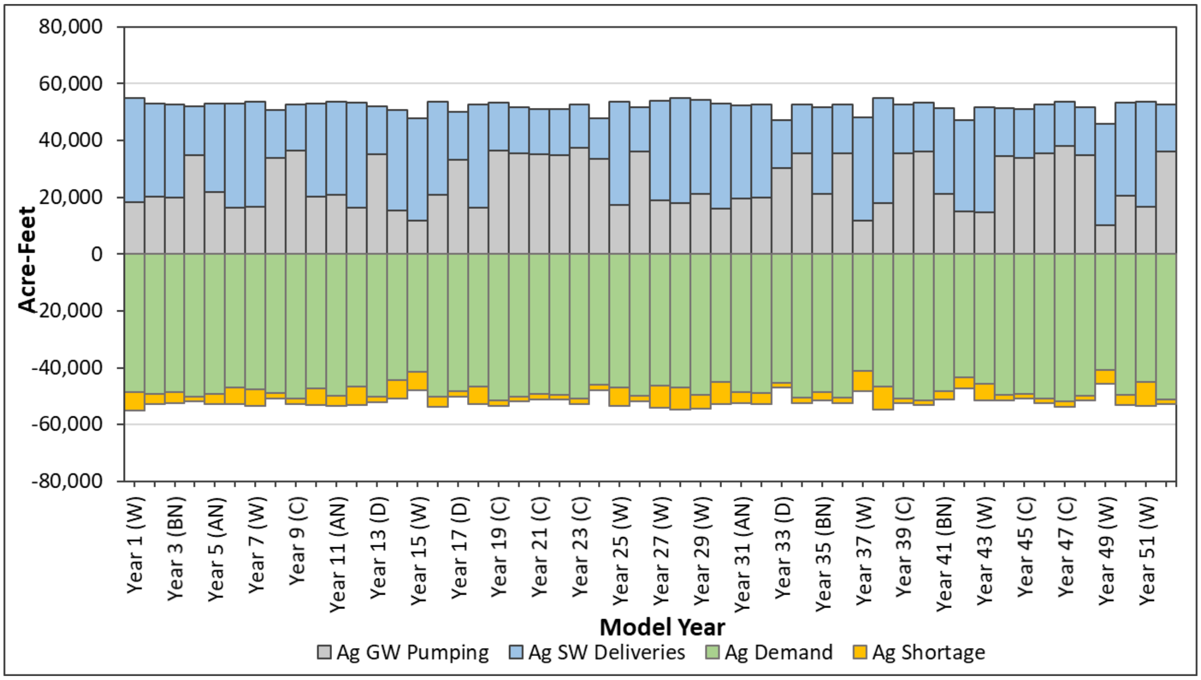


Figure 6: Woodbridge Irrigation District GSA Projected Urban Demand

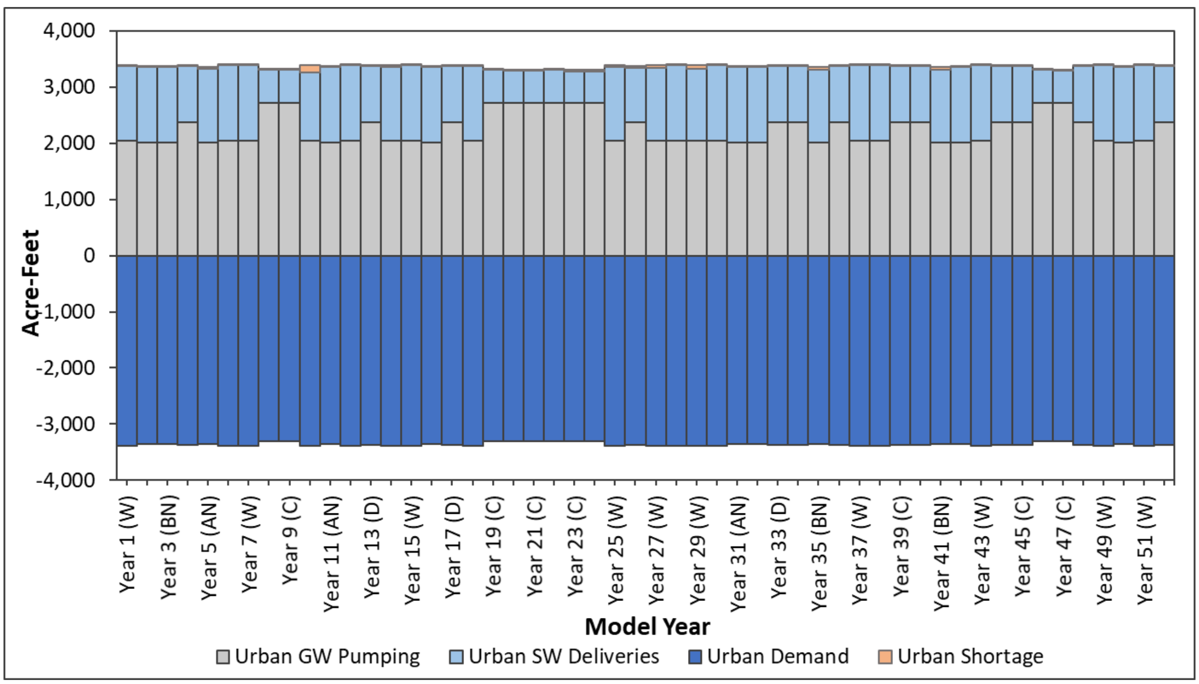


Figure 7: City of Lodi GSA Projected Agricultural Demand

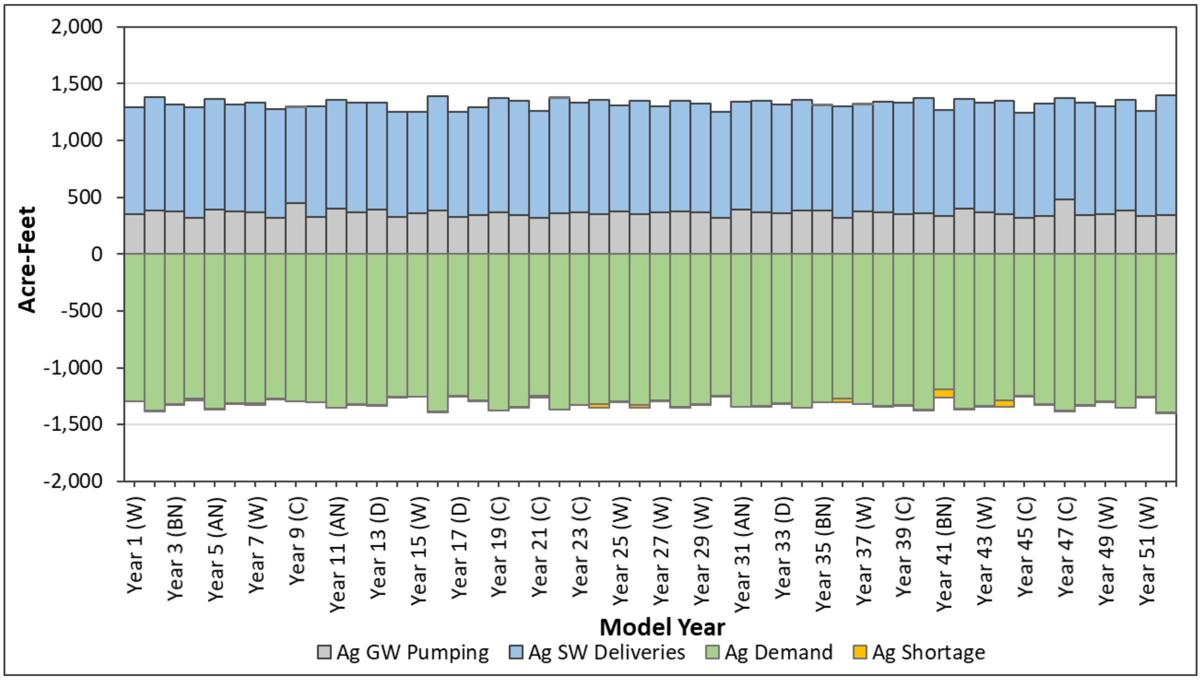


Figure 8: City of Lodi GSA Projected Urban Demand

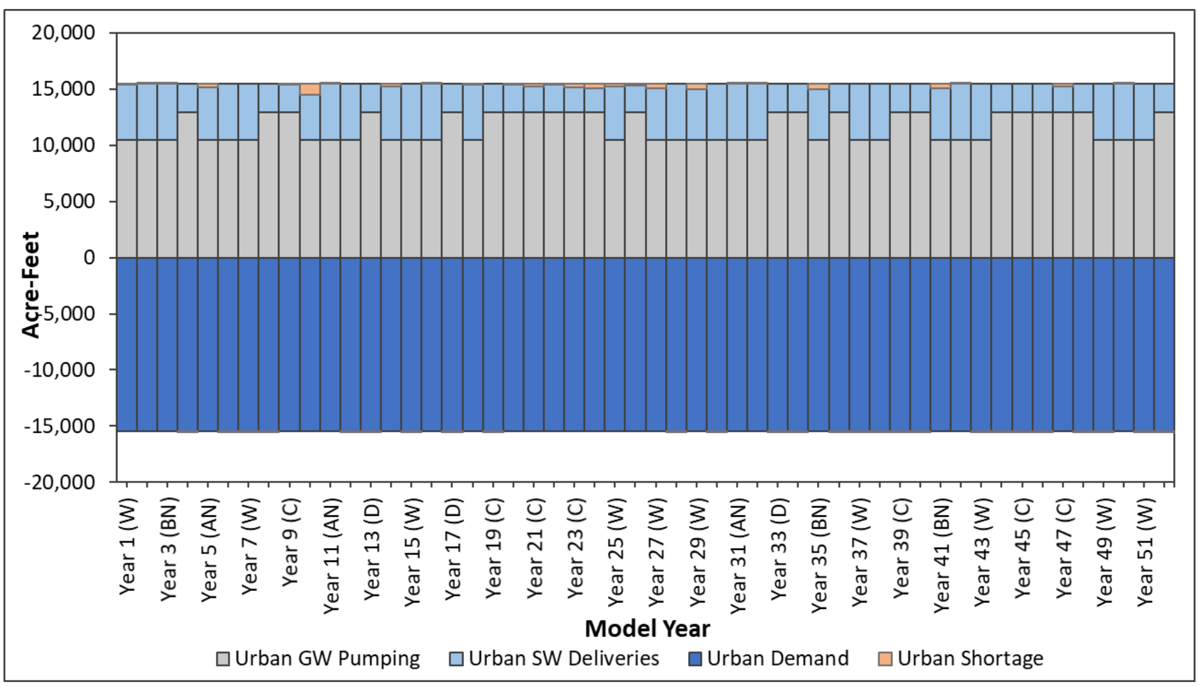


Figure 9: North San Joaquin Water Conservation District GSA Projected Agricultural Demand

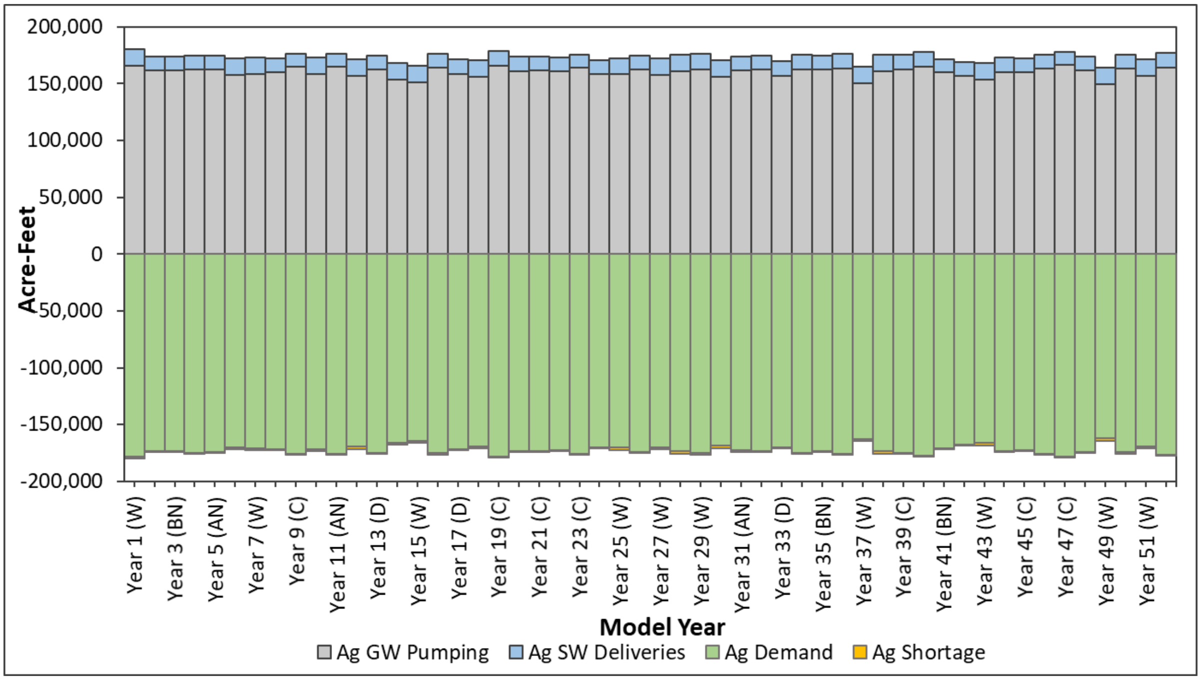


Figure 10: North San Joaquin Water Conservation District GSA Projected Urban Demand

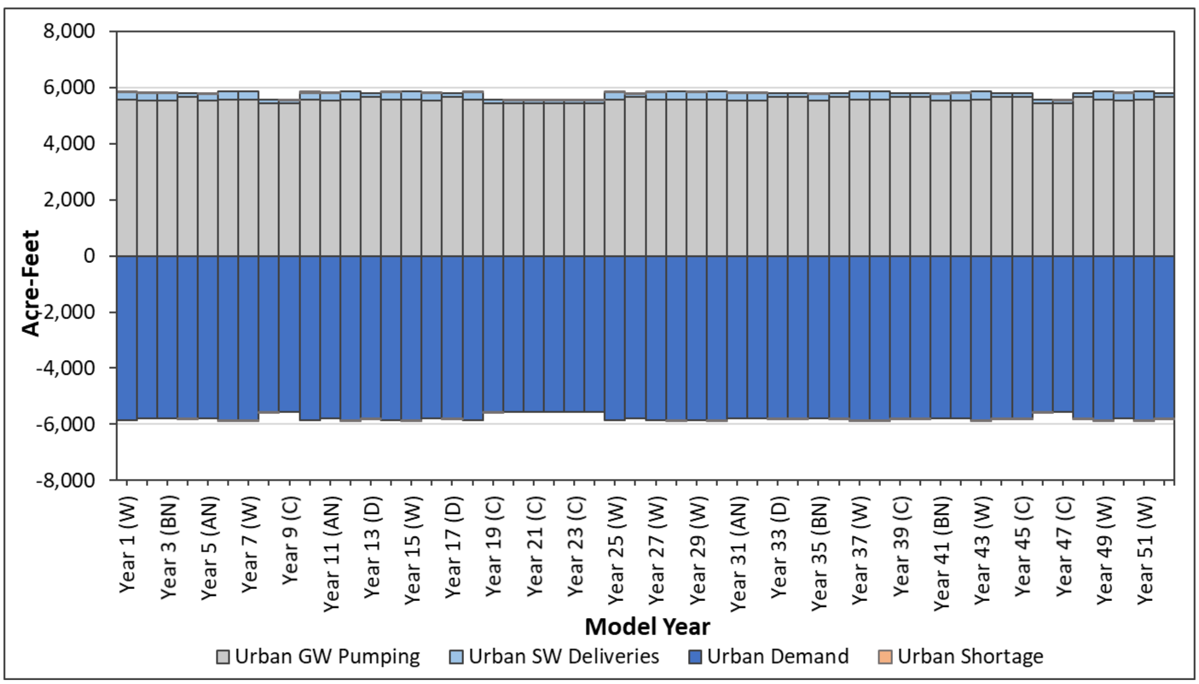


Figure 11: Lockeford Community Services District GSA Projected Urban Demand

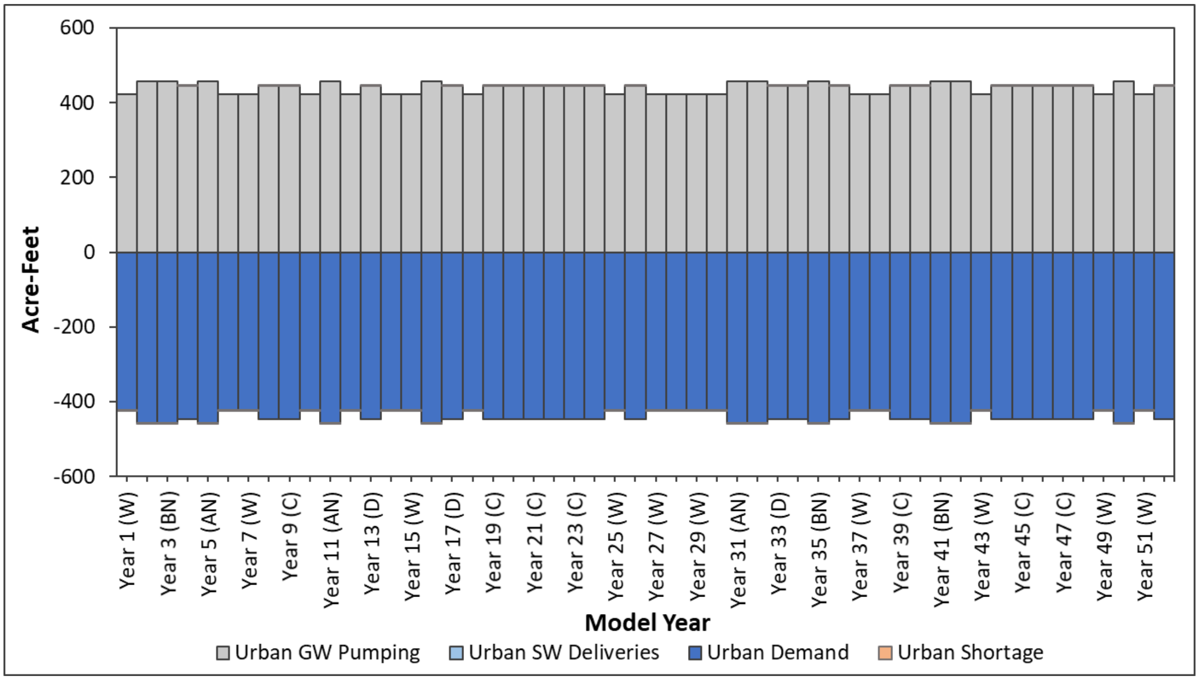


Figure 12: City of Stockton GSA Projected Urban Demand

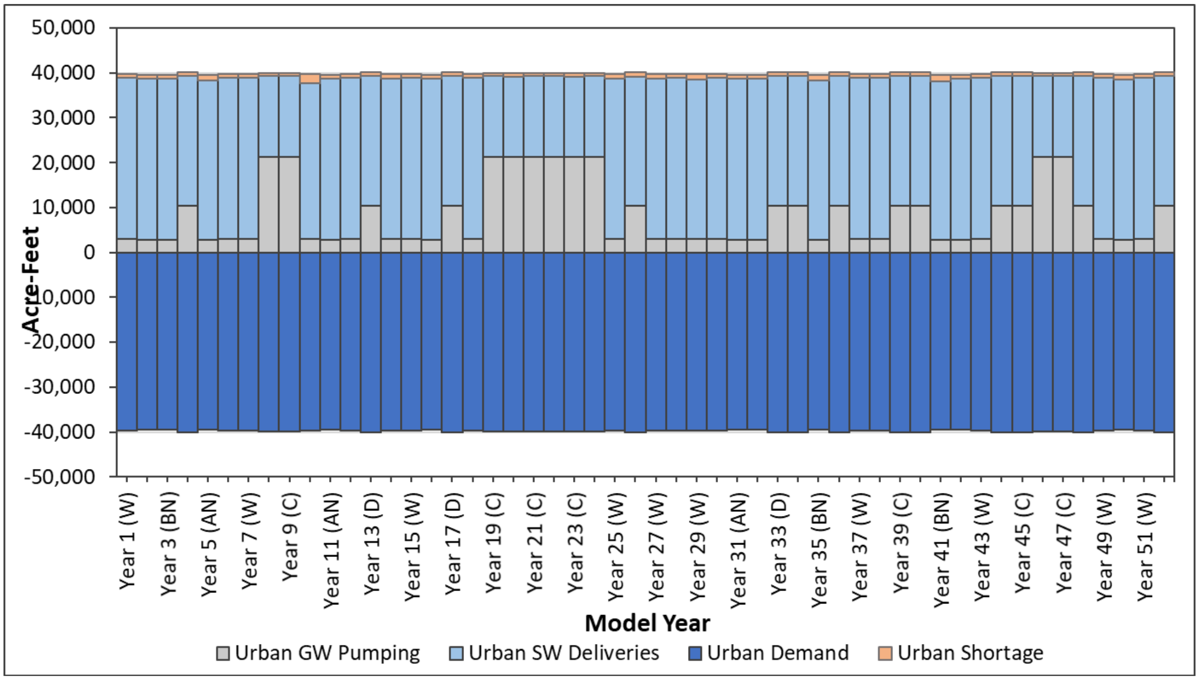


Figure 13: San Joaquin County #2 GSA Projected Urban Demand

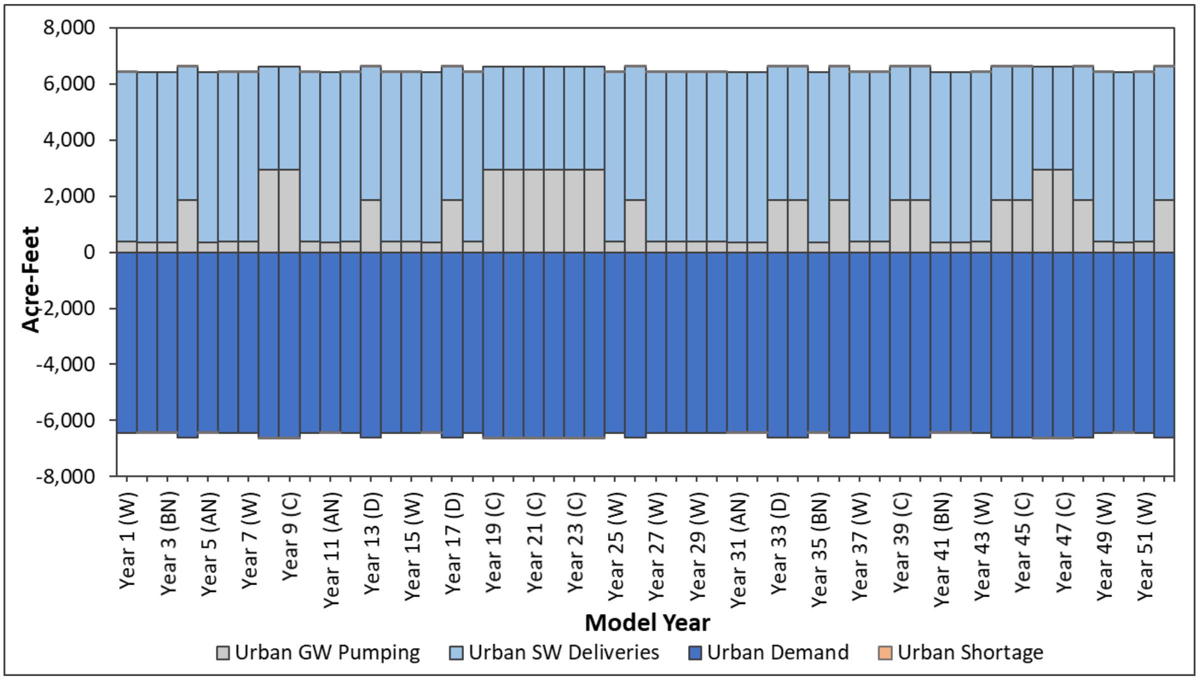


Figure 14: Stockton East Water District GSA Projected Agricultural Demand

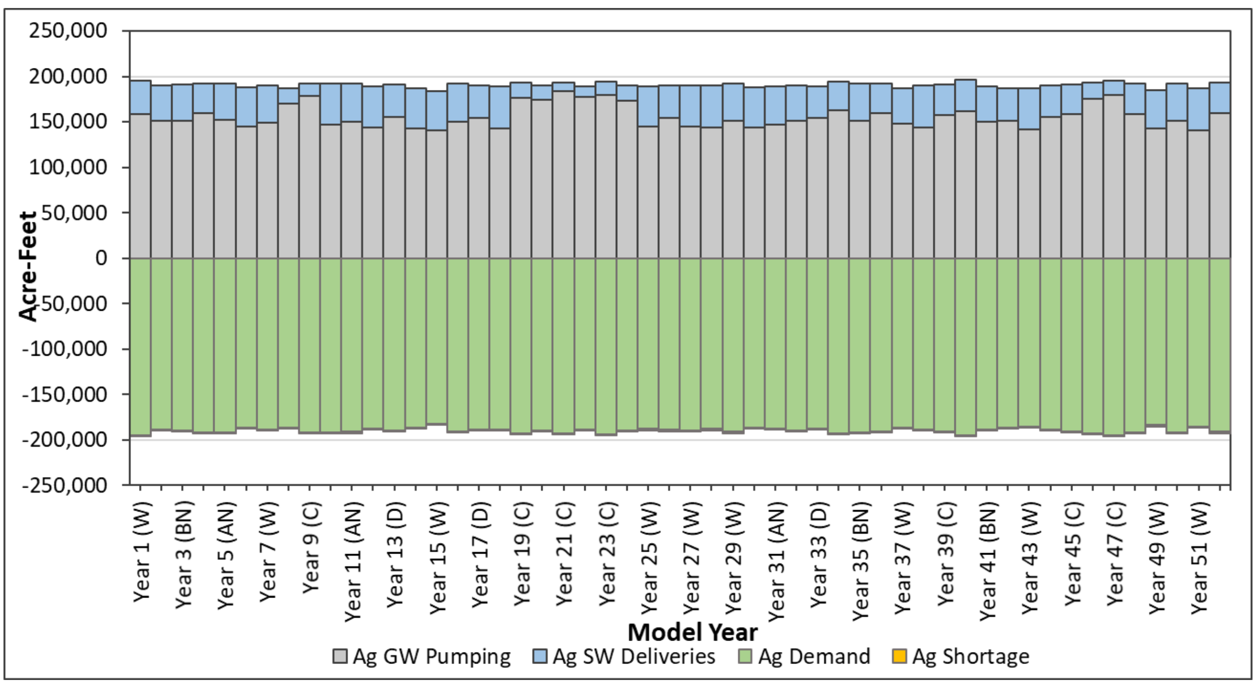


Figure 15: Stockton East Water District GSA Projected Urban Demand

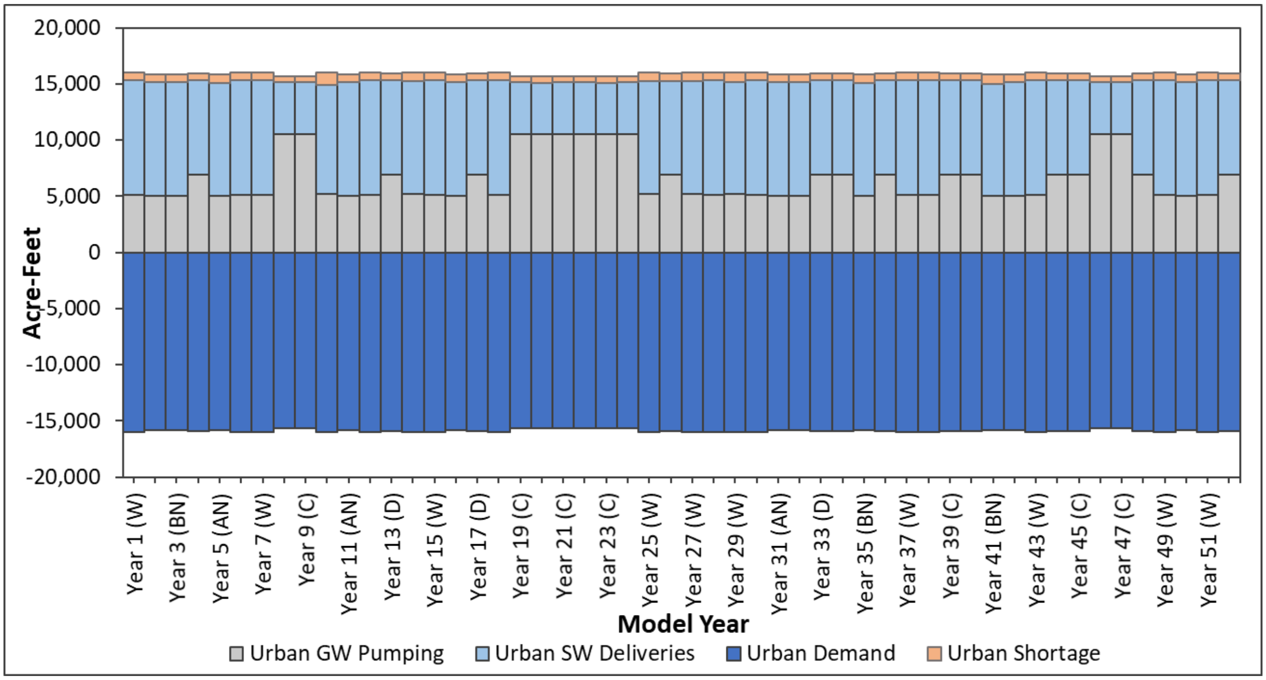


Figure 16: Linden County Water District GSA Projected Urban Demand

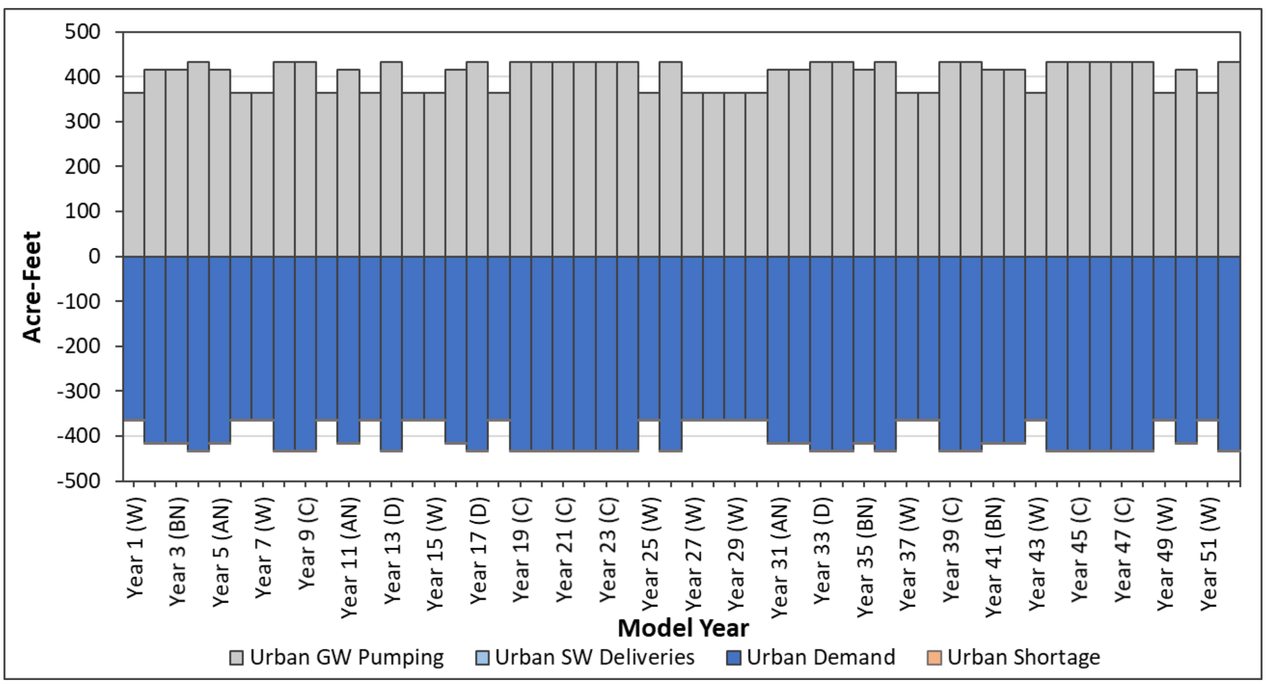


Figure 17: Central San Joaquin Water Conservation District GSA Projected Agricultural Demand

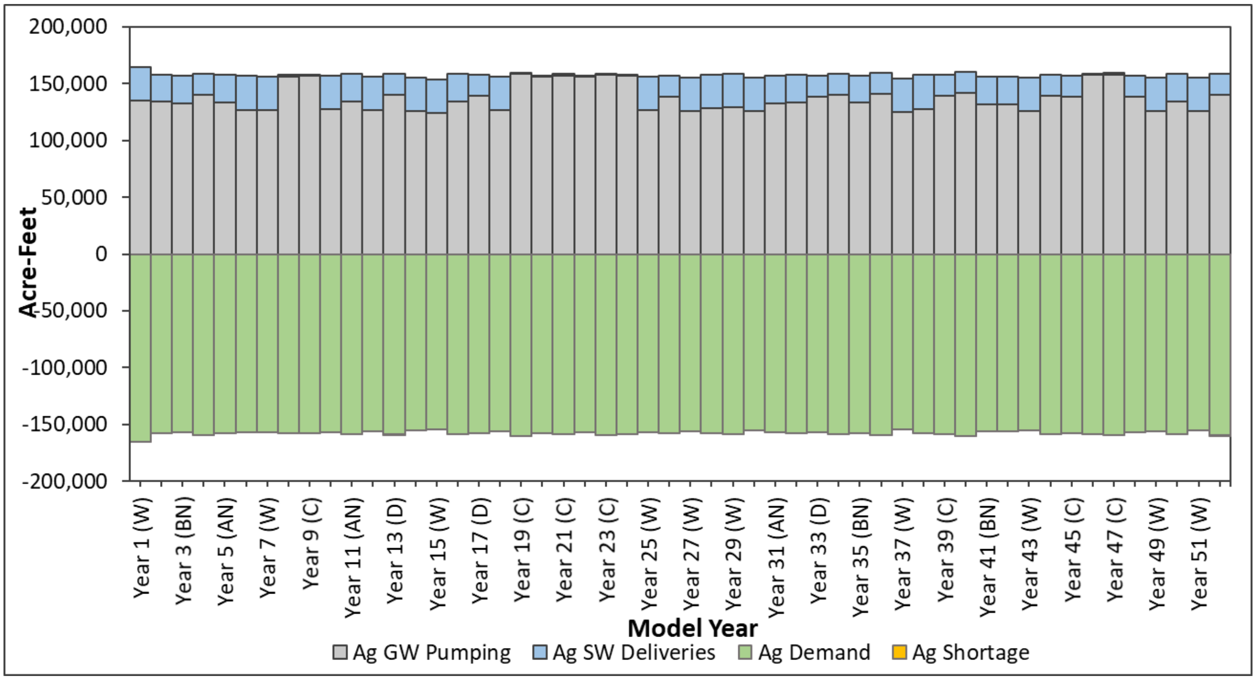


Figure 18: Central San Joaquin Water Conservation District GSA Projected Urban Demand

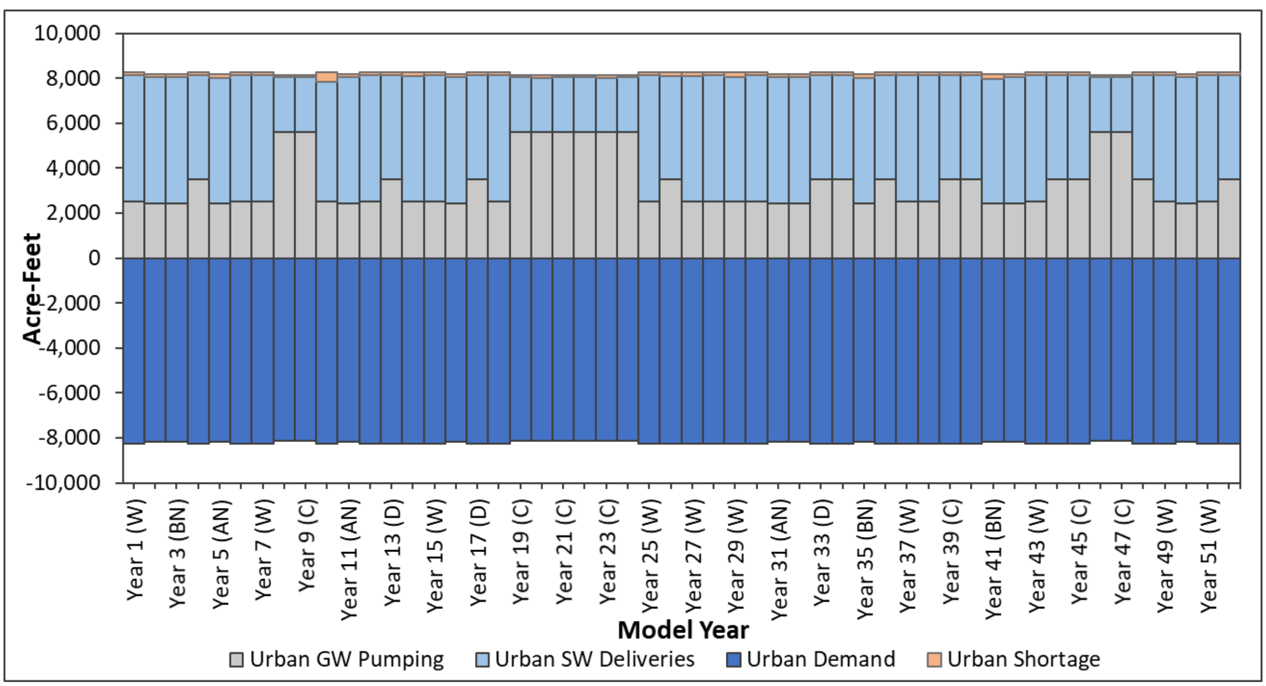


Figure 19: South Delta Water Agency GSA Projected Agricultural Demand

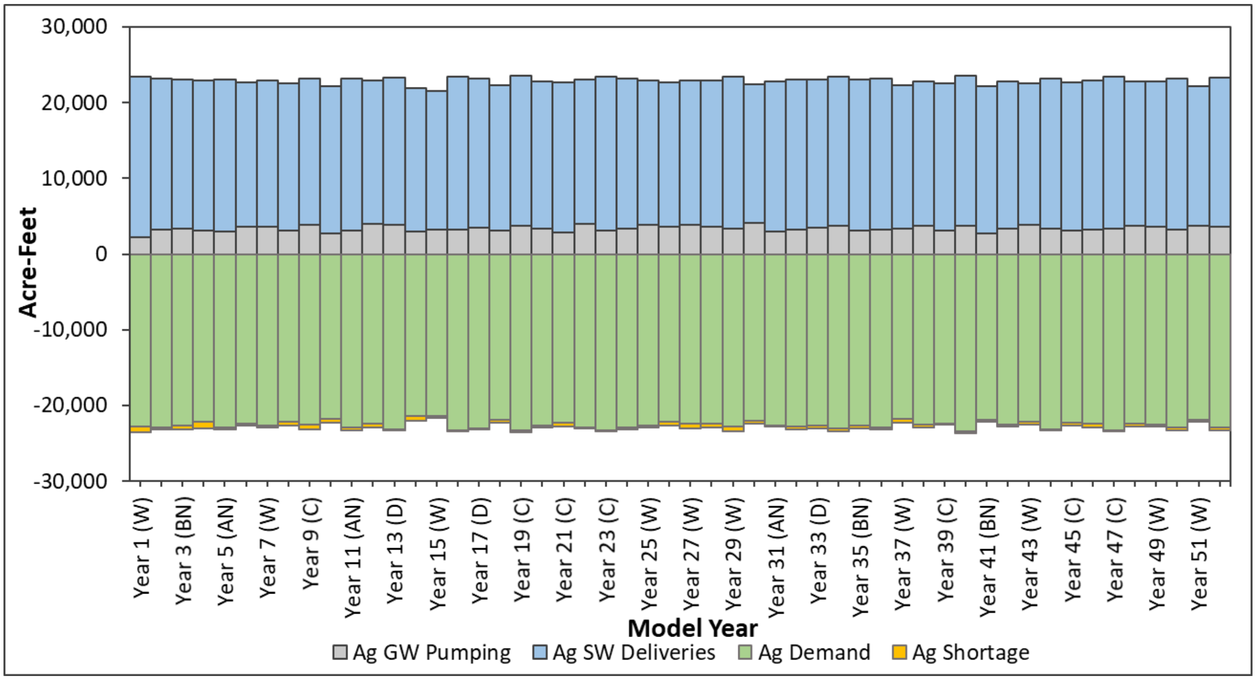


Figure 20: South Delta Water Agency GSA Projected Urban Demand

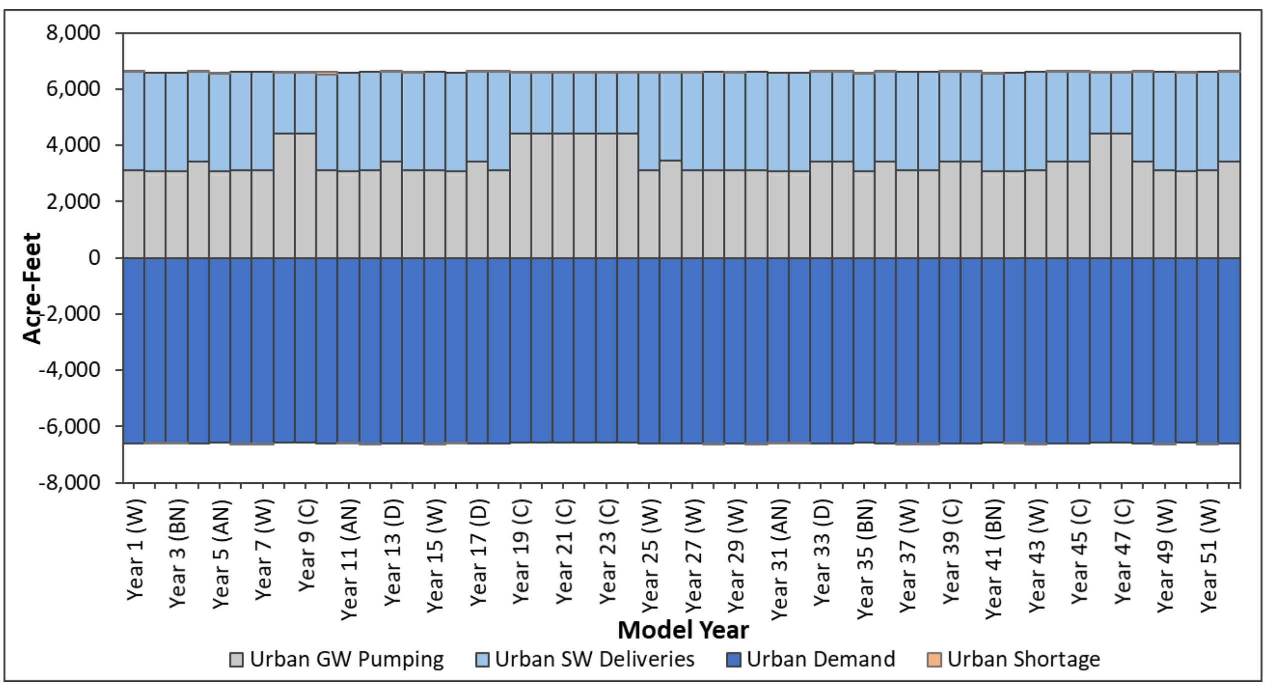


Figure 21: City of Manteca GSA Projected Urban Demand

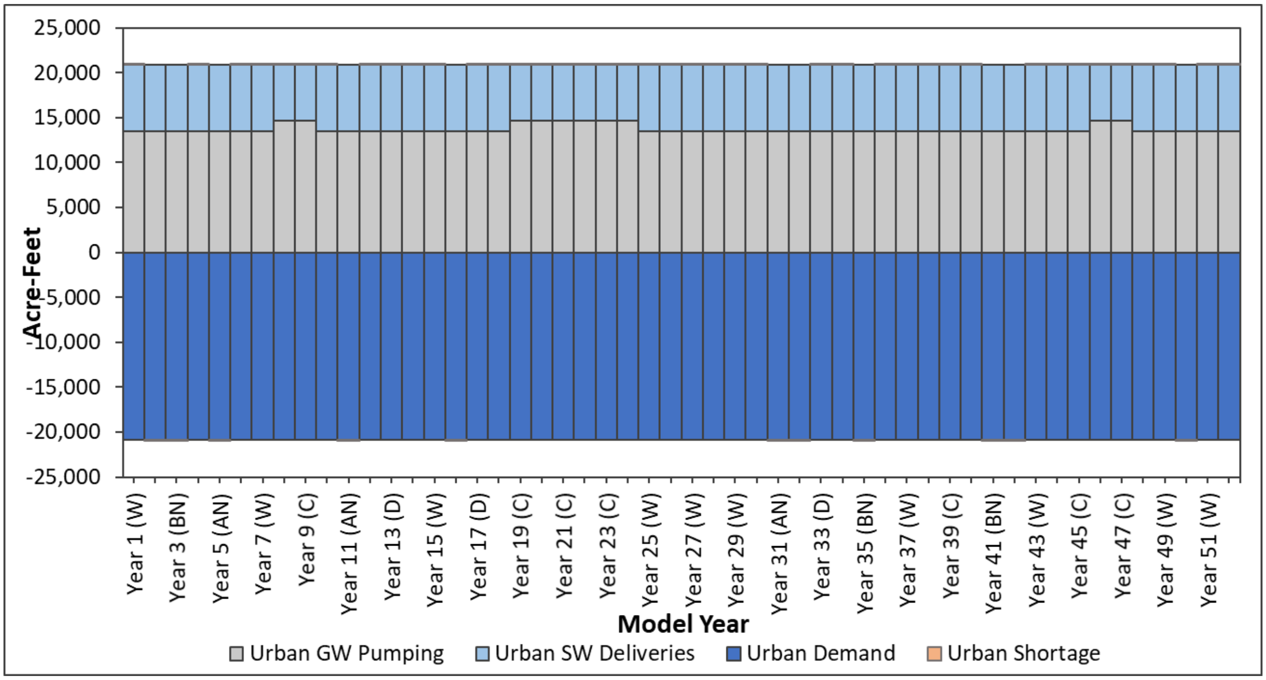


Figure 22: South San Joaquin Irrigation District GSA Projected Agricultural Demand

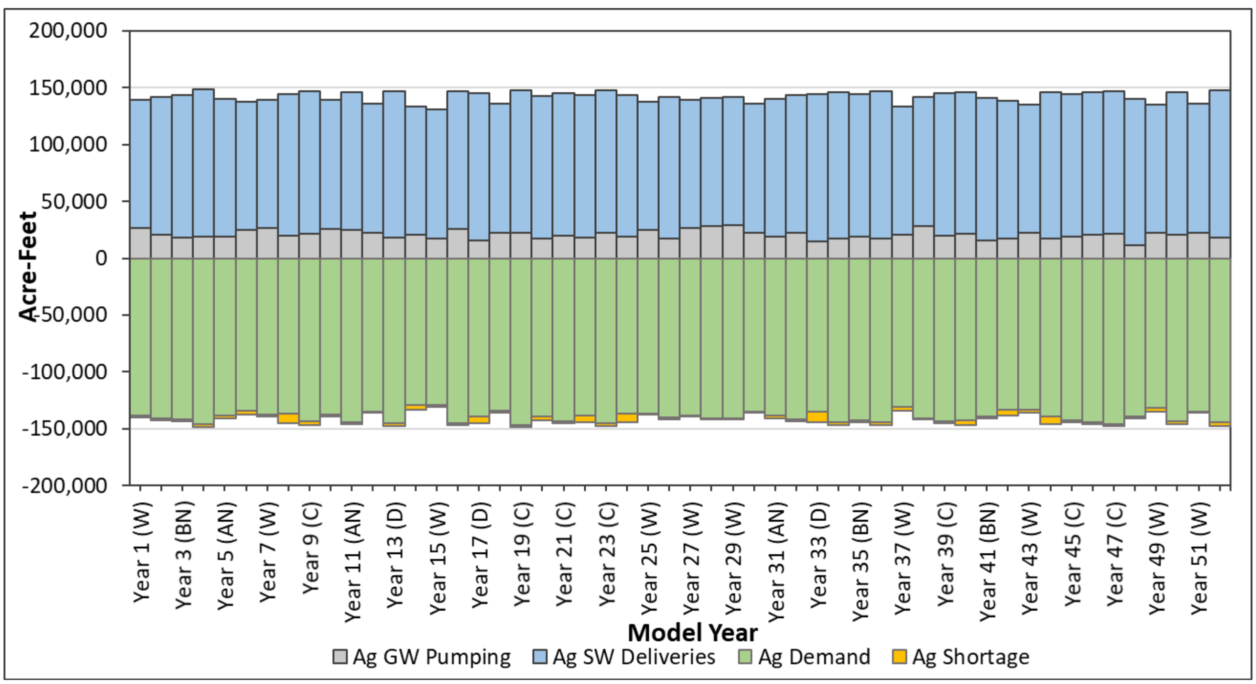


Figure 23: South San Joaquin Irrigation District GSA Projected Urban Demand

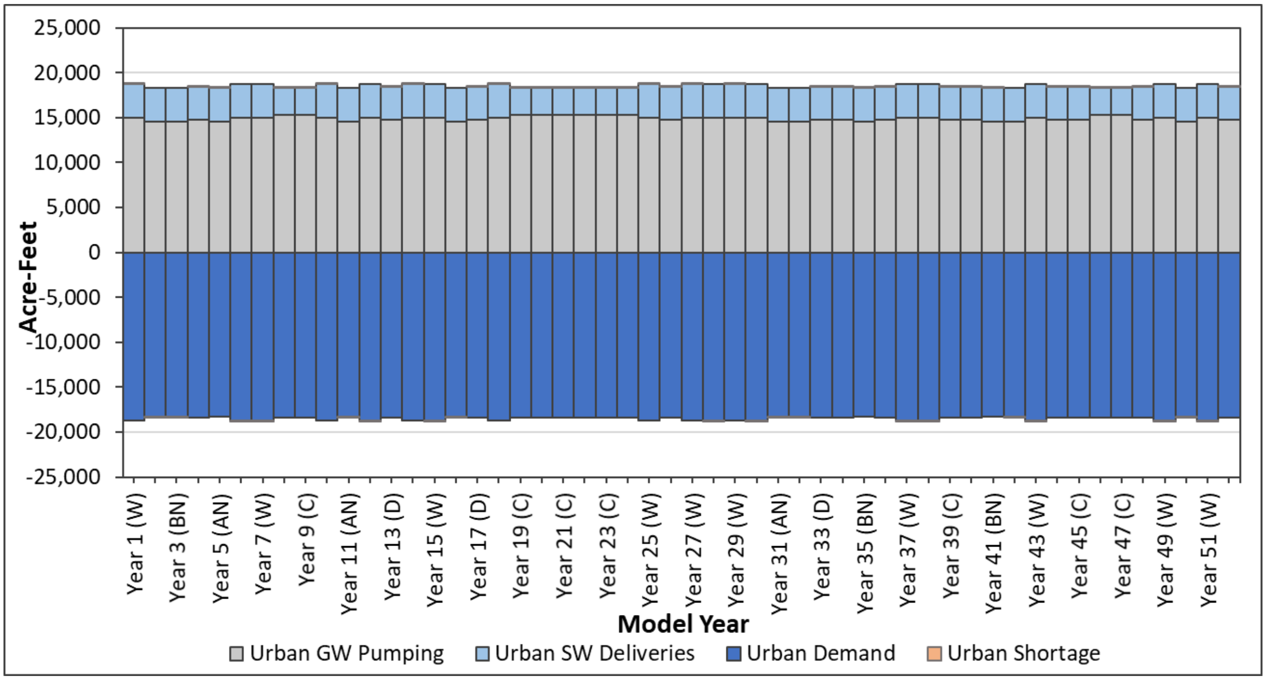


Figure 24: Oakdale Irrigation District GSA (North) Projected Agricultural Demand

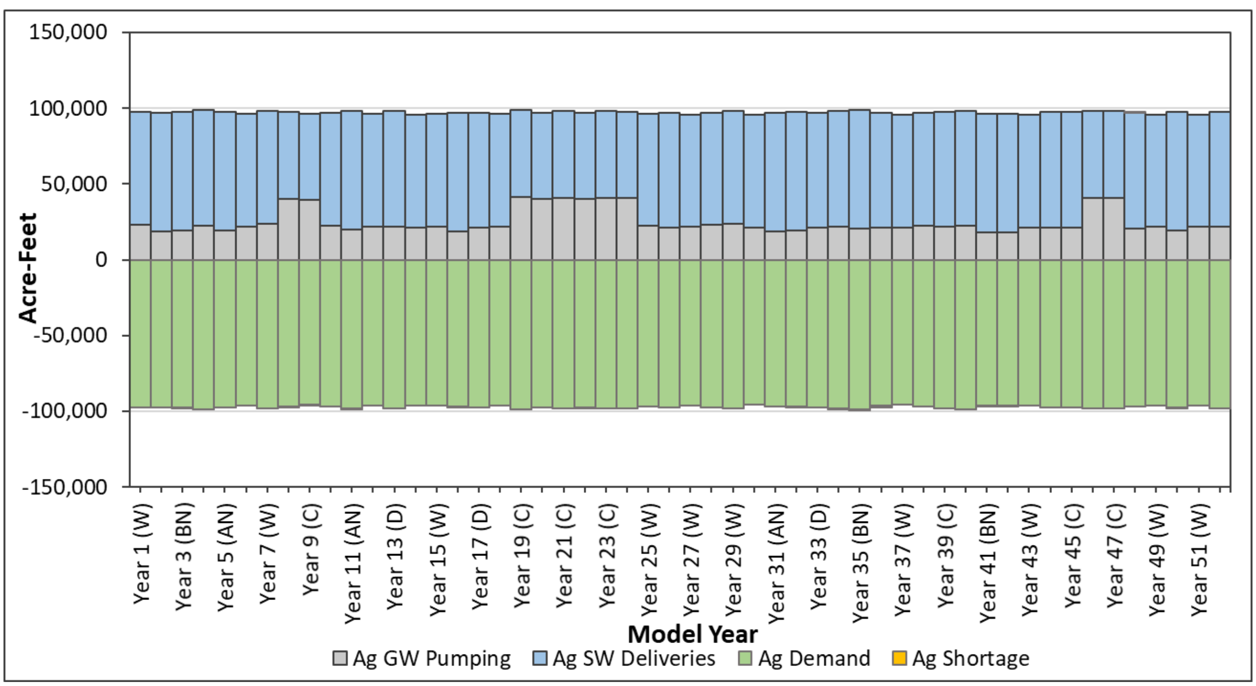


Figure 25: Oakdale Irrigation District GSA (North) Projected Urban Demand

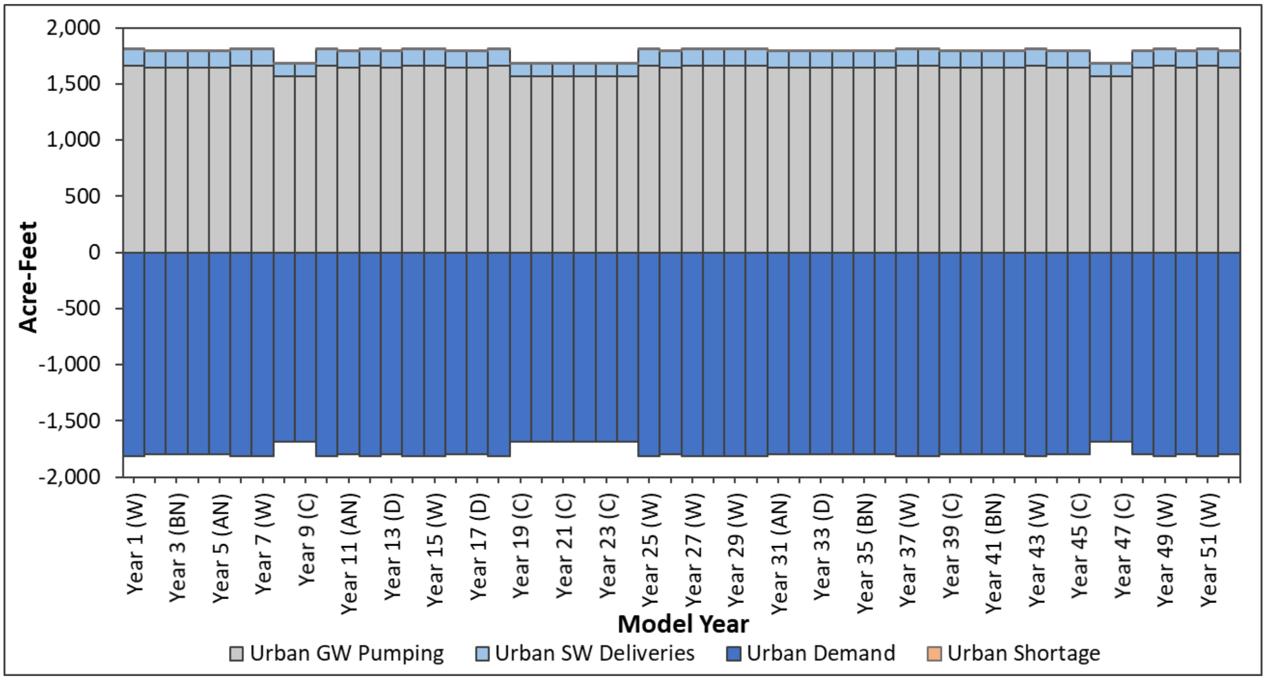


Figure 26: Oakdale Irrigation District GSA (South) Projected Agricultural Demand

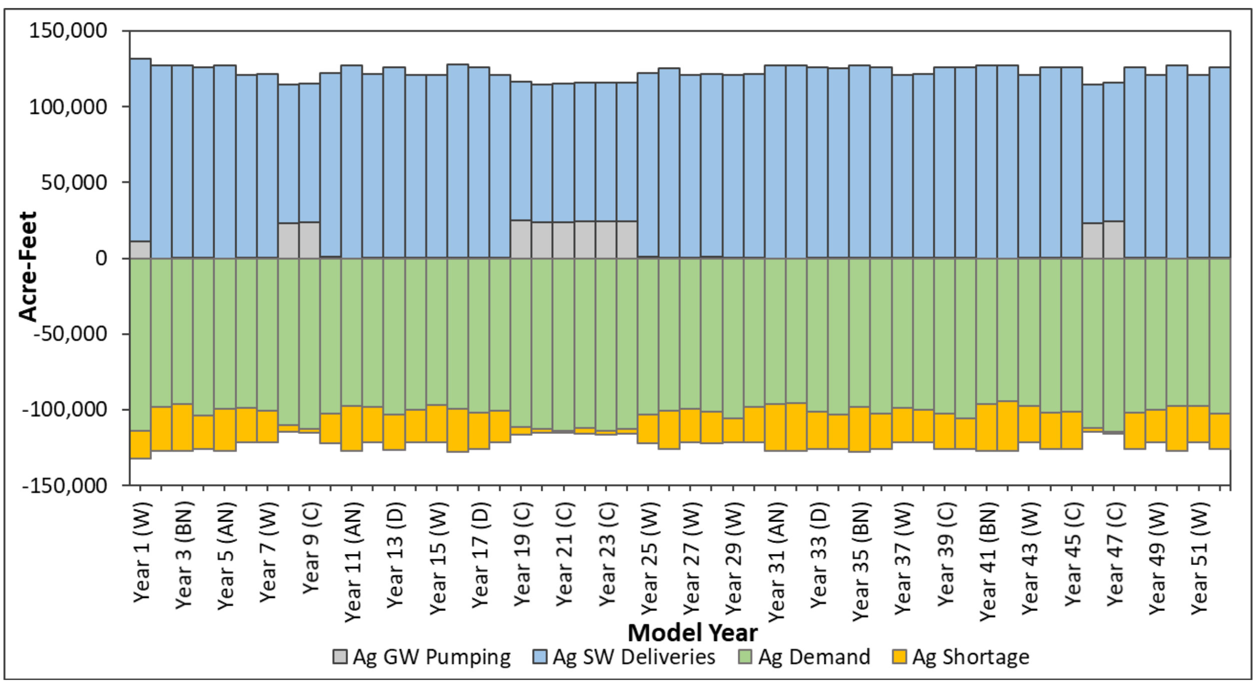


Figure 27: Oakdale Irrigation District GSA (South) Projected Urban Demand

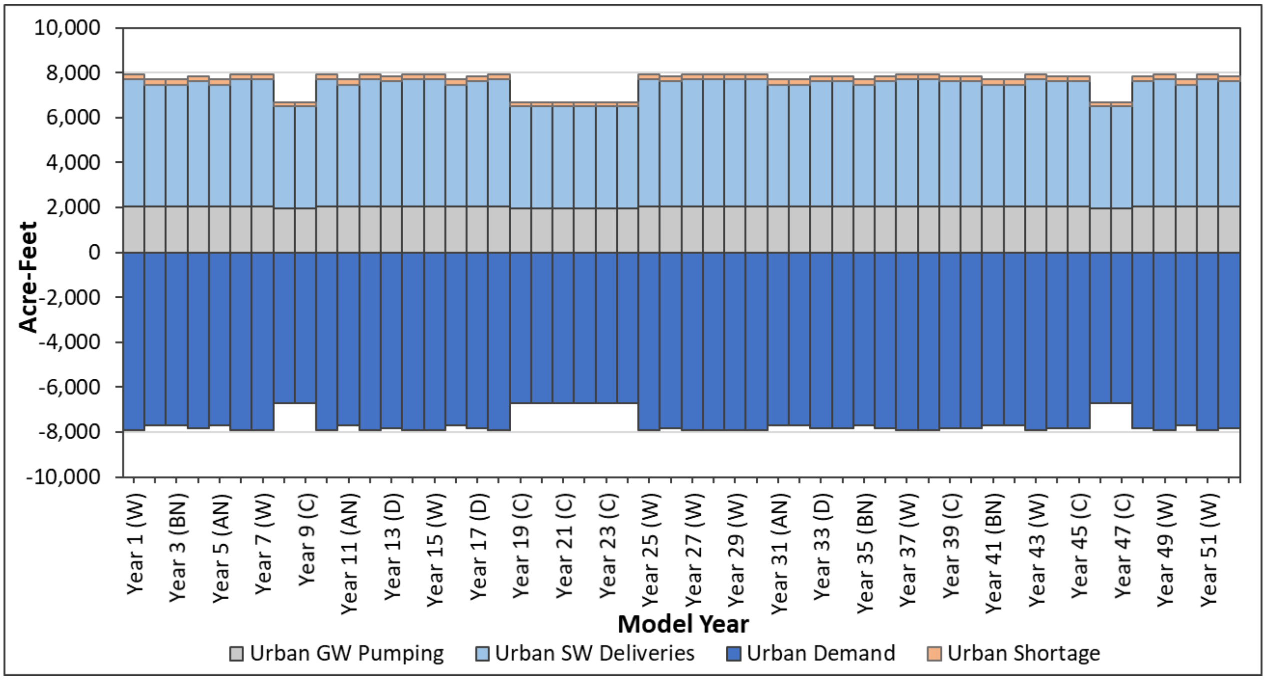


Figure 28: Eastside GSA Projected Agricultural Demand

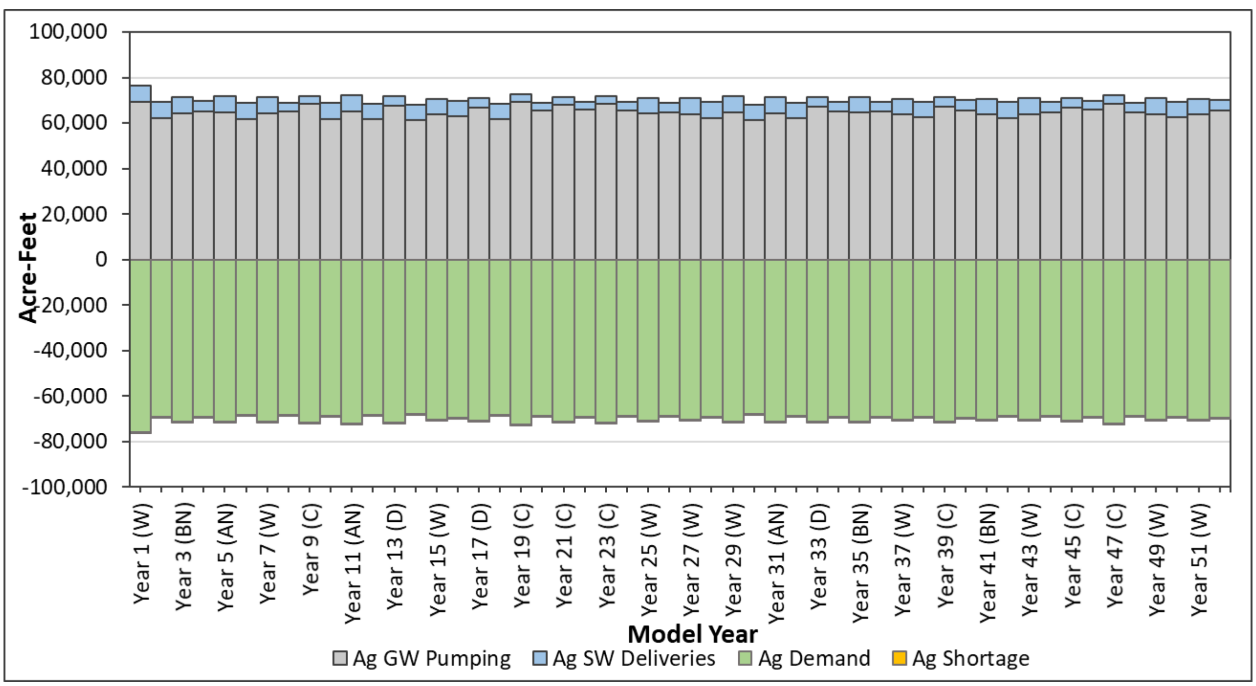
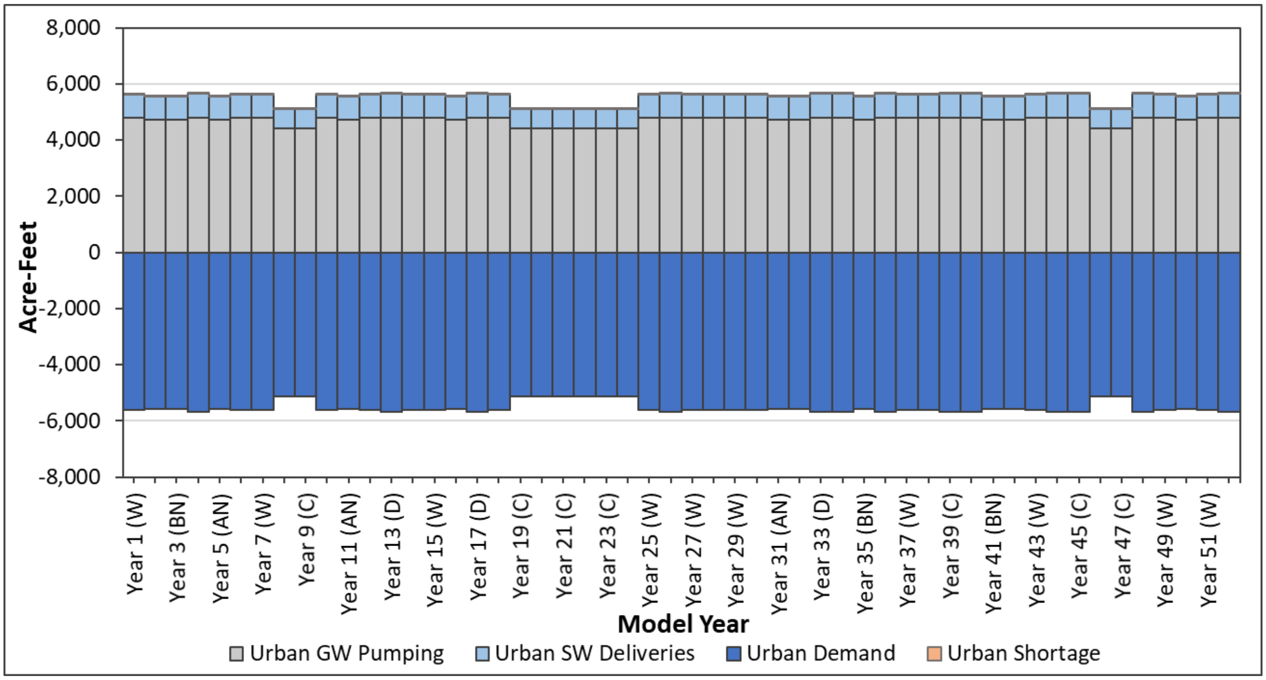


Figure 29: Eastside GSA Projected Urban Demand



APPENDIX 2-C.
EASTERN SAN JOAQUIN WATER RESOURCES MODEL (ESJWRM) REPORT VERSION 3.0 UPDATE (2024)

ATTACHMENT 2

Eastern San Joaquin Water Resources Model (ESJWRM)

Version 3.0 Update

Prepared for:

Eastern San Joaquin Groundwater Authority

October 2024

Woodard & Curran

Table of Contents

Tables

Figures

1 Acknowledgements

The development of Eastern San Joaquin Water Resources Model (ESJWRM or Model) over the years has involved a lot of stakeholders in Eastern San Joaquin Groundwater Subbasin (ESJ Subbasin or Subbasin), notably members of local Groundwater Sustainability Agencies (GSAs) and the Eastern San Joaquin Groundwater Authority (ESJGWA). All work on the ESJWRM Version 3.0 model update was presented to members of the ESJGWA's Project Management Committee (PMC). Individual GSAs were not consulted directly during this model update, but are listed below as providing data and support to the model over the years.

ESJGWA's Project Management Committee (PMC)

- Ashley Couch, Water Resources Manager of San Joaquin County
- Justin Hopkins, General Manager of Stockton East Water District (SEWD)
- Mitch Maidrand, Deputy Director of the Municipal Utilities Department of City of Stockton
- Scot Moody, General Manager of Oakdale Irrigation District (OID)
- Brandon Nakagawa, Water Resources Coordinator of South San Joaquin Irrigation District (SSJID)
- Steve Schwabauer, General Manager of North San Joaquin Water Conservation District (NSJWCD)
- Alternate: Andrew Watkins, SEWD Board Member
- Alternate: Hope Paulin, San Joaquin County Water Resources

Agricultural Water Purveyors

- Calaveras County Water District (CCWD)
- Central San Joaquin Water Conservation District (CSJWCD)
- North San Joaquin Water Conservation District (NSJWCD)
- Oakdale Irrigation District (OID)
- South San Joaquin Irrigation District (SSJID)
- Stockton East Water District (SEWD)
- Woodbridge Irrigation District (WID)

Municipal Water Purveyors

- California Water Service Company Stockton District (Cal Water)
- City of Escalon
- City of Lodi
- City of Manteca
- City of Ripon
- City of Stockton
- Linden County Water District (LCWD)
- Lockeford Community Services District (LCSD)
- Stockton East Water District (SEWD)

Woodard & Curran has served as the primary consultant in charge of updating, maintaining, calibrating, running, and processing the model results for ESJWRM since it was developed.

Woodard & Curran 2024 Project Team Working on ESJWRM Version 3.0 Update

- Ali Taghavi
- Dalia Portillo
- Emily Honn
- Katie Cole
- Leslie Dumas
- Liz DaBramo
- Nicole Koerth
- Sara Miller

2 Model Background

This section includes a history of the Eastern San Joaquin Water Resources Model (ESJWRM or Model) development and application and information on the model platform driving the calculations within ESJWRM. The ESJWRM is an integrated water resources model that simulates the surface water and groundwater conditions in the Eastern San Joaquin Groundwater Subbasin (ESJ Subbasin or Subbasin), and is developed to evaluate the recent historical, current, and estimated projected future groundwater conditions in the Subbasin. Additionally, the Model is developed to simulate projects and management actions, land and water use, and water demand and water supply scenarios under historical, current, and projected conditions, as part of the Groundwater Sustainability Plan (GSP) process to meet the Sustainable Groundwater Management Act (SGMA) regulatory requirements. The fine geographic scale of the model provides the opportunity for individual Groundwater Sustainability Agencies (GSAs) to evaluate the effect of changing conditions on local areas. The Eastern San Joaquin Groundwater Authority (ESJGWA) was formed by a Joint Powers Agreement (JPA) and coordinates the SGMA activities for the Subbasin. Various committees of the ESJGWA were involved in the development and subsequent applications of the ESJWRM. Specific information about the ESJWRM can be found in later sections.

2.1 Model Purpose

ESJWRM is a decision-making tool for the ESJ Subbasin. It can have various uses, including:

- Developing understanding of Subbasin inflows, outflows, and change in storage under variety of conditions and planning horizons (historical, current, future)
- Understanding of current and historical groundwater storage and depletions of interconnected surface water
- Estimating Subbasin sustainable yield
- Evaluating impact of demand reduction on Subbasin sustainability
- Evaluating impact of climate change on Subbasin sustainability
- Developing or evaluating Sustainable Management Criteria (SMC) for groundwater levels, groundwater storage, and depletions of interconnected surface water
- Evaluating projects and management actions needed to reach sustainability
- Providing information on Subbasin data gaps or focus needs

2.2 Historical Model Updates

The Historical ESJWRM has undergone nine updates to date, of which three were major updates:

1. **Major Update**: Development and Calibration of Historical ESJWRM Version 1.1 (WY 1995 through 2015) for November 2019 GSP
2. Extension of Data in Historical ESJWRM Version 1.1 from WY 2016 through 2019 for WY 2019 Annual Report
3. Extension of Data in Historical ESJWRM Version 1.1 through WY 2020 for WY 2020 Annual Report
4. **Major Update**: Model Update and Recalibration Resulting in Historical ESJWRM Version 2.0 (WY 1995 through 2020) for Revised June 2022 GSP

5. Extension of Data in Historical ESJWRM Version 2.0 through WY 2021 for WY 2021 Annual Report
6. Updated Monthly Agricultural Demand Distribution in Fall 2022 Resulting in Historical ESJWRM Version 2.2
7. Extension of Data in Historical ESJWRM Version 2.2 through WY 2022 for WY 2022 Annual Report
8. Extension of Data in Historical ESJWRM Version 2.2 through WY 2023 for WY 2023 Annual Report
9. **Major Update**: Model Update and Recalibration Resulting in Historical ESJWRM Version 3.0 for 2024 Periodic Evaluation and GSP Amendment

The original development of the Historical ESJWRM was completed in 2018, with application of ESJWRM for GSP development resulting in a November 2019 GSP (ESJGWA, 2019). The GSP version of the Historical ESJWRM (Historical ESJWRM Version 1.1) covers Water Years (WY) 1995 through 2015 (October 1, 1994 through September 30, 2015) and was documented in an August 2018 report (Woodard & Curran, 2018a) as well as a February 2018 technical memorandum (Woodard & Curran, 2018b). Historical ESJWRM Version 1.1 calibrated through WY 2015 was extended for the WY 2019 Annual Report and WY 2020 Annual Reports (ESJGWA, 2020; ESJGWA, 2021).

In 2021, the Historical ESJWRM was updated and recalibrated for the entire model period of record from WY 1996 through 2020. Updates to the model (Historical ESJWRM Version 2.0) are described in a 2022 report (Woodard & Curran, 2022a). Historical ESJWRM Version 2.0 was used in revisions to the GSP completed in 2022 (ESJGWA, 2022b). The time series for Historical ESJWRM Version 2.0 was extended through WY 2021 for the WY 2021 Annual Report (ESJGWA, 2022a). In late 2022, the monthly agricultural demand distribution for Historical ESJWRM was updated in select areas of the groundwater subbasin, causing slight changes to water budget numbers, but minimal differences to overall model calibration. This version, Historical ESJWRM Version 2.2, was the basis for two time series extensions through WY 2022 and WY 2023 for the WY 2022 and WY 2023 Annual Reports, respectively (ESJGWA, 2023; ESJGWA, 2024).

In 2024, the Historical ESJWRM Version 3.0 was updated and recalibrated for the entire model period of record from WY 1996 through 2023. Major changes included the revision of model layers, update of land use data, simulation of local reservoir seepage, and adjustments to surface water delivery data to several Subbasin agricultural agencies based on recent local information. This version, Historical ESJWRM Version 3.0, represents the latest base version of the historical model, which has an updated calibration for WY 1996 through 2023 and, as of this report, contains updated data through WY 2023. ESJWRM is planned to be the primary numerical model for assessment of subbasin sustainability, and as such will be maintained and updated annually for the GSP Annual Report preparation and to continue to analyze implementation and sustainability periods for the Subbasin.

2.3 Model Baseline Scenarios

The Historical ESJWRM has been the basis for other model scenarios, notably the ESJWRM Projected Conditions Baseline (PCBL). The PCBL Version 3.0 uses 55 years of hydrology data from WY 1969 through 2023 (October 1, 1968 through September 30, 2023). The PCBL represents estimated long-term hydrologic conditions of the Subbasin under the foreseeable future level of development. The future level of development represents approximately water year 2040 or the closest information available from planning documents and assumes urban buildout consistent with general plan or sphere of influence boundaries. The six baseline scenarios are listed below:

- Projected Conditions Baseline (PCBL)

- Projected Conditions Baseline with Demand Reduction (PCBL-DR)
- Projected Conditions Baseline with Category A Projects & Management Actions (PCBL-PMA)
- Projected Conditions Baseline with Climate Change (PCBL-CC)
- Projected Conditions Baseline with Climate Change and Demand Reduction (PCBL-CC-DR)
- Projected Conditions Baseline with Climate Change and Category A Projects & Management Actions (PCBL-CC-PMA)

The Current Conditions Baseline (CCBL) was previously a separate model scenario that was developed for the GSP but not maintained in the years and updates to the model since. Moving forward, the CCBL will represent a recent historical average and will be more consistent with the data reported in each Annual Report. In addition to these scenarios, the model was used for additional analysis in the 2024 GSP Amendment related to interconnected-surface water, groundwater storage, and achieving groundwater level sustainability.

2.4 Model Platform

The model platform, IWFM-2015, is maintained by the California Department of Water Resources (DWR). IWFM-2015 has had several updates since ESJWRM Version 1.1 was originally developed and the IWFM code was updated to the latest release version (IWFM-2015 Version 1443) at the time of Historical ESJWRM Version 3.0 development. New IWFM versions typically include error fixes and larger code changes that may impact the underlying calculations and therefore model results. Changes between model versions are documented on DWR's IWFM website (https://water.ca.gov/Library/Modeling-and-Analysis/Modeling-Platforms/Integrated-Water-Flow-Model) and the IWFM technical memorandums corresponding to Version 1443 are available online (Dogrul and Kadir, 2024a and 2024b).

The root zone simulation package of IWFM is called IWFM Demand Calculator (IDC) and can either be standalone or linked with IWFM. ESJWRM used the linked version of IDC for its root zone package. IDC is available on DWR's IDC website (https://water.ca.gov/Library/Modeling-and-Analysis/Modeling-Platforms/Integrated-Water-Flow-Model-Demand-Calculator) and the IDC technical memorandum is available online (Dogrul and Kadir, 2021c). The technical memorandums for IWFM and IDC include the equations that govern the flows simulated in IWFM models.

2.5 Model Reporting

The original development of ESJWRM was from 2016 through 2018, with application of ESJWRM to GSP development occurring from 2018 through 2020 and resulting in a November 2019 GSP (ESJGWA, 2019). The GSP version of the ESJWRM (ESJWRM Version 1.1), which covers Water Years (WY) 1995 through 2015 (October 1994 through September 30, 2015), was documented in an August 2018 report (Woodard & Curran, 2018a) as well as a February 2018 technical memorandum (Woodard & Curran, 2018b). The earlier reports cover the development of the model, the model platform, the model framework, and all input data and results. The 2022 model update report served as an update to the earlier model report (Woodard & Curran, 2018a) and only discussed portions of the model that were updated as part of the effort to develop Historical ESJWRM Version 2.0, PCBL Version 2.0, and PCBL-CC Version 2.0 (Woodard & Curran, 2022a). Additional documentation developed at the time as part of the 2022 Revised GSP included separate technical memoranda on ESJWRM baseline scenarios for Demand Reduction and Projects & Management Actions (Woodard & Curran, 2022b; Woodard & Curran, 2022c). These memoranda are included in this report in full and have been updated from the earlier versions. Similar to the 2022 report, this report serves as an update to the earlier model report (Woodard & Curran, 2018a; Woodard & Curran, 2022a) and only discusses portions of the model that were updated as part of the recent effort to develop ESJWRM Version 3.0 and all related scenarios.

2.6 Timeline of Model Development and Updates

Below is the timeline, complete through October 2024, of all modeling activities related to ESJWRM:

- September 2016-January 2019: Development and calibration of Historical ESJWRM (Woodard & Curran, 2018a; Woodard & Curran, 2018b)
    - Historical ESJWRM Version 1.1 (WY 1995-2015)
- March 2018-May 2019: Development of GSP scenarios (all use 50 years of hydrologic data: WY 1969-2018) (ESJGWA, 2019)
    - Current Conditions Baseline (CCBL) Version 1.0
    - PCBL Version 1.0
    - PCBL-DR Version 1.0
    - PCBL-CC Version 1.0
- March 2020: Historical model extension for GSP Annual Report (ESJGWA, 2020)
    - Historical ESJWRM Version 1.2 (WY 1995-2019)
- March 2021: Historical model extension for GSP Annual Report (ESJGWA, 2021)
    - Historical ESJWRM Version 1.3 (WY 1995-2020)
- July 2021-January 2022: Update and recalibration of Historical ESJWRM (WY 1995-2020) (Woodard & Curran, 2022a)
    - Historical ESJWRM Version 2.0 (WY 1995-2020)
- March 2022: Historical model extension for GSP Annual Report (ESJGWA, 2022a)
    - Historical ESJWRM Version 2.0 (WY 1995-2021)
- January 2022-May 2022: Updates to scenarios for revised GSP based on updates to Historical ESJWRM Version 2.0 (all use 52 years of hydrologic data: WY 1969-2020)
    - PCBL Version 2.0 (Woodard & Curran, 2022a)
    - PCBL-DR Version 2.0 (Woodard & Curran, 2022c)
    - PCBL-CC Version 2.0 (Woodard & Curran, 2022a)
    - PCBL-CC-DR Version 2.0 (Woodard & Curran, 2022c)
    - PCBL-PMA Version 2.0 (Woodard & Curran, 2022b)
    - PCBL-CC-PMA Version 2.0 (Woodard & Curran, 2022b)
- September 2022-December 2022: Updates to monthly agricultural demand distribution for Historical ESJWRM
    - Historical ESJWRM Version 2.2 (WY 1995-2020)

- January 2023: Updates to PCBL based on monthly agricultural demand distribution made in Historical ESJWRM Version 2.2 (52 years of hydrologic data: WY 1969-2020)
    - PCBL Version 2.1
- March 2023: Historical model extension for GSP Annual Report (ESJGWA, 2023)
    - Historical ESJWRM Version 2.2 (WY 1995-2022)
- March 2024: Historical model extension for GSP Annual Report (ESJGWA, 2024)
    - Historical ESJWRM Version 2.2 (WY 1995-2023)
- December 2023-May 2024: Update and recalibration of Historical ESJWRM (WY 1995-2023)
    - Historical ESJWRM Version 3.0 (WY 1995-2023)
- April-July 2024: Updates to scenarios based on updates to Historical ESJWRM Version 3.0 (all use 55 years of hydrologic data: WY 1969-2023)
    - PCBL Version 3.0
    - PCBL-DR Version 3.0
    - PCBL-PMA Version 3.0
    - PCBL-CC Version 3.0
    - PCBL-CC-DR Version 3.0
    - PCBL-CC-PMA Version 3.0
    - Use of Historical ESJWRM and PCBL related to interconnected surface water and groundwater storage

3 Historical Calibration Update

The Eastern San Joaquin Water Resources Model (ESJWRM or Model) was developed primarily to evaluate the current and recent historical groundwater conditions of the Eastern San Joaquin Groundwater Subbasin (ESJ Subbasin or Subbasin) and simulate various current and future condition scenarios as part of the Groundwater Sustainability Plan (GSP) preparation process under the Sustainable Groundwater Management Act (SGMA) (Woodard & Curran, 2018a). The fine geographic scale of the model provides the opportunity for individual Groundwater Sustainability Agencies (GSAs) to evaluate the effect of changing ESJ Subbasin conditions on smaller GSA areas. The Eastern San Joaquin Groundwater Authority (ESJGWA) was formed by a Joint Powers Agreement (JPA) and coordinates the SGMA activities for the Subbasin. The ESJGWA members include the 16 GSAs in the Subbasin.

As discussed in the section above, this report builds off of the earlier documents covering the Historical ESJWRM (Woodard & Curran, 2018a; Woodard & Curran, 2022a) and serves as an update the previous documentation and includes all updates made to the Historical ESJWRM Version 3.0 since the Historical ESJWRM Version 2.0 model report.

3.1 Purpose of Historical ESJWRM Version 3.0 Update

There were many factors driving the update of the historical ESJWRM in 2024. These factors included:

- Responding to Recommended Corrective Actions (RCAs) from the Subbasin's 2020 GSP and 2022 Revised GSP
- Using the latest data and understanding for the preparation of the Periodic Evaluation and GSP
    - Extending hydrology through Water Year 2023
    - Using Airborne Electromagnetic (AEM) data to refine model layering and stratigraphy
    - Using latest publicly released statewide land use data (DWR Statewide Crop Mapping for 2022)
    - Updating distribution of rural residential urban demand within model
    - Understanding of demand reduction, projects & management actions, minimum thresholds, and interconnected surface water
- Updated tool to help understand and analyze conditions for the Subbasin or local agencies within the Subbasin

3.2 Current Conditions Baseline

The Current Conditions Baseline (CCBL) was previously a separate model scenario that was developed for the GSP but not maintained in the years and updates to the model since. Moving forward, the CCBL will represent a recent historical average and will be more consistent with the data reported in each Annual Report. Current conditions in Version 3.0 are represented as an average of the last five water years (2019-2023) in Historical ESJWRM Version 3.0. This includes three (3) dry years and two (2) wet years.

3.3 Model Code and Data Updates Since 2022 Revised Groundwater Sustainability Plan

Since the Historical ESJWRM Version 2.0 was finalized in 2022 (documented in Woodard & Curran, 2022a), there have been several updates to the model:

1. Updates to monthly agricultural demand distribution for Historical ESJWRM resulting in Historical ESJWRM Version 2.2 (WY 1995-2020)
2. Extension of Data through Water Year 2021
3. Extension of Data through Water Year 2022
4. Extension of Data through Water Year 2023
5. Model Update and Recalibration in 2024 (resulting in Historical ESJWRM Version 3.0)

In late 2022, the monthly agricultural demand distribution for Historical ESJWRM Version 2.0 was updated in select areas of the groundwater subbasin, causing slight changes to water budget numbers, but minimal differences to overall model calibration. Historical ESJWRM Version 2.2 was the result of edits to the minimum soil moisture for select crops, target soil moisture for several crops, and soil hydraulic conductivity by GSA. Additionally, several agricultural diversions were re-distributed to monthly values based on monthly demand averages. The changes to the model resulted in minor impacts to agricultural areas and focused on the monthly distribution of agricultural demand and supply in the model. The calibration of Historical ESJWRM Version 2.2 was consistent with Historical ESJWRM Version 2.0 as documented (Woodard & Curran, 2022a).

The next three updates were completed as part of the preparation of ESJ Subbasin GSP Annual Reports to the DWR. These updates included only an extension of model time series data (i.e., land use, surface water diversions, groundwater well pumping, and urban demand) and the model provided estimates of total surface water supplies, groundwater pumping, and change in groundwater storage for the water year covered by the model report. Updated data came from public sources for updated hydrology and from GSAs and Subbasin agencies for local water supplies. Below is a list of the agencies sent data requests for updates to model data:

Agricultural Water Purveyors

- Calaveras County Water District (CCWD)
- Central San Joaquin Water Conservation District (CSJWCD)
- North San Joaquin Water Conservation District (NSJWCD)
- Oakdale Irrigation District (OID)
- South San Joaquin Irrigation District (SSJID)
- Stockton East Water District (SEWD)
- Woodbridge Irrigation District (WID)

Municipal Water Purveyors

- California Water Service Company Stockton District (Cal Water)
- City of Escalon
- City of Lodi
- City of Manteca
- City of Ripon

- City of Stockton
- Linden County Water District (LCWD)
- Lockeford Community Services District (LCSD)
- Stockton East Water District (SEWD)

Work on Historical ESJWRM Version 3.0 began in late 2023 and had the goals to update select datasets in the model, most notably the model layering by utilizing AEM survey data. The updates to Historical ESJWRM Version 3.0 were managed under the guidance of the ESJGWA's Project Management Committee (PMC), The PMC was comprised of the following members, with representatives from most of the largest water districts in the Subbasin:

- Ashley Couch, Water Resources Manager of San Joaquin County
- Justin Hopkins, General Manager of Stockton East Water District (SEWD)
- Mitch Maidrand, Deputy Director of the Municipal Utilities Department of City of Stockton
- Scot Moody, General Manager of Oakdale Irrigation District (OID)
- Brandon Nakagawa, Water Resources Coordinator of South San Joaquin Irrigation District (SSJID)
- Steve Schwabauer, General Manager of North San Joaquin Water Conservation District (NSJWCD)
- Alternate: Andrew Watkins, SEWD Board Member
- Alternate: Hope Paulin, San Joaquin County Water Resources

3.3.1 IWFM Version

The model platform, IWFM-2015, has had several updates since Historical ESJWRM Version 2.0 was developed and the IWFM code has been updated to the latest release version (IWFM-2015 Version 1443) for Historical ESJWRM Version 3.0. New IWFM versions typically include error fixes and larger code changes that may impact the underlying calculations and therefore model results. Changes between model versions are documented on DWR's IWFM website (https://water.ca.gov/Library/Modeling-and-Analysis/Modeling-Platforms/Integrated-Water-Flow-Model) and the latest IWFM technical memorandums are available online (Dogrul and Kadir, 2024a and 2024b). Since Historical ESJWRM Version 3.0 was finalized, an updated IWFM-2024 Version 1594 was released. The impact of the model code changes will be evaluated in a future model update.

3.3.2 Hydrologic Period

The updated Historical ESJWRM Version 3.0 simulates water years 1995 through 2023 (October 1, 1994 through September 30, 2023). Most of the time series extensions took place during the model updates for the GSP Annual Reports, but are repeated in the sections below to fully document updates since Historical ESJWRM Version 2.0. These updates are listed in the sections below.

3.3.3 Precipitation

Consistent with previous ESJWRM reports, rainfall data for the model area is derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) database used in the DWR's CALSIMETAW (California Simulation of Evapotranspiration of Applied Water) model. The database contains daily precipitation data from October 1, 1921 on a 4-kilometer grid throughout the model area (OSU, 2024). ESJWRM has monthly rainfall data defined for every model element and adjacent foothill watershed in order to preserve the spatial distribution of the monthly rainfall. Each of the model elements was mapped to the nearest of 364 available PRISM reference nodes, uniformly distributed across the model domain. Historical ESJWRM Version 3.0 includes the mapped precipitation time series for water years 2016 through 2023.

3.3.4 Stream Inflow

Stream inflows to the model were extended using updated data from United States Geological Survey (USGS) stream gages and the United States Army Corps of Engineers (USACE) reservoir releases. Dry Creek, with data estimated using a regression after January 1998, was updated using recent monthly averages for similar water year types. At the time of the WY 2023 model report update, gage data for Mokelumne River and Stanislaus River were unavailable, so data for WY 2023 was updated using recent monthly averages for similar water year types. SSJID system outflows to Stanislaus River was extended using recent averages by aggregated water year types (wet, dry, and normal). A table of stream input data may be found in Table 1.

Table 1: Summary of ESJWRM Stream Inflow Data in Historical ESJWRM Version 3.0

Stream	Stream Node	Source	Gage Name	Period of Record	Average Annual Streamflow (acre-feet)
Cosumnes River	1	USGS	USGS 11335000: Cosumnes River at Michigan Bar, CA	October 1907 to present/ongoing	401,000
Dry Creek	140	USGS	Estimated in C2VSim by correlation with USGS 11329500: Dry Creek near Galt, CA	Not continuous October 1926 to December 1997	28,000
		USGS	Estimated in C2VSim by correlation with USGS 11335000: Cosumnes River at Michigan Bar, CA	Used October 1987 to September 1995 and January 1998 to September 2015	
		n/a	Average of Historical Data by Month and Water Year Type	Used October 2015 to present/ongoing	
Mokelumne River	290	USGS	USGS 11323500: Mokelumne River below Camanche Dam, CA	October 1904 to present/ongoing	550,000
Calaveras River	758	USGS	USGS 11308900: Calaveras River below New Hogan Dam near Valley Springs, CA	February 1961 to September 1990	162,000
		USACE	New Hogan Dam releases	October 1990 to present/ongoing	
Stanislaus River	1033	USGS	USGS 11302000: Stanislaus River below Goodwin Dam near Knights Ferry, CA	February 1957 to present/ongoing	577,000

Stream	Stream Node	Source	Gage Name	Period of Record	Average Annual Streamflow (acre-feet)
Tuolumne River	1248	USGS	USGS 11289650: Tuolumne River below Lagrange Dam near Lagrange, CA	October 1970 to present/ongoing	901,000
San Joaquin River	1497	USGS	USGS 11303500: San Joaquin River near Vernalis, CA	October 1923 to present/ongoing	3,145,000
SSJID System Outflows to Stanislaus River	1212	SSJID	n/a	n/a	24,000

3.3.5 Land Use and Cropping Patterns

Historical ESJWRM Version 3.0 update represents a larger shift in land use methodology than that described in previous updates. As a result, the land use data is described in full with text pulled from the Historical ESJWRM Version 1.1 model report (Woodard & Curran, 2018b).

For the model to calculate water supply requirements, every model element needs to have land use defined for every year of the simulation. Historical ESJWRM Version 3.0 uses the same land use categories as previous Historical ESJWRM versions and includes 23 irrigated crop categories and 3 general land use categories. All of the irrigated crop categories except for rice are simulated as non-ponded crops, meaning they are grown without standing water. Rice is simulated as both no decomposition (assumed 20% of total rice area) and flooded decomposition (assumed 80% of total rice area) to represent the current understanding of local growing practices. The general land use categories include urban landscape (e.g., residential areas, golf courses, and school fields), riparian vegetation (e.g., native vegetation located near surface water), and native vegetation. The irrigated crop categories were combined into 6 high-level groupings of crops with similar water use or irrigation practices. Table 2 lists the land use categories.

Table 2: Land Use Categories in Historical ESJWRM Version 3.0

Land Use Type	Model Category	Grouped Categories
Irrigated Crops	Almonds Cherries Citrus & Subtropical Other Orchard Pistachios Walnuts	Fruit and Nut Trees
	Vineyards	Vineyards
	Alfalfa Pasture	Alfalfa and Irrigated Pasture
	Grain	Grain

Land Use Type	Model Category	Grouped Categories
	Corn Cotton Dry Beans Field Crops Safflower Sugar Beets	Field Crops
	Cucurbits Onion & Garlic Potatoes Tomato Fresh Tomato Processing Truck Crops	Truck Crops
	Rice	Rice
Other Land Use	Urban Landscape Riparian Vegetation Native Vegetation	

Spatial land use data was used to specify land use types and crop acreages for each model element for each year. The major reference sources include DWR land use surveys, CropScape, DWR statewide crop mapping (previously referred to as LandIQ), and local information (including discussions with GSAs and referencing agricultural water management plans). Crop categories are not consistent across all the land use data sources, so individual mappings were developed to pair each crop type to a specific model land use category. The primary goal of the land use update for Historical ESJWRM Version 3.0 was to analyze and incorporate the recent statewide crop mapping provided by DWR. Previous updates had only briefly looked at and incorporated WY 2014 and WY 2016 data. The sources for land use data investigated are described below.

- Periodic land use surveys for each county by DWR. Surveys include over 70 different crop categories, as well as urban and native vegetation, for each parcel or field (DWR, 1993-2000). DWR land use surveys are regarded to have high accuracy due to extensive ground truthing. ESJWRM uses parts of county surveys from 1993 through 2000 to represent WY 1995 in the model, as explained further below.

- USDA's remote sensing CropScape data is an annual dataset beginning in 2007 available for the entire country (USDA NASS, 2007-present). CropScape includes 256 land use categories that come from annual satellite imagery collected during the growing season on 30-meter by 30-meter pixels. Based on reports on the CropScape website, the level of accuracy for this data is about 85-97% for crop-specific land cover categories. Although this level of accuracy is relatively high, the accuracy varies depending on many factors, including the time of the satellite image, growing season timing, cloud cover, type of crop, and maturity state of the crop.

- Beginning in 2014, DWR retained Land IQ to develop a statewide assessment of agricultural land use in summer 2014. Land IQ used remote sensing methods to collect and process the data at the parcel scale, which was then ground truthed for a reported overall accuracy of 96.6% (DWR, 2014). Land IQ did not include a native vegetation category, so any blank land was assumed to be native vegetation. DWR contracted to produce the data more regularly and to date has published statewide land use data for 2014, 2016, 2018, 2019, 2020, 2021, and 2022.

With five consecutive years of DWR statewide surveys (2018-2022), several data sources used in the Historical ESJWRM Version 1.1 and Version 2.0 appeared to be inconsistent with the latest data from DWR in terms of cropping acreages and distribution of crops. For more consistency in cropping patterns and agricultural demand in the ESJWRM, the 2014 statewide crop mapping from DWR and the 2007-2015 CropScape data was removed from the model and replaced by interpolated acreages, as discussed in more detail below. Moving forward, the DWR statewide crop mapping will be processed and put in the model as updated data is available.

For ESJWRM, the land use surveys by county conducted by DWR were merged and assumed to represent water year 1995 in the model (Figure 1). Urban extent for this land dataset was reviewed and updated since county surveys had previously labeled roads as urban areas, but DWR statewide crop mapping did not include roads in the surveyed areas (so they were assumed to be native vegetation). The county land use surveys gave the impression of urban acreage decreasing during the model time period, which is inconsistent with local knowledge, so the urban acreage for 1995 was updated based on the extent of urban area in DWR statewide survey for 2022. The county surveys used to represent WY 1995 include:

1. San Joaquin County (1996)
2. Sacramento County (1993)
3. Amador County (1997)
4. Calaveras County (2000)
5. Stanislaus County (1996)

Along with the county surveys DWR uses for WY 1995, ESJWRM uses the DWR statewide crop mapping spatial data for 2016, 2018, 2019, 2020, 2021, and 2022. At the time of the Historical ESJWRM Version 3.0 development, 2023 data statewide crop mapping data was not yet available. Since there was no statewide crop mapping for 2017, 2016 land use is assumed to cover 2017 as well. Similarly, until 2023 statewide crop mapping is available, 2022 land use is assumed to represent 2023 as well.

To fill the gap between 1995 and 2016, all land use and crop categories that were originally from the USDA CropScape database were replaced and interpolated at the element level spatial resolution for each year. Thus, the geographic distribution of interpolated land use and cropping patterns are honored.

Historical ESJWRM Version 2.2 update included revisions to the Subbasin's two smallest GSAs, LCSD and LCWD, based on coordination with the GSAs. Due to the small size of these GSAs, model elements did not exactly align with GSA boundaries, so agricultural land use associated with the surrounding districts, NSJWCD for LCSD and SEWD for LCWD, was included in elements representing these two small urban communities. In discussions with the GSAs, it was agreed that the agricultural land use would be removed from model elements assigned to LCSD (15 elements) and LCWD (5 elements). In total, this edit impacted an average of 250 acres per year.

Figure 1 and Figure 2 show the spatial distribution of the land use categories in the Subbasin for 1995 and 2022. Figure 3 and Figure 4 show the pie charts of annual crop acreages in the Subbasin by grouped crop category for 1995 and 2022. Figure 5 shows the annual trends of all land use categories in the ESJ Subbasin and Figure 6 shows the annual trends of just grouped crop acreages in the Subbasin. Figure 5 shows how urban acreage and crops as a whole increased in the Subbasin from 1995 to 2022, with native vegetation decreasing. Figure 6 makes the linear interpolation between 1995 and 2016 clear and shows how there are small changes even among the statewide crop mapping datasets from year to year, which are expected to continue as new datasets are added to the model.

Overall, land use trends from 1995 through 2023 show a 4.7% increase in total and irrigated agricultural acreage, with about 380,000 irrigated acres in ESJ Subbasin at the beginning of simulation and about 398,000 acres with agricultural production by 2023. . As shown in Figure 3 and Figure 4, fruit and nut trees show the largest growth, both in terms of acreage and in terms of the proportion of the total crops in the Subbasin.

Historical ESJWRM Version 3.0 changes to the land use methodology overall included changes to the total agricultural land as a result of removing CropScape data from 2007-2015 and reducing urban acreage in the 1995 dataset caused by the transfer of roads from urban to native vegetation in order to be more consistent with the methodology of the recent DWR statewide crop mapping. As shown in Figure 7, the urban acreage is reduced by 23,000 acres in 1995 and all of it becomes native vegetation, which increases by 23,000 acres in 1995. The removal of CropScape data leads to impacts to the agricultural area, native vegetation, and urban area, and changes in CropScape years leads to differences in the linear interpolation years between 1995 and 2007.

Figure 1: 1995 Land Use in Historical ESJWRM Version 3.0

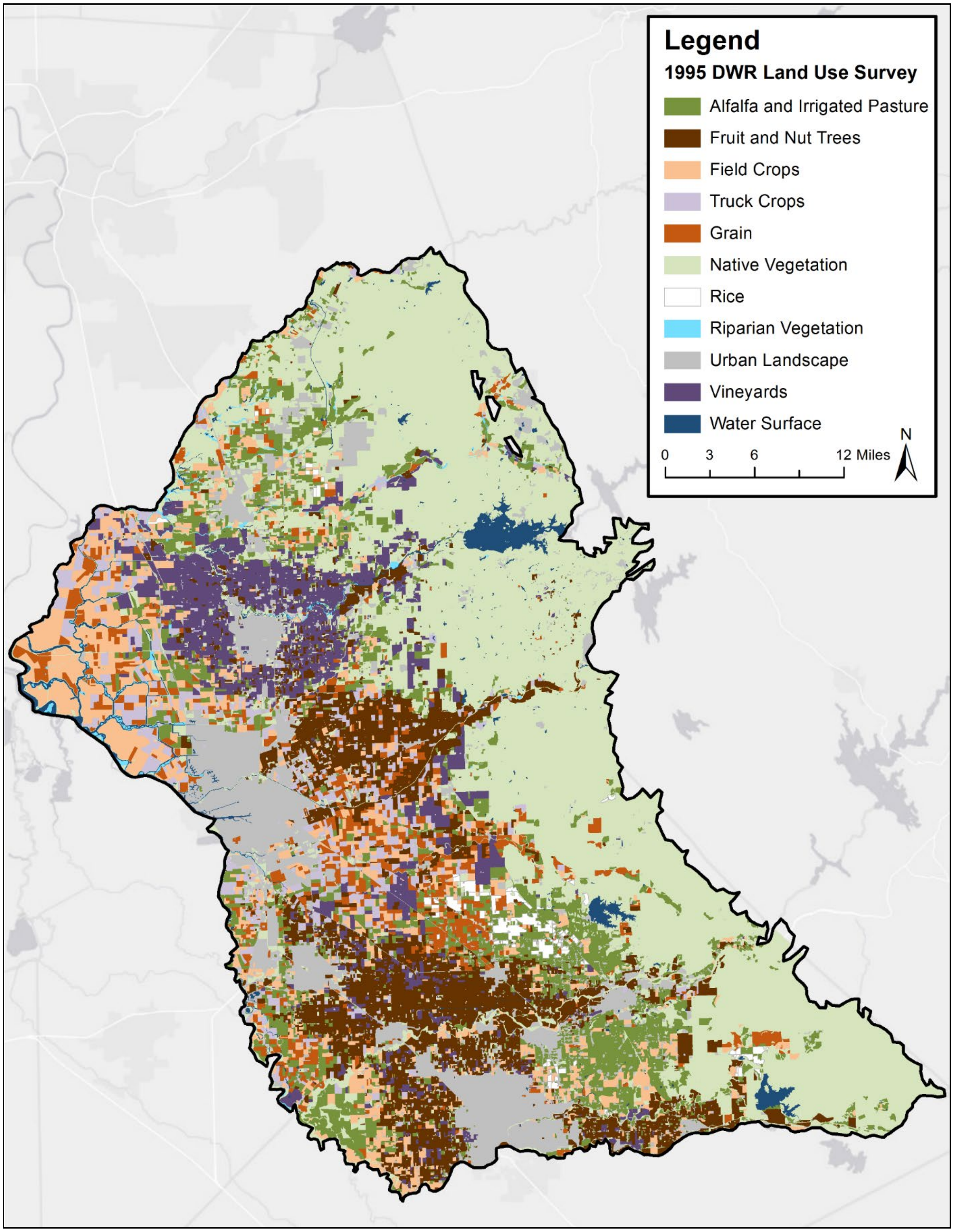


Figure 2: 2022 Land Use in Historical ESJWRM Version 3.0

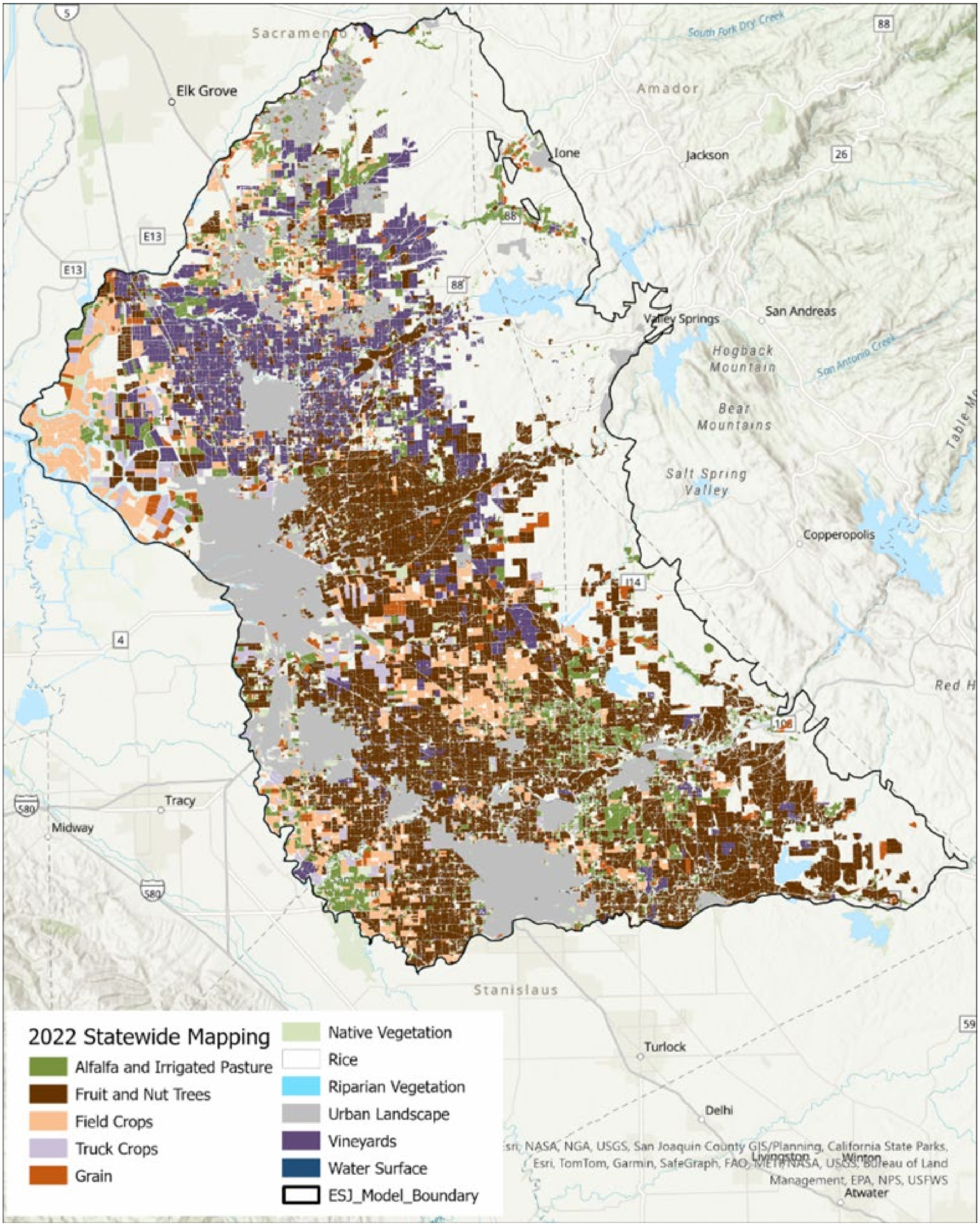


Figure 3: 1995 Grouped Crop Acreage for ESJ Subbasin in Historical ESJWRM Version 3.0

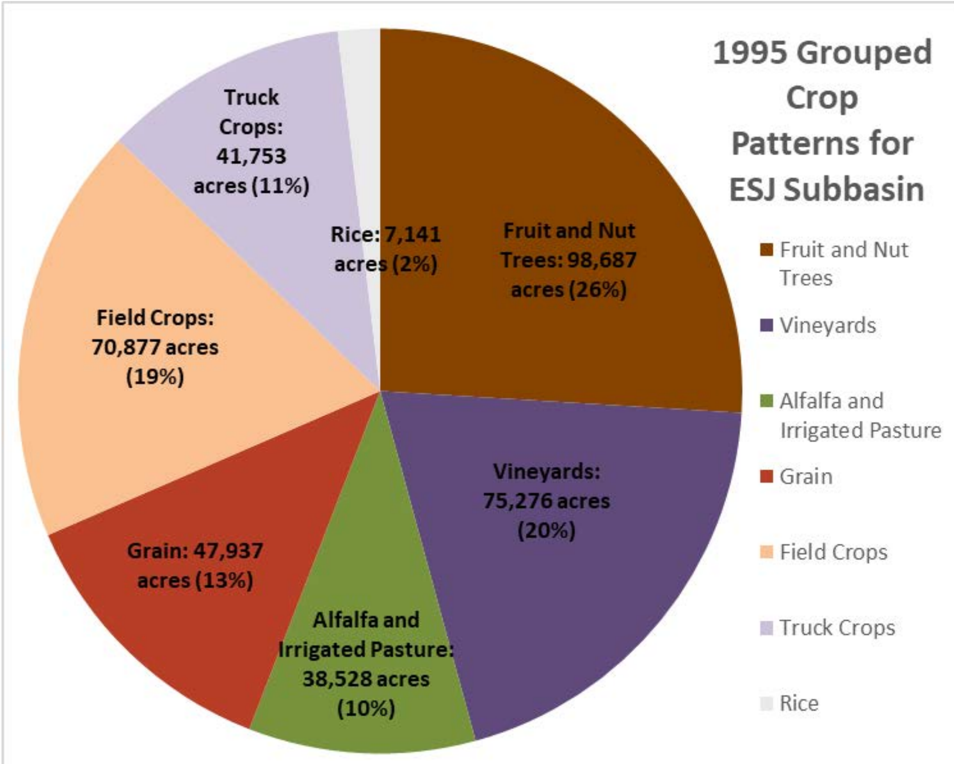


Figure 4: 2022 Grouped Crop Acreage for ESJ Subbasin in Historical ESJWRM Version 3.0

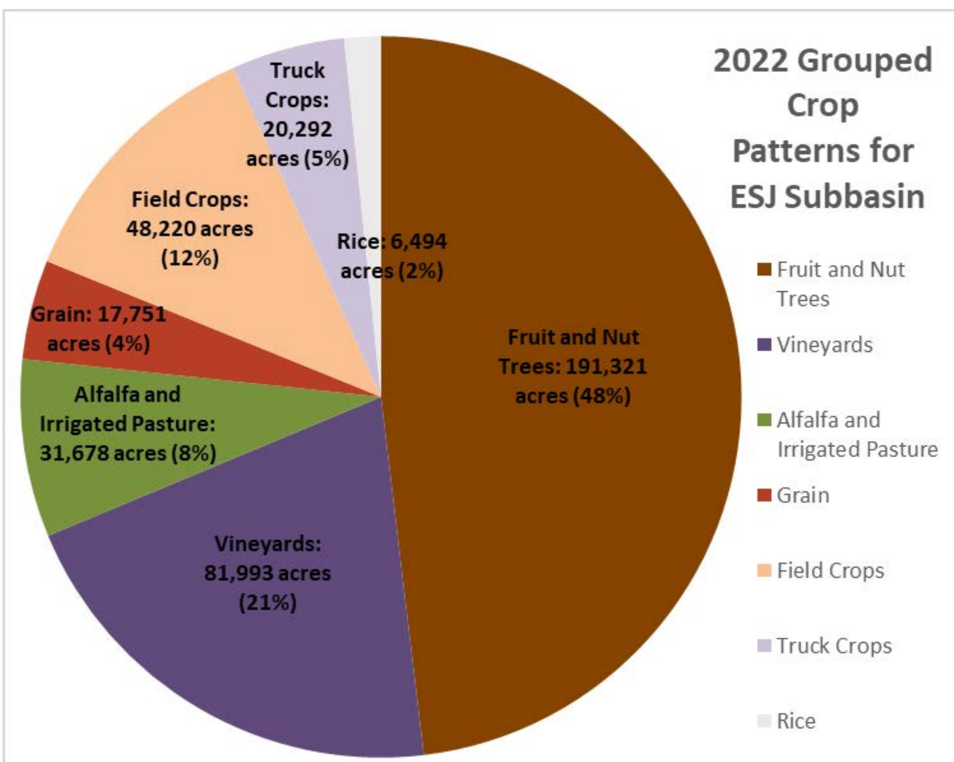


Figure 5: Annual Land Use for ESJ Subbasin in Historical ESJWRM Version 3.0

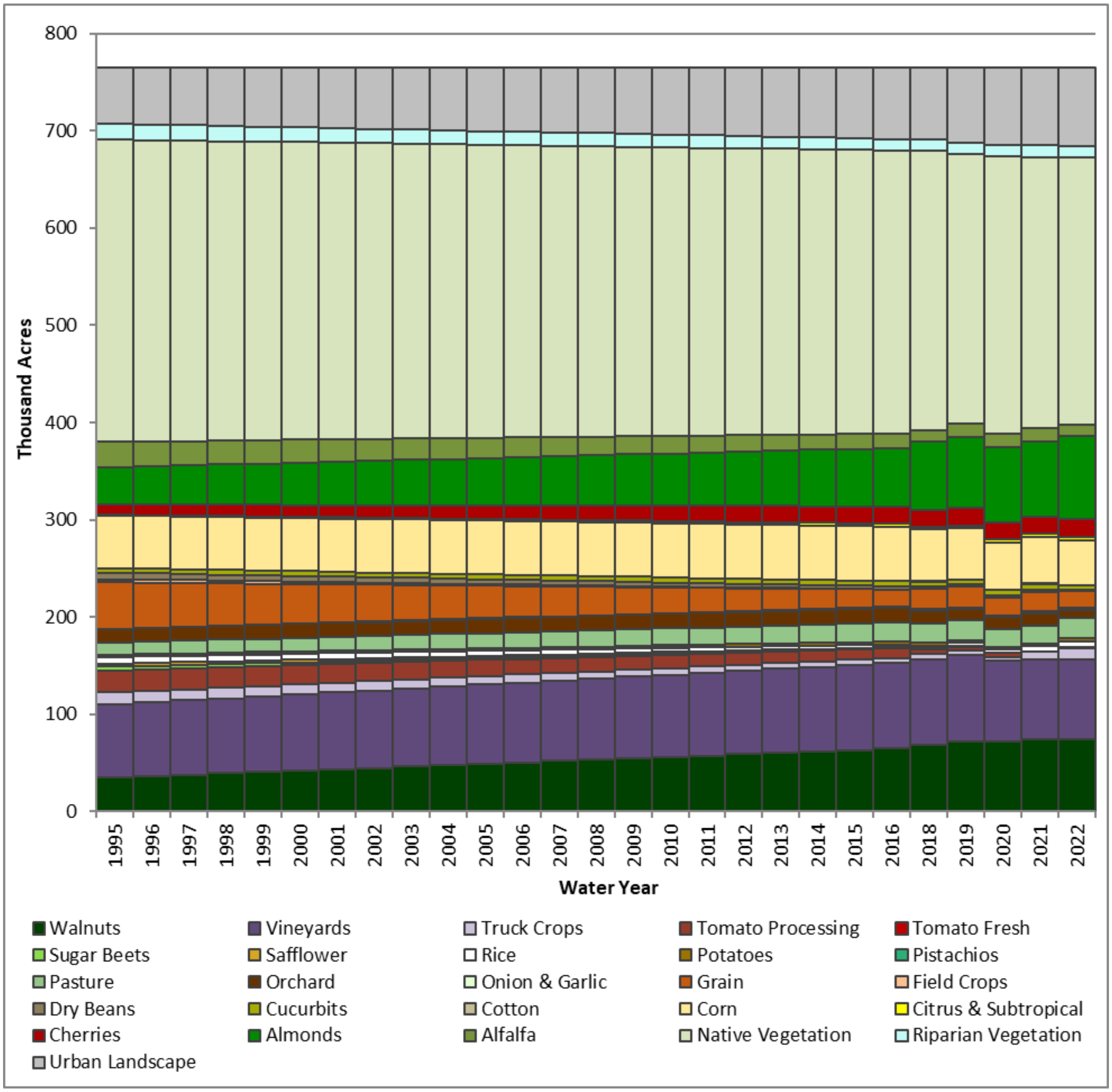


Figure 6: Annual Grouped Crop Acreage for ESJ Subbasin in Historical ESJWRM Version 3.0

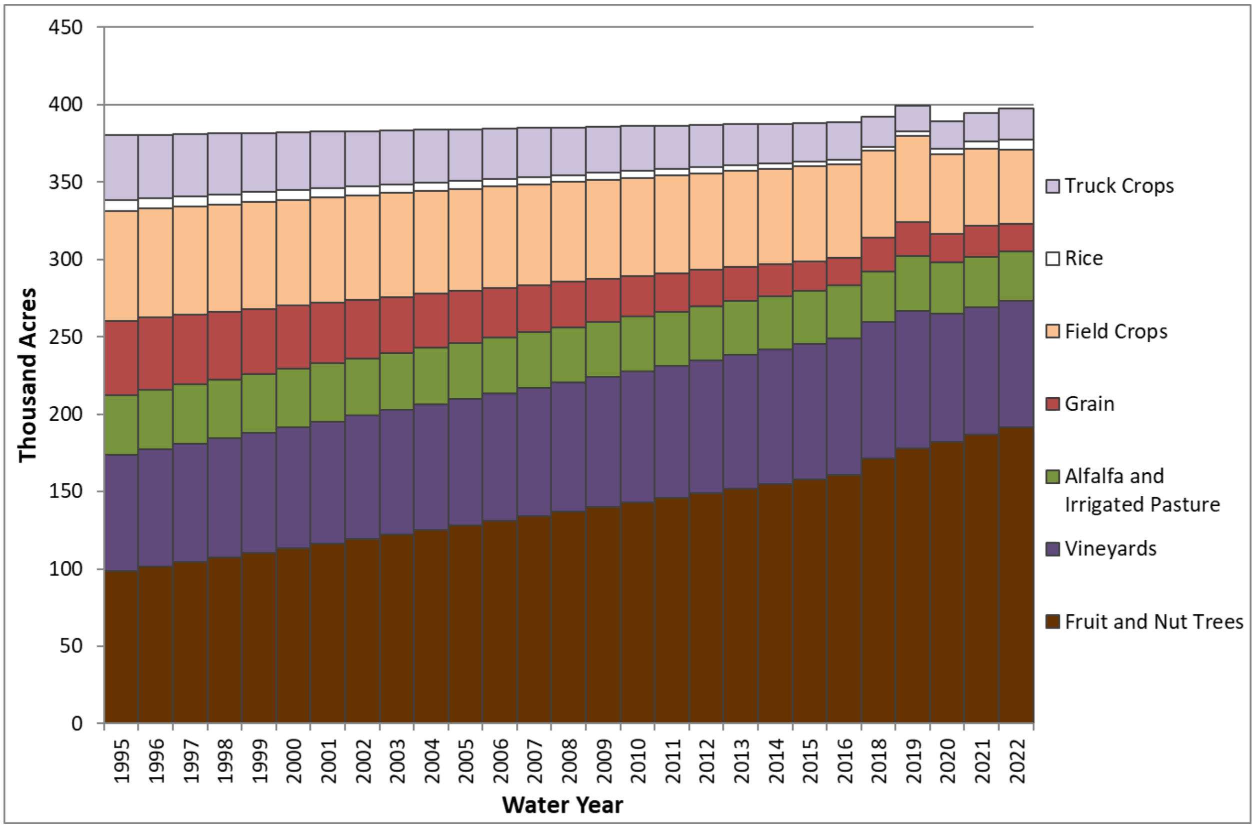
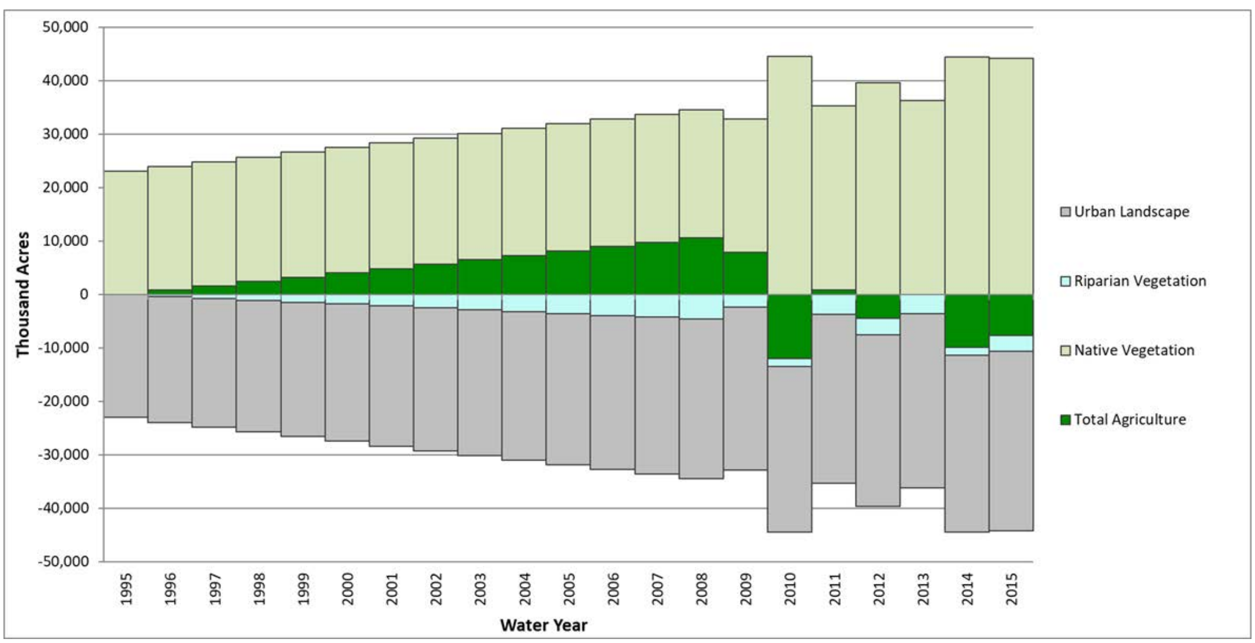


Figure 7: Difference between Historical ESJWRM Version 3.0 and Historical ESJWRM Version 2.2 Land Use Acreages by Broad Category



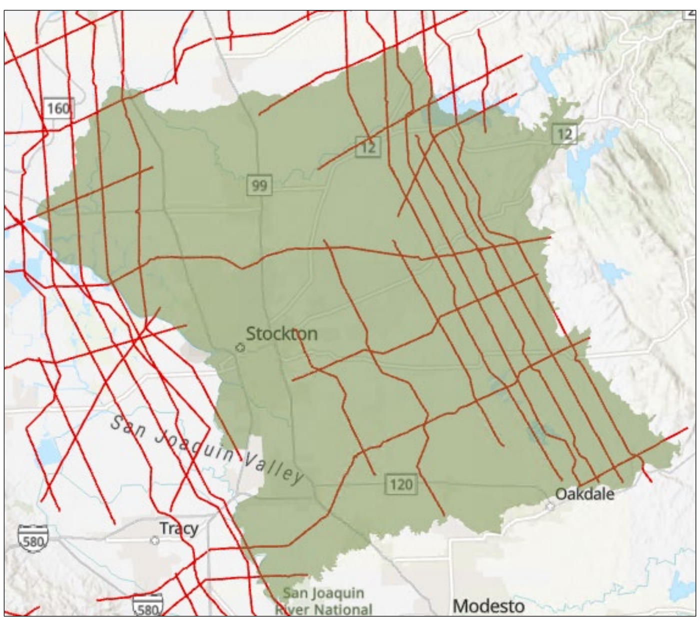
3.3.6 Model Layering

The Historical ESJWRM Version 3.0 has undergone significant refinements to better reflect subsurface conditions and improve the accuracy of groundwater dynamics. Historical ESJWRM Version 2.2 and earlier was based on the C2VSimFG Version 1.0 layering; the layering was fully updated for the Historical ESJWRM Version 3.0 and the stratigraphy now includes a newly defined shallow alluvium layer, updated Corcoran Clay boundaries, and refined model layers informed by the recent airborne electromagnetic (AEM) surveys.

DWR recently conducted airborne electromagnetic (AEM) surveys in high and medium-priority groundwater basins across California. The purpose of the AEM surveys was to provide technical assistance to water managers implementing GSPs under SGMA by providing data on subsurface hydrogeologic characteristics for aquifer systems underlying the surveyed groundwater basins. AEM surveys provide high resolution, geologically-based data to support both validation and refinement of the existing understanding of the Subbasin's aquifer system. AEM includes detailed resistivity and texture datasets and information related to the coarseness of sediments (sands versus clays), the degree of saturation of rock (saturated or not), and the water quality of saturated rock (saline or not). AEM surveys measure the electrical resistivity of subsurface materials, allowing geophysicists to interpret subsurface lithology, to identify and map structural features such as faults, and to assess water quality including the presence and extent of saltwater intrusion. This dataset is invaluable for refining layers by providing a new large-scale, vertically and horizontally continuous texture dataset, which is particularly useful in areas where existing well logs may not provide a full picture of subsurface conditions.

The ESJ Subbasin was surveyed in April 2022 (Figure 8). The AEM data were processed and used to generate three resistivity inversion models; a smooth, sharp, and a few-layer model. The AEM data were then processed using compiled lithologic well logs that were converted to coarse and fine-material classifications. These binary classifications were correlated to the resistivity values to produce a percent coarse-fraction texture model for each flight line. This texture model, along with existing surficial geologic maps, was used to update the ESJWRM layers.

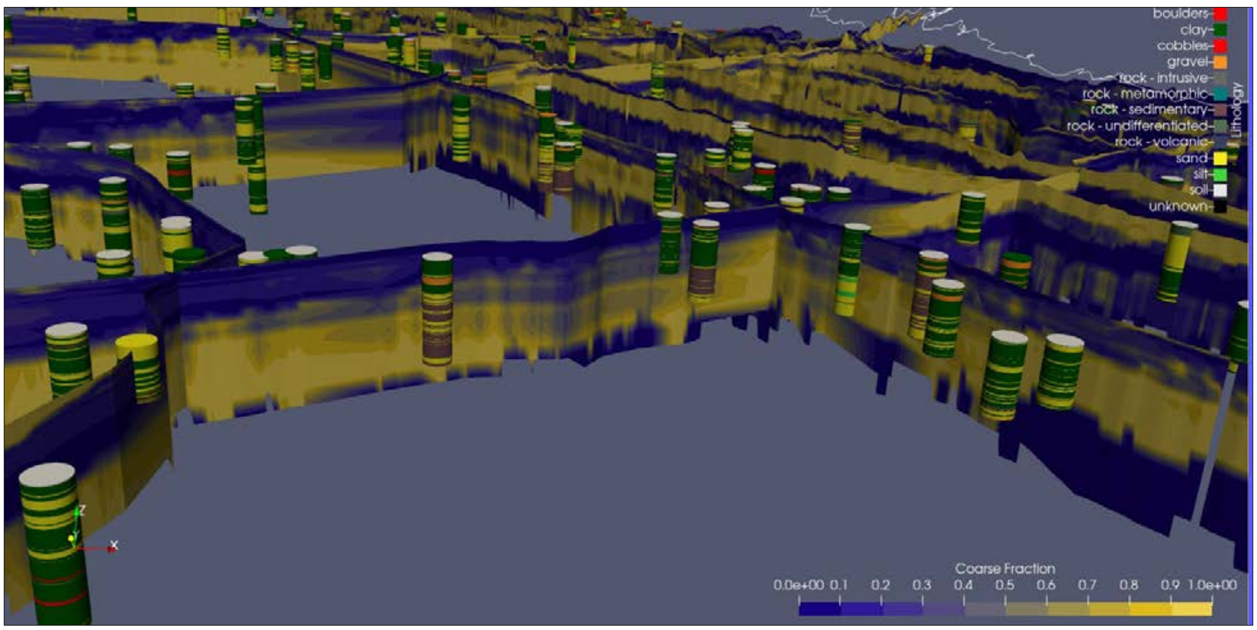
Figure 8: 2022 AEM Survey Lines Above ESJ Subbasin



To update the model layers, cross sections for each flight line in the ESJWRM extent were developed, showing the AEM coarse-faction data, supplemental well logs, and existing model layers (Figure 9). Picks were identified for where model layers should exist based on contacts mapped in the texture dataset. The location of where layers were pinching out at the surface were identified by formation outcrop locations pulled from surface geology maps. In areas with data gaps in the AEM resistivity survey, such as urban areas, areas with confined livestock, and vineyards (Figure 8), contacts identified in supplemental well logs were relied upon. These picks were then interpolated to generate an updated model surface using the ESRI ArcGIS platform. The new model layers were printed on the cross section to compare how the resulting surfaces matched the texture dataset and were iteratively refined as needed.

ESJWRM model layers were updated using a combination of AEM resistivity and texture data, lithologic well logs, and existing geologic maps, resulting in a more accurate representation of the subsurface conditions within the ESJWRM extent.

Figure 9: Example of 3-D Representation of AEM Data with Well Logs



3.3.6.1 Defining Shallow Alluvium Layer

The purpose of defining a new shallow layer in ESJWRM was to create a near surface layer that better represents shallow alluvium. The ideal layer was determined to have the following attributes:

- Captures the coarse deposits that interact with the surface
- Has useful thickness and depth in model area and along streams
- Include formations of similar, generally coarse, alluvial rock types
- Is regionally consistent

Geologic formations within the ESJWRM extent were compared based on their depositional environment, degree of consolidation, and age. Generally, younger, unconsolidated or loosely consolidated coarser deposits were identified as suitable formations for inclusion in the shallow alluvium layer. The following formations were considered in this evaluation:

- Modesto and Riverbank Formations
- Turlock Lake
- Tulare
- Unnamed very young fan deposits

The Laguna Formation, which underlies the formations listed above, is considered the most consolidated and the oldest of all alluvial deposits in the model extent. It was determined to be too deep to be useful for evaluating groundwater dynamics in the shallow parts of the alluvium. Therefore, the new shallow Layer 1 was defined as the depth to the top of the Laguna Formation.

Portions of the new Layer 1 were further adjusted to accommodate modeling constraints. Some portions of the new Layer 1 were extremely thin (<10 feet), which could cause computational problems. A minimum thickness of 20 feet was applied to all areas where Layer 1 existed to ensure the model could converge. Additionally, streams must be able to recharge water into the top-most layer, so the thickness of Layer 1 was adjusted at stream nodes to a minimum thickness of 20 feet plus the largest stream depth. This adjustment is consistent with typical alluvial sediments deposition patterns.

3.3.6.2 Updating Foothill Layering

Historical ESJWRM Version 2.2 and earlier stratigraphy based on C2VSimFG's model layering had well refined layers in the western portion of the model extent, but layers did not follow the dips of the geologic formations as they approached the Sierra Nevada foothills towards the east. The purpose of refining the layering in Historical ESJWRM Version 3.0 was to generate more realistic, geologically representative layers that better reflect subsurface conditions.

3.3.6.3 Updating Corcoran Clay Extent

The existing Corcoran Clay layer in Historical ESJWRM Version 2.2 and earlier was based on the Central Valley Hydrologic Model (CVHM) spatial database. The extent, depth, and thickness of the Corcoran Clay were updated using data re-downloaded from the USGS (Faunt, 2012). Contours of the Corcoran Clay's depth and thickness were interpolated to create continuous top and bottom surfaces, which were then mapped to the ESJWRM groundwater nodes.

Most of the previous ESJWRM Corcoran Clay extent aligned with the updated USGS dataset, except for the northern extent, which previously stopped halfway between Ripon and Manteca. The new northern boundary now extends just north of Lathrop and Manteca. While the thickness of the Corcoran Clay remained similar in areas along the Stanislaus River, it changed by as much as 100 feet in other areas compared to the previous layers.

3.3.6.4 Final Model Layers

The final model layers are described below, in order from top to bottom.

- Layer 1: This layer represents the shallowest alluvium in the model extent, consisting of coarse unconsolidated to semi-consolidated deposits that interact with the ground surface and streams.

The top of the layer is defined by the ground surface elevation from the USGS 10-meter resolution DEM. The bottom of the layer is generally defined by the top of the Laguna Formation.

- Layer 2: This layer represents the remaining top unconfined portion of the aquifer, consisting of older alluvium deposits such as those from the Laguna Formation. The top is defined as the bottom of Layer 1. In the AEM texture cross sections, the base of Layer 2 was identified by the base of a distinct coarse bed representing the unconsolidated to semi-consolidated alluvial sands, gravels and silts of the Laguna Formation. Where the Corcoran Clay exists, the base of Layer 2 is defined as the top of the Corcoran Clay.
- Aquitard 2: The Corcoran Clay separates Layers 2 and 3 in the southwest corner of the model. The extent, thickness, and depth of the Corcoran Clay originated from the CVHM spatial database published by the USGS.
- Layer 3: This layer represents the primary pumping layer in ESJWRM. It is located beneath the confining layer where the Corcoran Clay exists and below Layer 2 in the rest of the model extent. In the AEM texture cross sections, the top of this layer was often identified by a distinct contact between coarse and finer sediments, aligning with the finer-grained deposits (black sands interbedded with clays) of the upper Mehrten Formation. The bottom generally aligns with the base of the Mehrten Formation.
- Layer 4: This layer represents the confined portion of the aquifers that extends to the base of freshwater. The original development of the bottom of Layer 4 included data provided by DWR and Williamson et al. 1989.
- Layer 5: This layer consists of saline water, ranging from the base of freshwater to the base of continental deposits, and is currently a non-production zone. The original development of the bottom of Layer 5 included Page 1974's "Base and Thickness of the Post-Eocene Continental Deposits in the Sacramento Valley" and the thickness of the aquifer developed by Williamson et al. 1989.

3.3.6.5 Comparison of Updated Layers in Previous ESJWRM Versions

Table 3 includes a useful comparison of the mapping of the old layering used in Historical ESJWRM Version 2.2 and earlier and the updated layering used in Historical ESJWRM Version 3.0 moving forward. Though layer thicknesses sometimes changed dramatically, especially in the Sierra Nevada foothill areas, the understanding of the layering remains consistent.

Table 3: Difference between Historical ESJWRM Version 3.0 and Historical ESJWRM Version 2.2 and Earlier Layering

Layering in Historical ESJWRM Version 3.0	Layering in Historical ESJWRM Version 2.2 and Earlier	Understanding of Layer Extent	Understanding of Layer Confinement
Layer 1	Layer 1	Shallowest alluvium	Unconfined
Layer 2		Older alluvium	Unconfined
Corcoran Clay Aquitard (where exists)	Corcoran Clay Aquitard (where exists)	Confining unit	Confining unit
Layer 3	Layer 2	Primary pumping layer	Confined
Layer 4	Layer 3	Pumping layer, extends to base of fresh water	Confined
Layer 5	Layer 4	Saline water, no pumping, extends to base of continental deposits	Confined

The figures below (Figure 10, Figure 11, and Figure 12) show the AEM data along survey lines in the model domain with coloring according to the coarse fraction (darker=finer and coarser=lighter). ESJWRM layering is shown in red lines with Historical ESJWRM Version 2.2 and earlier on the top figure and the updated layers in Historical ESJWRM Version 3.0 in the bottom figure.

The model stratigraphy refinements in Historical ESJWRM Version 3.0 have many benefits to the model and the understanding of the aquifer system underlying the Subbasin. These benefits include:

- River reaches with hydraulic connection to the shallow alluvium which have stream-groundwater interaction are more readily identified in the model
- Improved ability to model recharge projects and quantify benefits
- Improved representation of Corcoran Clay
- Representation of hydrogeology in the Sierra Nevada foothills is more realistic and allows for direct recharge of deeper layers

Figure 10: North-South Example of Historical ESJWRM Version 3.0 (bottom) and Historical ESJWRM Version 2.2 and Earlier (top) Layering with AEM Coarse Fraction

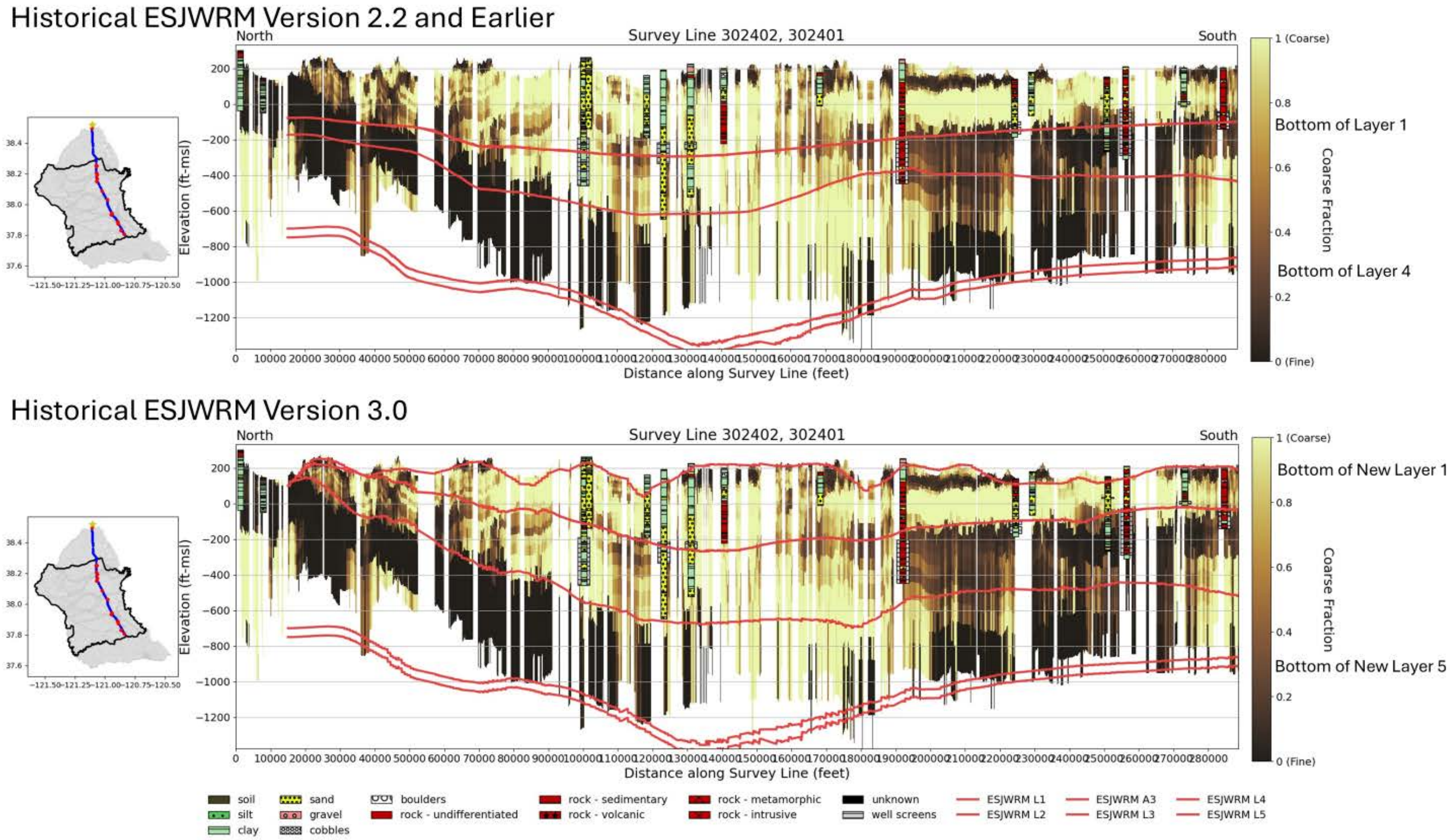


Figure 11: Northern East-West Example of Historical ESJWRM Version 3.0 (bottom) and Historical ESJWRM Version 2.2 and Earlier (top) Layering with AEM Coarse Fraction

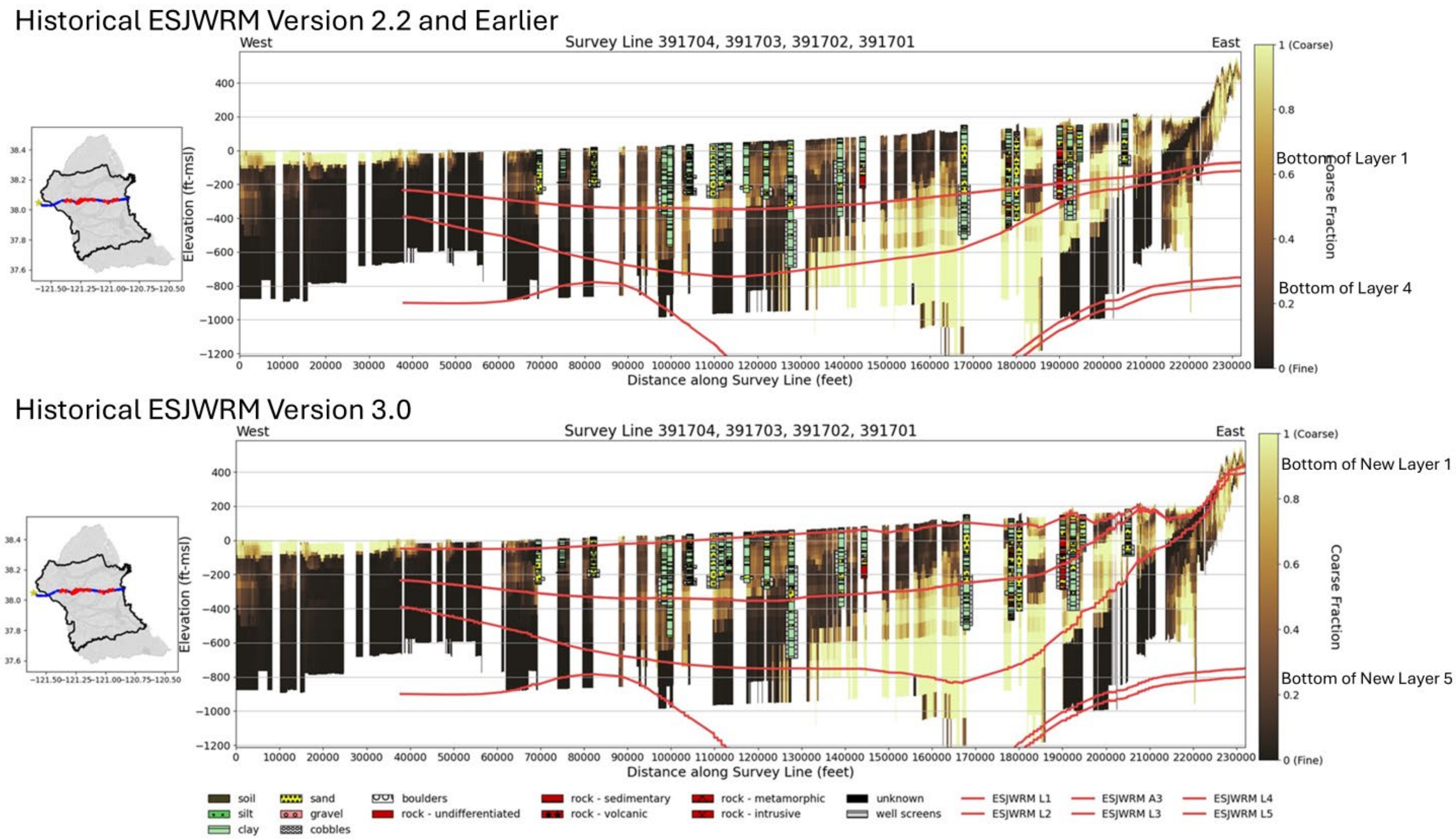
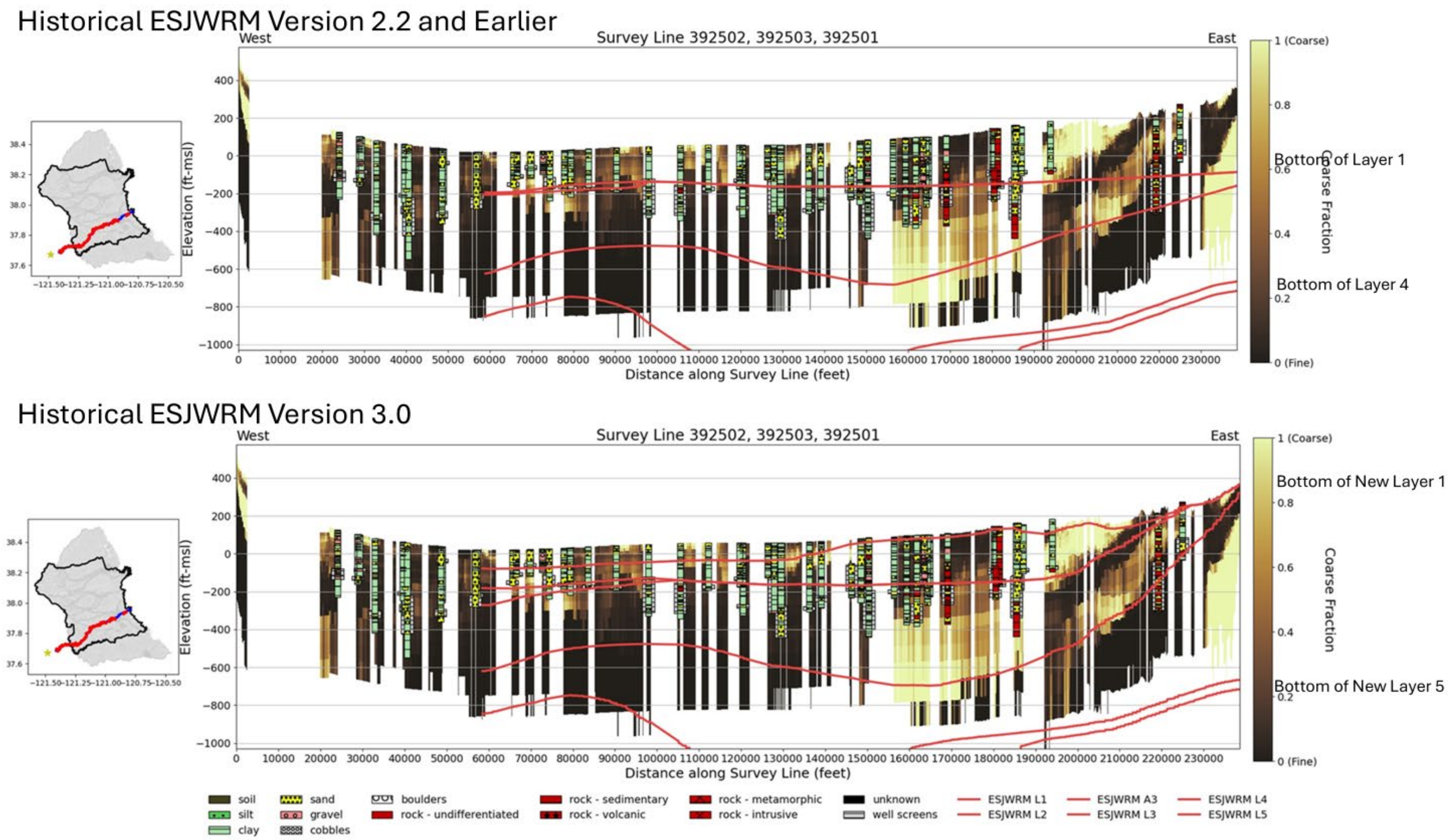


Figure 12: Southern East-West Example of Historical ESJWRM Version 3.0 (bottom) and Historical ESJWRM Version 2.2 and Earlier (top) Layering with AEM Coarse Fraction



3.3.7 Boundary Conditions

The boundary conditions in the model remain the same as ESJWRM Version 2.2, with some edits due to the inclusion of the additional model layer (see Section 3.2.6), Boundary conditions in ESJWRM consist of eastern flows from the Sierra Nevada Mountains simulated in the model as small watersheds, Camanche Reservoir seepage estimated using a constrained general head boundary condition, Woodward Reservoir, Farmington Dam, and Modesto Reservoir seepage represented as stream diversions, flows from outside of the model area represented with general head boundary conditions, and groundwater levels at or near zero near the edges of the Sacramento-San Joaquin Delta are represented using specified head boundary conditions. Data was extended through water year 2023 using a monthly average by water year type. Layer assignments increased by one to account for the new model layering and new lines were added for boundary conditions related to the new Layer 1. Small watersheds all previously drained their baseflow into Layer 1, but in Historical ESJWRM Version 3.0 were updated to drain into the top model layer (since Layer 1 isn't continuous across the model).

3.3.8 Urban Demand

Urban demand, comprised of annual population and monthly per capita water use (PCWU), is specified for incorporated urban areas or communities and estimated for rural urban demand. No changes were made to the urban demand for incorporated areas from Historical ESJWRM Version 2.2, which are still based on Department of Finance population data and urban demand calculated as surface water deliveries plus groundwater pumping deliveries.

The rural population, or people not in urban centers, was previously estimated in Historical ESJWRM Version 1.1 and Version 2.0 by calculating an estimate of the rural population per acre in San Joaquin County and applying that population estimate to the unincorporated acreage of the model. This method lumped all rural residential population into one large group that was then spatially assigned by the model based on urban acreage. Since the group area covered all areas in Cosumnes, ESJ, and Modesto Subbasins that were not covered by urban centers, the area of distribution of the urban demand was most likely not realistic.

In Historical ESJWRM Version 3.0, the rural residential population was updated to rely on Census Tract, which are much smaller areas that can more accurately pinpoint where urban demand is occurring in the model (demand within the Census Tract will still be assigned based on urban acreage). The data used was a downloaded Census Tract shapefile and the annual population per tract (American Community Survey Total Population or B01003 for 2010 through 2022 at time of model update), both from the United States Census Bureau. Population data was extrapolated backwards to 1995 and forwards to 2023 using reasonable trends determined from the 2010 through 2022 population data or from nearby urban cities. City populations were removed from Census Tracts, leaving only rural residential population remaining in each Census Tract. This population is combined with a monthly per capita water use determined by averaging ESJ Subbasin urban areas' per capita water uses.

The change in rural residential urban demand increased the rural population and increased the total urban demand in the Historical ESJWRM Version 3.0 by almost 13 TAFY (demand is met entirely by groundwater pumping).

3.3.9 Surface Water Diversions

Surface water diversions were not largely changed from Historical ESJWRM Version 2.0. Two additional diversions were added:

- NSJWCD south system recharge
- Farmington reservoir seepage

Three additional diversions were edited:

- Separated NSJWCD south system agricultural use from recharge (due to new diversion above)
- Losses from New Hogan delivery system associated with SEWD operations
- Losses from New Melones delivery system associated with SEWD operations

GSAs provide updated surface water diversion data on an annual basis during GSP Annual Report model updates. If GSAs do not provide updated numbers, recent historical averages by water year type are used instead. A summary of diversions simulated in the model is provided in Table 4, along with fractions for recoverable loss (i.e., percolation or canal seepage), non-recoverable loss (i.e., evaporation), and delivery (i.e., amount delivered is equal to the total amount minus the recoverable and non-recoverable losses). Historical ESJWRM Version 3.0 includes 66 diversions, 63 of which are listed in Table 4 and 3 diversions that are placeholders that are not currently being used in the model. The Projected Conditions Baseline Version 3.0 averages are also included in Table 4 and are discussed in Section 4.1.3.

Table 4: Summary of ESJWRM Surface Water Deliveries in Historical ESJWRM Version 3.0 and PCBL Version 3.0

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
1	Mokelumne River to North San Joaquin WCD North System for Ag	Mokelumne River	North San Joaquin WCD North System	Ag	50%	0%	50%	370	0	NSJWCD
2	Mokelumne River to North San Joaquin WCD South System for Ag	Mokelumne River	North San Joaquin WCD South System	Ag	0%	0%	100%	410	2,000	NSJWCD
3	Mokelumne River to North San Joaquin WCD for CALFED GW Recharge Project	Mokelumne River	CALFED GW Recharge Project	Recharge	100%	0%	0%	250	800	NSJWCD
4	Mokelumne River to North San Joaquin WCD For Tracy Lake Recharge Project	Mokelumne River	Tracy Lake Recharge Project	Recharge	50%	0%	50%	270	2,000	NSJWCD
5	Mokelumne River to City of Lodi (by agreement with Woodbridge ID) for M&I	Mokelumne River	City of Lodi	Urban	0%	0%	100%	5,400	5,000	Lodi
6	Mokelumne River to City of Lodi (by agreement with NSJWCD) for M&I	Mokelumne River	City of Lodi	Urban	0%	0%	100%	370	0	Lodi

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
7	Mokelumne River to City of Lodi (banked from agreement with WID) for M&I	Mokelumne River	City of Lodi	Urban	0%	0%	100%	550	0	Lodi
8	Mokelumne River to Woodbridge ID for Ag	Mokelumne River	Woodbridge Irrigation District	Ag	30%	2%	68%	57,800	44,000	WID
9	Mokelumne River Export to Contra Costa WD (by agreement with Woodbridge ID)	Mokelumne River	Export out of model	Urban	0%	0%	100%	2,000	0	WID
10	Mokelumne River to City of Stockton for Delta Water Supply Project (by agreement with Woodbridge ID) for M&I	Mokelumne River	City of Stockton	Urban	0%	0%	100%	7,500	10,000	City of Stockton
11	San Joaquin River at Empire Tract to City of Stockton for Delta Water Supply Project for M&I	San Joaquin River	City of Stockton	Urban	0%	0%	100%	9,500	21,000	City of Stockton

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
12	Calaveras River to Bellota Pipeline to Stockton East WD WTP for M&I	Calaveras River	Export out of model (imported in Diversions 14, 15, and 16)	Urban	0%	0%	100%	13,700	13,000	SEWD
13	Stanislaus River at Goodwin Dam to Farmington Flood Control Basin to Lower Farmington Canal to Peters Pipeline to Stockton East WD WTP for M&I	Import (outside of ESJWRM)	Export out of model (imported in Diversions 14, 15, and 16)	Urban	0%	0%	100%	28,000	49,000	SEWD
14	Stockton East WD WTP to City of Stockton for M&I	Import (exported in Diversions 12 and 13)	City of Stockton	Urban	0%	0%	100%	17,900	5,000	UWMP
15	Stockton East WD WTP to Cal Water for M&I	Import (exported in Diversions 12 and 13)	Cal Water	Urban	0%	0%	100%	21,700	19,000	UWMP
16	Stockton East WD WTP to San Joaquin County in Stockton for M&I	Import (exported in Diversions 12 and 13)	San Joaquin County in Stockton	Urban	0%	0%	100%	1,400	2,000	UWMP

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
17	Calaveras River to Calaveras County WD for Ag	Import (outside of ESJWRM)	Calaveras County WD	Ag	9%	1%	90%	1,100	1,000	CCWD
18	Calaveras River to Jenny Lind for M&I	Import (outside of ESJWRM)	Jenny Lind	Urban	0%	0%	43%	1,800	2,000	CCWD
19	Calaveras River to Stockton East WD for Ag	Calaveras River	Stockton East Water District	Ag	0%	0%	100%	23,600	21,000	SEWD
20	Calaveras River to Stockton East WD Losses	Calaveras River	Stockton East Water District, including canals	Recharge	89%	11%	0%	17,600	17,000	SEWD
21	Calaveras River to Farmington Groundwater Recharge Program	Calaveras River	Farmington Groundwater Recharge Program	Recharge	100%	0%	0%	1,900	5,000	SEWD
22	San Joaquin River to North Delta for Ag	San Joaquin River	North Delta Subregion	Ag	5%	1%	94%	139,000	126,000	Estimated by model
23	San Joaquin River to South Delta for Ag	San Joaquin River	South Delta Subregion	Ag	5%	1%	94%	27,400	19,000	Estimated by model
24	Stanislaus River at Goodwin Dam to Farmington Flood Control Basin to Lower Farmington Canal to Stockton East WD for Ag	Import (outside of ESJWRM)	Stockton East Water District	Ag	0%	0%	100%	4,500	7,000	SEWD

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
25	Stanislaus River to Stockton East WD Losses	Import (outside of ESJWRM)	Stockton East Water District, including canals	Recharge	88%	12%	0%	3,800	7,000	SEWD
26	Stanislaus River at Goodwin Dam to Farmington Flood Control Basin via Little Johns Creek and Lower Farmington Canal to Central San Joaquin WCD for Ag	Import (outside of ESJWRM)	Central San Joaquin WCD	Ag	15%	2%	83%	30,600	24,000	SEWD
27	Stanislaus River to Farmington Groundwater Recharge Program	Import (outside of ESJWRM)	Farmington Groundwater Recharge Program	Recharge	100%	0%	0%	3,600	5,000	SEWD
28	Stanislaus River at Goodwin Dam to Oakdale ID North for Ag	Import (outside of ESJWRM)	Export out of model (imported in Diversions 52, 55, and 57)	Ag	0%	0%	0%	98,600	88,000	OID
29	Stanislaus River at Goodwin Dam to Oakdale ID South for Ag [Modesto Subbasin]	Import (outside of ESJWRM)	Export out of model (imported in Diversions 53, 54, 56, and 58)	Ag	0%	0%	0%	136,900	121,000	OID

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
30	Stanislaus River to Woodward Reservoir to South San Joaquin ID for Ag	Import (outside of ESJWRM)	Export out of model (imported in Diversions 59, 60, and 61)	Ag	0%	0%	0%	187,900	150,000	SSJID
31	Stanislaus River to Woodward Reservoir to South San Joaquin ID Division 6 for Ag	Import (outside of ESJWRM)	Export out of model (imported in Diversions 59, 60, and 61)	Ag	0%	0%	0%	5,300	7,000	SSJID
32	Woodward Reservoir Seepage	Import (outside of ESJWRM)	Woodward Reservoir	Recharge	100%	0%	0%	17,100	16,000	SSJID
33	Stanislaus River to Woodward Reservoir to Nick C. DeGroot WTP to City of Manteca for M&I	Import (outside of ESJWRM)	City of Manteca	Urban	0%	0%	100%	7,000	11,000	UWMP
34	Stanislaus River to Woodward Reservoir to Nick C. DeGroot WTP to City of Escalon for M&I	Import (outside of ESJWRM)	City of Escalon	Urban	0%	0%	100%	0	0	UWMP
35	Stanislaus River to Woodward Reservoir to Nick C. DeGroot WTP to City of Lathrop for M&I [Tracy Subbasin]	Import (outside of ESJWRM)	City of Lathrop	Urban	0%	0%	100%	1,700	6,000	UWMP

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
36	Stanislaus River to Woodward Reservoir to Nick C. DeGroot WTP to City of Ripon for M&I	Import (outside of ESJWRM)	City of Ripon	Urban	0%	0%	100%	0	0	UWMP
37	Tuolumne River to Modesto ID for Ag [Modesto Subbasin]	Import (outside of ESJWRM)	Modesto ID	Ag	3%	19%	78%	229,900	194,000	Stanislaus River Basin Plan ESJWRM Update
38	Tuolumne River to City of Modesto (via Modesto ID) for M&I [Modesto Subbasin]	Import (outside of ESJWRM)	Element group representing City of Modesto	Urban	3%	1%	96%	30,500	27,000	Stanislaus River Basin Plan ESJWRM Update
39	Cosumnes River to Riparian for Ag [Cosumnes Subbasin]	Cosumnes River	Riparian diverters along river	Ag	10%	2%	88%	2,700	2,000	C2VSim
40	Dry Creek to Riparian for Ag [Split Across Subbasins]	Dry Creek	Riparian diverters along river	Ag	10%	2%	88%	5,800	6,000	C2VSim
41	Mokelumne River to Riparian for Ag	Mokelumne River	Riparian diverters along river	Ag	10%	2%	88%	9,800	11,000	C2VSim
42	Calaveras River to Riparian for Ag	Calaveras River	Riparian diverters along river	Ag	10%	2%	88%	11,400	11,000	C2VSim

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
43	Stanislaus River to Riparian for Ag [Split Across Subbasins]	Stanislaus River	Riparian diverters along river	Ag	15%	3%	82%	30,600	30,000	C2VSim
44	Tuolumne River to Riparian for Ag [Modesto Subbasin]	Tuolumne River	Riparian diverters along river	Ag	15%	3%	82%	6,100	6,000	C2VSim
45	San Joaquin River to Riparian for Ag [Split Across Subbasins]	San Joaquin River	Riparian diverters along river	Ag	15%	3%	82%	5,800	6,000	C2VSim
46	Modesto ID Groundwater Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	Modesto ID	Ag	0%	0%	100%	22,300	24,000	Stanislaus River Basin Plan ESJWRM Update
47	Tuolumne River to Modesto Reservoir Seepage [Modesto Subbasin]	Import (outside of ESJWRM)	Modesto Reservoir	Recharge	100%	0%	0%	23,000	23,000	Stanislaus River Basin Plan ESJWRM Update
48	City of Modesto GW Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	City of Modesto	Urban	3%	1%	96%	33,000	32,000	Stanislaus River Basin Plan ESJWRM Update
49	City of Oakdale GW Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	City of Oakdale	Urban	3%	1%	96%	4,700	5,000	Stanislaus River Basin Plan

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
										ESJWRM Update
50	City of Waterford GW Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	City of Waterford	Urban	3%	1%	96%	1,600	1,000	Stanislaus River Basin Plan ESJWRM Update
51	City of Riverbank GW Pumping Deliveries [Modesto Subbasin]	Import (outside of ESJWRM)	City of Riverbank	Urban	3%	1%	96%	4,500	4,000	Stanislaus River Basin Plan ESJWRM Update
52	Farm Deliveries to Oakdale ID North for Ag	Import (exported in Diversion 28)	Oakdale ID in ESJ Subbasin	Ag	0%	0%	100%	78,700	74,000	OID AWMP
53	Farm Deliveries to Oakdale ID South for Ag [Modesto Subbasin]	Import (exported in Diversion 29)	Oakdale ID in Modesto Subbasin	Ag	0%	0%	100%	121,500	114,000	OID AWMP
54	Recycled Water to Oakdale ID South for Ag [Modesto Subbasin]	Import (exported in Diversion 29)	Oakdale ID in Modesto Subbasin	Ag	0%	0%	100%	3,300	3,000	OID AWMP
55	Deliveries to Annual Contracts by Oakdale ID North for Ag	Import (exported in Diversion 28)	Oakdale ID in ESJ Subbasin	Ag	0%	0%	100%	2,300	3,000	OID AWMP

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
56	Deliveries to Annual Contracts by Oakdale ID South for Ag [Modesto Subbasin]	Import (exported in Diversion 29)	Oakdale ID in Modesto Subbasin	Ag	0%	0%	100%	2,200	2,000	OID AWMP
57	Canal and Drain Seepage in Oakdale ID North	Import (exported in Diversion 28)	Oakdale ID in ESJ Subbasin	Recharge	100%	0%	0%	17,800	18,000	OID AWMP
58	Canal and Drain Seepage in Oakdale ID South [Modesto Subbasin]	Import (exported in Diversion 29)	Oakdale ID in Modesto Subbasin	Recharge	100%	0%	0%	18,500	18,000	OID AWMP
59	Farm Deliveries to South San Joaquin ID for Ag	Import (exported in Diversions 30 and 31)	South San Joaquin ID	Ag	0%	0%	100%	142,500	120,000	SSJID AWMP
60	Direct Diversion from Main Distributary Canal to South San Joaquin ID for Ag	Import (exported in Diversions 30 and 31)	South San Joaquin ID	Ag	0%	0%	100%	1,400	0	SSJID AWMP
61	Main Distributary Canal and Lateral Seepage in South San Joaquin ID	Import (exported in Diversions 30 and 31)	South San Joaquin ID	Recharge	90%	10%	0%	33,200	28,000	SSJID AWMP
62	Mokelumne River to North San Joaquin WCD South System Recharge	Mokelumne River	North San Joaquin WCD South System	Recharge	100%	0%	0%	860	2,000	NSJWCD

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Historical ESJWRM Version 3.0 Average Annual Diversion*** (acre-feet)	PCBL Version 3.0 Average Annual Diversion*** (acre-feet)	Data Source
					RL*	NL**	Delivery			
63	Farmington Seepage	Import (outside of ESJWRM)	Farmington Reservoir	Recharge	100%	0%	0%	570	500	USACE

*RL = Recoverable Loss (canal seepage or recharge)

**NL = Non-Recoverable Loss (evaporation)

*** Averages calculated only for years with diversions occurring (i.e., non-zero average)

3.3.10 Groundwater Pumping

Groundwater pumping within ESJWRM is separated into well or distributed pumping. The former largely includes district-operated wells that provide irrigation water through district conveyance canals and laterals along with surface water supplies, while the latter includes estimated private groundwater pumping by individual land owners and pumpers; the locations of which are not available and so are spatially distributed throughout the agricultural and rural areas.

Additional agency wells were added during GSP Annual Report data requests to Cal Water for urban, Manteca for urban, Manteca for ag, and SSJID for ag. There were no further updates to well pumping for Historical ESJWRM Version 3.0. Table 5 lists the number of wells by type and agency included in ESJWRM.

Distributed pumping is estimated by IWFM within the model simulation for each element. There were no changes made to distributed pumping in Historical ESJWRM Version 3.0.

Table 5: Summary of ESJWRM Well Pumping in Historical ESJWRM Version 3.0

Agency	Number of Urban Pumping Wells	Number of Agricultural Pumping Wells	Average Annual Urban Pumping (acre-feet)	Average Annual Agricultural Pumping (acre-feet)
Cal Water	57	---	7,600	0
Escalon	4	---	1,500	0
Lathrop	6	---	2,300	0
Linden County WD	4	---	430	0
Lockeford CSD	4	---	500	0
Lodi	29	---	13,100	0
Manteca	16	32	9,100	1,300
Oakdale ID*	---	26	0	6,200
Ripon	9	9	3,900	1,000
SEWD	5	---	1,300**	0
SSJID	---	29	0	5,300
Stockton	37	---	8,000	0
Other Modesto Subbasin Wells	---	246	0	68,600
Total Average Annual Pumping (acre-feet)			48,640	82,200

* Includes wells located both in ESJ Subbasin and Modesto Subbasin

** Average only when wells were active (WY 2015-2023)

3.3.11 Agricultural Operations

Factors that apply to the agricultural operations represented in the model include agricultural return flow fractions, agricultural reuse fractions, and target soil moisture content.

In Historical ESJWRM Version 2.2, the target soil moisture specifies the fraction of field capacity that IWFM uses to iteratively adjust demand and was updated for the beginning of irrigation season for each crop's irrigation period and for the end of season in October for vineyards. The minimum soil moisture was adjusted for all crops during the Historical ESJWRM Version 2.2 update.

Canal and drain seepage for agricultural agencies is included in surface water diversion information and discussed in Section 3.2.9 above. The Historical ESJWRM Version 3.0 strives to represent agricultural operations as realistically as possible by working with local agricultural agencies for better understanding of processes. Files that control agricultural operations were extended through water year 2023 by repeating the recent historical data.

3.4 Calibration Updates and Results

The goals of model calibration are (1) to achieve a reasonable water budget for each component of the hydrologic cycle modeled (i.e., land and water use, soil moisture, stream flow, and groundwater) and (2) to maximize the agreement between simulated and observed groundwater levels at selected well locations and simulated and observed streamflow hydrographs at selected gaging stations. These objectives are achieved through verification of the model input data and adjustment of model parameters.

Due to uncertainty in the model initial conditions, a one year "ramp up" period is included to allow groundwater levels to stabilize. Thus, the model calibration period for the ESJWRM is October 1995 through September 2023 or water years 1996 through 2023 (28 years).

3.4.1 Calibration Process

Model calibration begins after data analysis and input data file development is completed. The calibration effort can be broken down into subsets that align with packages within the IWFM platform. As an integrated groundwater model, the results of each part of the simulation are dependent on one another. The model calibration can be considered a systematic process that includes the following activities:

- Collect data and set calibration targets
- Calibrate land and water use
- Calibrate groundwater system
- Calibrate stream system
- Refine groundwater level calibration using PEST
- Perform sensitivity analysis
- Conduct additional refinements to model as necessary

3.4.1.1 Agricultural Demand Adjustment

As part of the calibration of the land and water use budget, root zone parameters are adjusted as needed to achieve reasonable estimates of agricultural demand and to develop the components of a balanced root zone budget. Demand adjustment serves as the foundation of the IWFM calibration for agricultural areas, as estimated demand often translates directly to groundwater pumping, which is the primary stress on the groundwater system. To adjust agricultural demand, element-level root zone parameters, particularly the soil hydraulic conductivity, were adjusted in accordance with the hydrologic soil group and area of the model. Soil hydraulic conductivity was adjusted in the areas of the model to better match reported groundwater pumping, demand, and per unit water use as reported in agricultural water management plans (AWMP) or other reports by various agencies, including OID, SSJID, and NSJWCD.

3.4.2 Aquifer Calibration Verification

Aquifer parameter calibration of ESJWRM utilized a parametric grid covering the model area that reflected the scale at which parameters were adjusted throughout the calibration process. The parametric grid, originally adopted from DWR's California Central Valley Groundwater-Surface Water Simulation Model with coarse grid (C2VSimCG) nodes, was slightly modified to cover the entire ESJWRM model along the boundaries and additional nodes were added or moved within areas of the model to provide better control. Aquifer parameters included in ESJWRM are horizontal hydraulic conductivity, vertical hydraulic conductivity, specific storage, and specific yield.

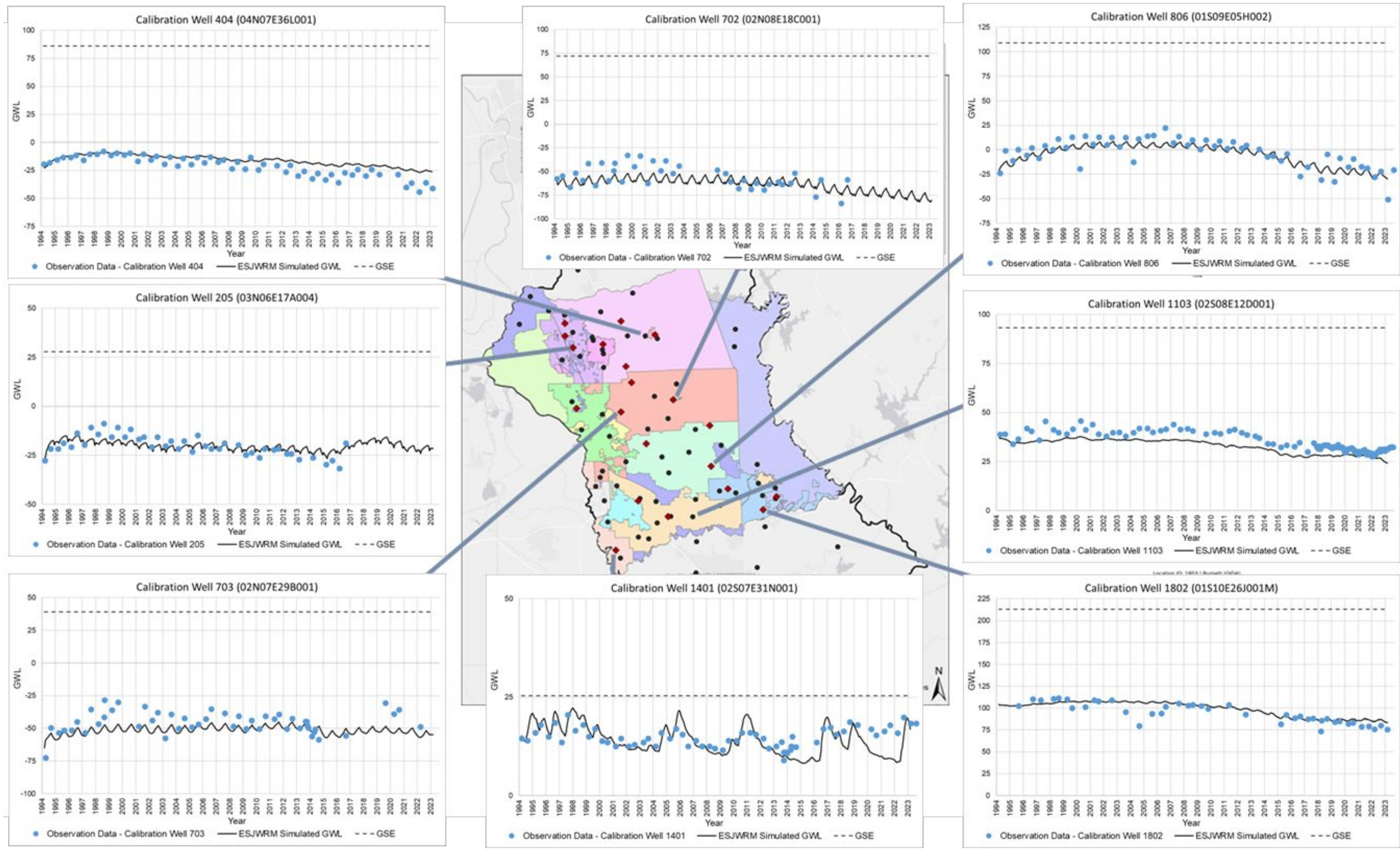
ESJWRM was calibrated to local data and information, surface water flows, groundwater hydrographs, and groundwater contours. The sources used to check model results include local knowledge, agricultural water management plans, urban water management plans, other local planning efforts, measured groundwater levels, and observed streamflow data.

The goal of groundwater level calibration is to achieve the maximum agreement between simulated and observed groundwater elevations at calibration wells while maintaining reasonable values for aquifer parameters. Calibration wells remained the same as for Historical ESJWRM Version 2.0.

Simulated groundwater levels are calibrated to observed levels through adjustments to hydrogeologic parameters or aquifer parameters including hydraulic conductivity, specific storage, and specific yield. Upon model update, the model calibration was verified using the pre-update hydrogeologic aquifer parameters. As a result of model updates in Historical ESJWRM Version 3.0, a limited number of model parameters were adjusted, including vertical hydraulic conductivity, to accommodate the more reasonable vertical movement of groundwater for the new Layer 1 and Layer 2.

The results of the groundwater level calibration indicate that the ESJWRM reasonably simulates the long-term hydrologic responses under various hydrologic conditions. Figure 13 shows a selection of calibration wells with their resulting groundwater level hydrographs showing the updated calibration of Historical ESJWRM Version 3.0

Figure 13: Groundwater Level Calibration of Historical ESJWRM Version 3.0



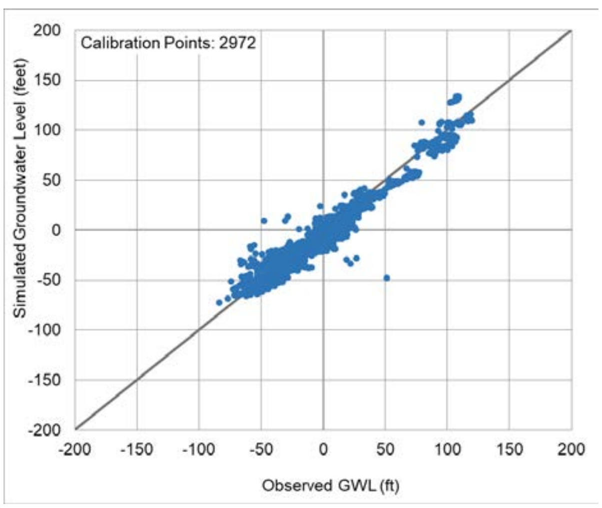
The ESJWRM calibration status was measured using two metrics: the groundwater level trend and the relationship between simulated and observed groundwater levels. The statistics were evaluated to meet the American Standard Testing Method (ASTM) standard. In addition to quantifiable metrics, the ESJWRM calibration was evaluated by generating reasonable regional groundwater flow directions and producing realistic water budgets.

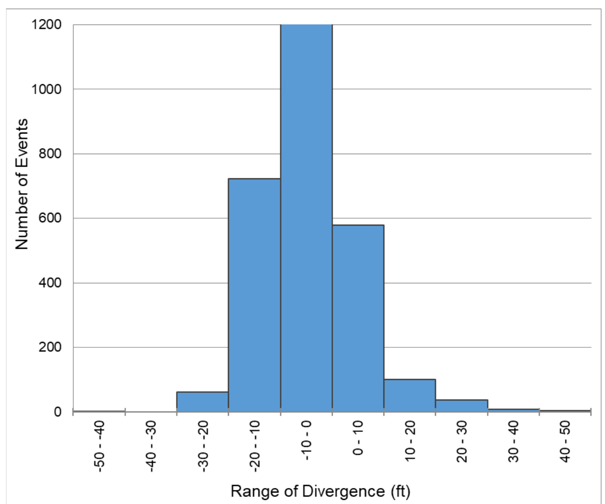
The "Standard Guide for Calibrating a Groundwater Flow Model Application" (ASTM D5981) states that "the acceptable residual should be a small fraction of the head difference between the highest and lowest heads across the site." The residual is defined as the simulated head minus the observed head. An analysis of all calibration water levels within the model indicated the presence of 200+ feet of water level changes. Using 10 percent as the "small fraction", the acceptable residual level would be 20 feet. Calibration goals for the groundwater level residuals were set such that no more than 10 percent of the observed groundwater levels would exceed the acceptable residual level of 20 feet.

- 68.5% of observed groundwater levels are within +/- 10 feet of its respective simulated values
- 96.2% of observed groundwater levels are within +/- 20 feet of its respective simulated values
- 99.5% of observed groundwater levels are within +/- 30 feet of its respective simulated values

The residual histogram and scatter plot of simulated versus observed values for the ESJ Subbasin original calibration wells for the calibration period is shown in Figure 14.

Figure 14: Calibration Statistics of Historical ESJWRM Version 3.0





3.4.3 Sensitivity Analysis

Sensitivity analysis is a way of investigating how sensitive certain model results are to changes in certain model parameters. A sensitive parameter is when the simulation results are greatly affected by changes in that parameter within its valid range. Conversely, an insensitive parameter means the changes in that parameter within its valid range do not affect the simulation results greatly.

Model parameters that are sensitive can be the largest sources of error and uncertainty when not precisely measured and well understood. Historical ESJWRM Version 2.0 sensitivity analysis revealed that none of the sensitivity runs resulted in a significant improvement in statistics or results. This means that the model was stable and that the calibration was at or near an optimal point when global parameter changes are considered.

Since there was not significant changes to the model calibration between Historical ESJWRM Version 2.2 and Historical ESJWRM Version 3.0, updated sensitivity analysis was not performed at this time.

3.5 Historical Model Results

A water budget balances supplies, demands, and any subsequent change in storage occurring within the specific portion of the hydrologic cycle. IWFM automatically outputs budgets at the subregion scale for processes involving groundwater, land surface, streams, root zone, small watersheds, and unsaturated zone. IWFM can output budgets down to a single element or any specific grouping of elements.

During this step of the calibration process, model results are reviewed and summarized into monthly and annual (by water year) budgets. The primary budgets reviewed for calibration are the land and water use budget and the groundwater budget. After extensive budget analysis, key model datasets and parameters are adjusted, particularly groundwater aquifer parameters, to better match local budgets from local agricultural water purveyors and local planning efforts. The Historical ESJWRM Version 3.0 water budget results are summarized in the following sections.

3.5.1 Land and Water Use Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
    - Groundwater pumping
    - Surface water deliveries
    - Shortage (if applicable)
- Outflows:
    - Demand (either agricultural or urban)
    - Surplus (if applicable)

The average annual water demand for the Subbasin within the calibration period was 1,272 thousand acre-feet (TAF), consisting of 1,149 TAF agricultural demand and 123 TAF urban demand. This demand was met by an annual average of 568 TAF of surface water deliveries (512 TAF of agricultural and 56 TAF of urban deliveries) and was supplemented by 723 TAF of groundwater production (657 TAF of agricultural and 66 TAF of urban pumping). The average annual water surplus for the Subbasin within the calibration period was 18 TAF. Of this annual average, all of the surplus is from agricultural excess and the urban shortage is extremely minor at 1.4 TAF. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. The small agricultural surplus indicates a minor misalignment of demands and supplies likely due to the timing, volume, or delivery location of the supplies. The annual simulated land and water use budgets for the calibration period are presented in Figure 15 and Figure 16 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands and water supplies. If supply and demand do not balance, there is a surplus or shortage indicated on the land and water use budget. Table 6 shows the annual averages described above for Historical ESJWRM Version 3.0's calibration period.

Table 6: ESJ Subbasin Land and Water Use Budget Annual Averages of Historical ESJWRM Version 3.0

Land and Water Use Budget Component	ESJWRM Version 3.0 Annual Average for WY 1996-2023
Agricultural Area (thousand acres)	387
Agricultural Demand (TAF)	1,149
Agricultural Groundwater Pumping (TAF)	657
Agricultural Surface Water Deliveries (TAF)	512
Agricultural Surplus (TAF)[1]	20
Urban Area (thousand acres)	69
Urban Demand (TAF)	123
Urban Groundwater Pumping (TAF)	66
Urban Surface Water Deliveries (TAF)	56
Urban Shortage (TAF)[1]	1

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 15: ESJ Subbasin Agricultural Demand of Historical ESJWRM Version 3.0

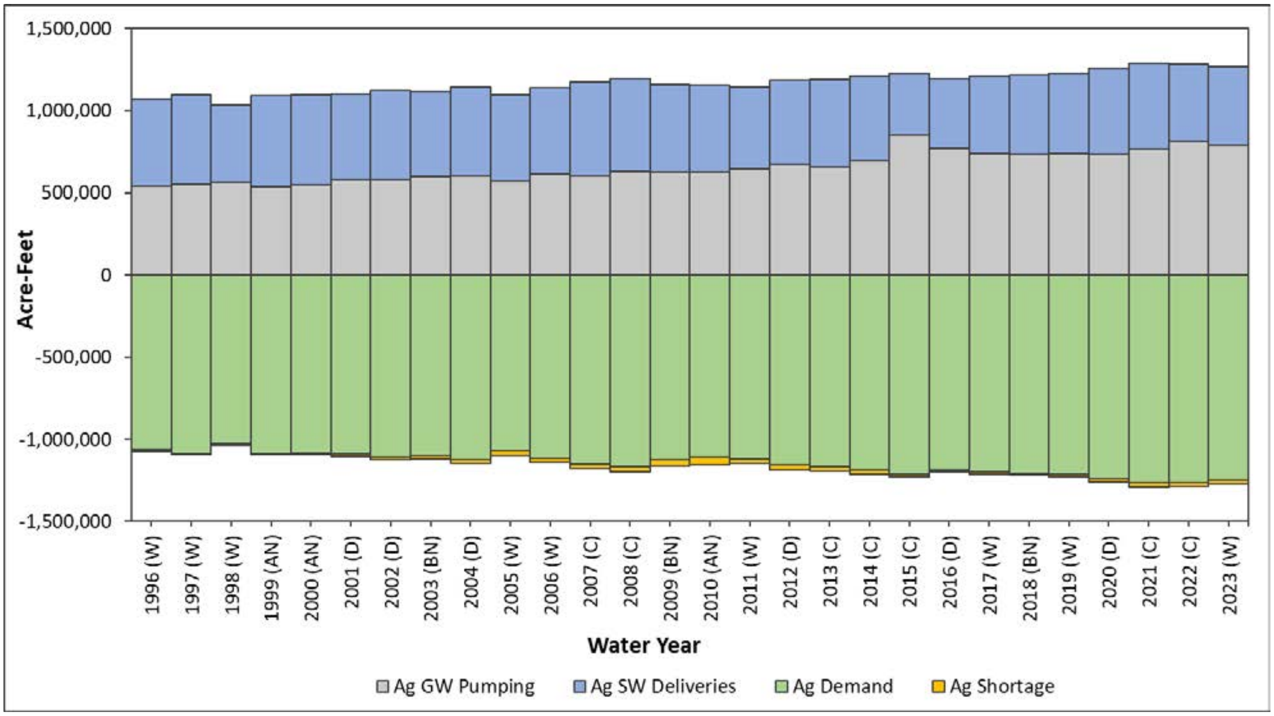
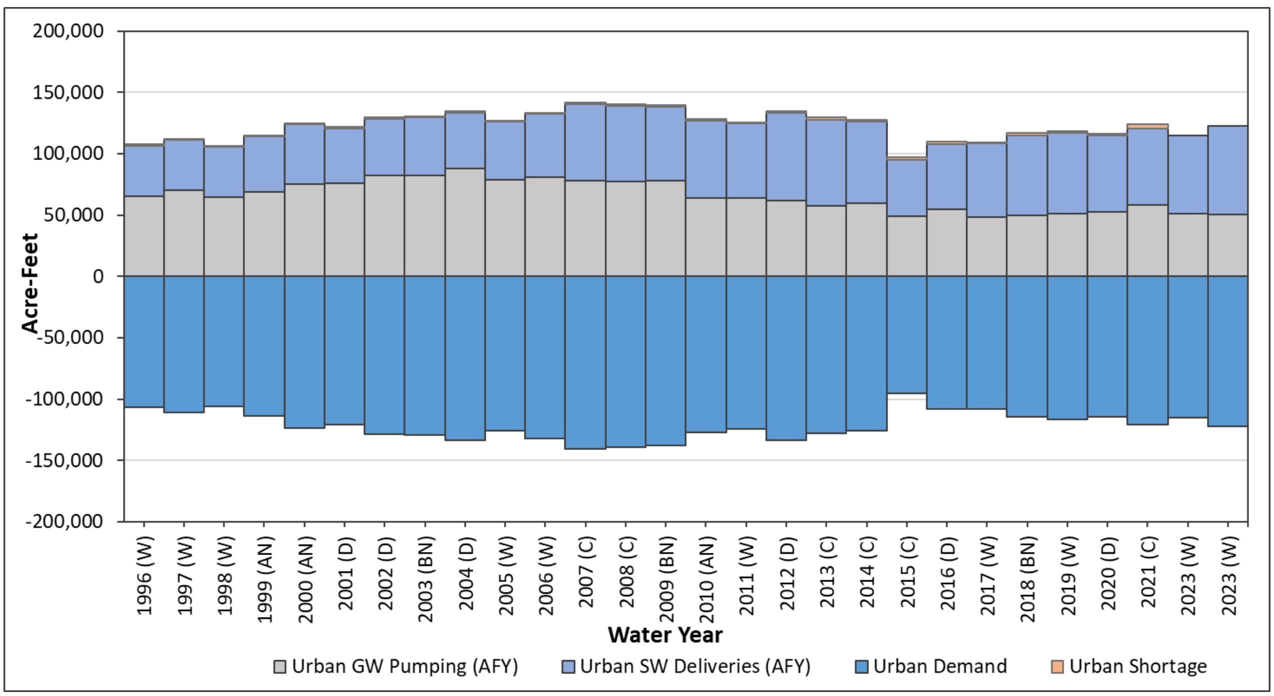


Figure 16: ESJ Subbasin Urban Demand of Historical ESJWRM Version 3.0



3.5.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget, corresponding to the major hydrologic processes affecting groundwater flow in the ESJ Subbasin, are:

- Inflows:
  - Deep percolation (from rainfall and irrigation applied water)
  - Gain from stream (or recharge due to stream seepage)
  - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
  - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
  - Groundwater pumping
  - Loss to stream (or outflow to streams and rivers)
  - Boundary outflow (to surrounding groundwater subbasins)
  - Change in groundwater storage (can be either an inflow or outflow)

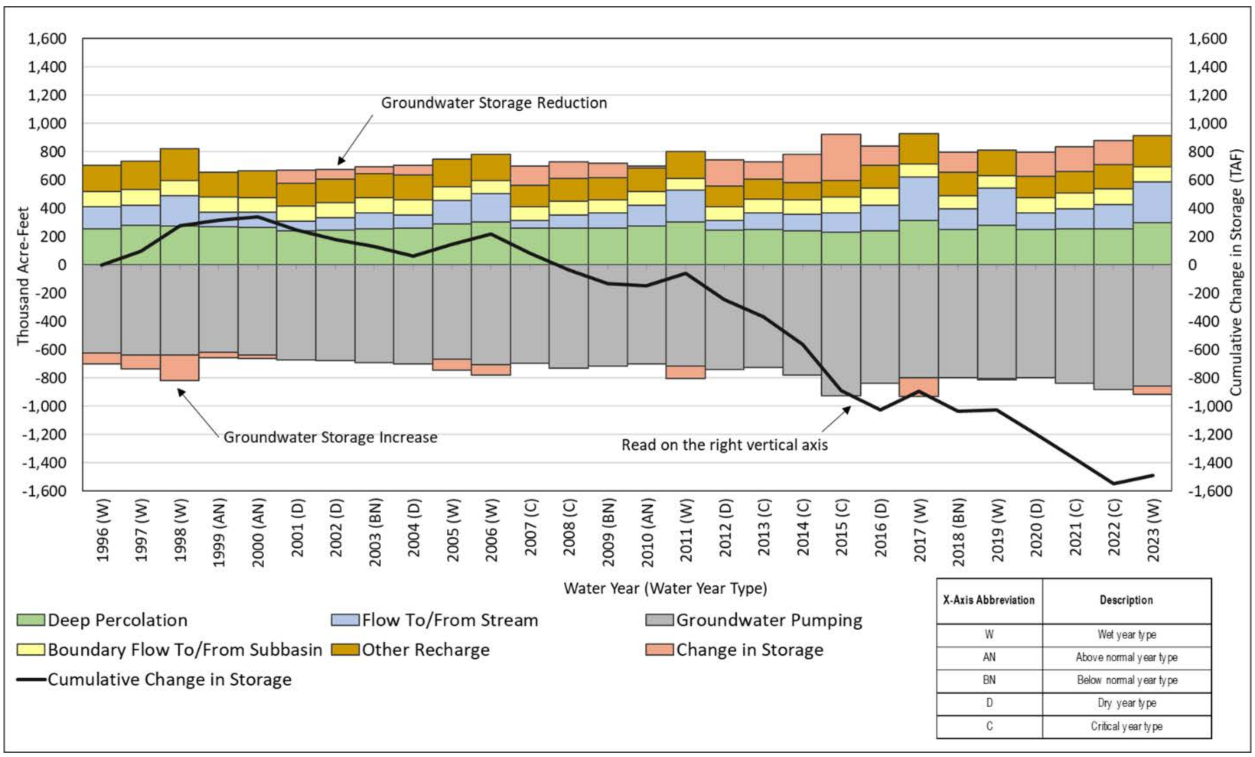
The largest component in the groundwater budget is an average annual 732 TAF of pumping, offset by 275 TAF of deep percolation, a net gain from stream of 159 TAF, 170 TAF of other recharge (includes recharge from unlined canals, reservoir seepage, managed aquifer recharge, and Sierra Nevada Mountain recharge), and a net boundary inflow of 79 TAF annually. The cumulative change in groundwater storage can be calculated from the change in groundwater storage. The groundwater storage in ESJ Subbasin during the calibration period was an average of -48 TAFY. These averages are shown in Table 7 and the Subbasin annual groundwater budget is shown in Figure 17.

Table 7 shows the annual averages described above for Historical ESJWRM Version 3.0’s calibration period. The average annual deficit in groundwater storage estimation determined using Historical ESJWRM Version 1.1 was 41 TAF (1996-2015) and in Historical ESJWRM Version 2.0 was 37 TAF (1996-2020). The average annual groundwater storage deficit in Historical ESJWRM Version 3.0 is estimated to be 48 TAF. This change in storage deficit is as a result of model updates, data refinements, period of record updates, and calibration updates.

Table 7: ESJ Subbasin Hydrologic Groundwater Budget of Historical ESJWRM Version 3.0

Hydrologic Groundwater Budget Component	ESJWRM Version 3.0 Annual Average for WY 1996-2023
Deep Percolation (TAF)	275
Deep Percolation of Precipitation (TAF)	*60*
Deep Percolation of Applied Water (TAF)	*215*
Other Recharge (TAF)	170
Net Stream Seepage (TAF)[1]	159
Net Boundary Inflow (TAF)	79
Groundwater Pumping (TAF)	732
Change in Groundwater Storage (TAF)	-48

Figure 17: ESJ Subbasin Hydrologic Groundwater Budget of Historical ESJWRM Version 3.0



[1] ESJGWA updates the ESJWRM approximately once per year as new data becomes available. Upon completion of the historical ESJWRM Version 3.0, comments regarding Calaveras River seepage were made that require further analysis and may require a recalibration of the model. This additional information on Calaveras River seepage will be considered during the next round of model updates.

4 Projected Conditions Baseline Update

The refinements and enhancements made to the historical data for the updated historical calibration ESJWRM (Historical ESJWRM Version 3.0) required an update to the projected conditions baseline ESJWRM. The version of the Projected Conditions Baseline (PCBL) presented in the GSP finalized in November 2019 is called PCBL Version 1.0. The updated version of the PCBL using Historical ESJWRM Version 2.0 extended dataset and calibration results is referred to as PCBL Version 2.0. The updated version resulting from Historical ESJWRM Version 3.0 is PCBL Version 3.0. This section presents the key data sources and assumptions used to develop the PCBL Version 3.0 and provides the model results.

The PCBL used to develop the projected water budgets represents estimated long-term hydrologic conditions of the Subbasin under the foreseeable future level of development. The future level of development represents approximately water year 2040 or the closest information available from planning documents.

4.1 Assumptions Used to Develop Projected Conditions Baseline Update

This section discusses the assumptions made in converting PCBL Version 2.0 to PCBL Version 3.0. The data and calibration parameters were updated to be consistent with the Historical ESJWRM Version 3.0. Initial groundwater levels and soil conditions in the PCBL represent those at the end of the simulation period of the Historical ESJWRM Version 3.0 (September 30, 2023).

Consistent with Section 354.18(c)(3) of the GSP Regulations, an analysis was performed for the Subbasin evaluating the projected water budget. Section 354.18(c)(3) of the GSP Regulations states:

"(3) Projected water budgets shall be used to estimate future baseline conditions of supply, demand, and aquifer response to Plan implementation, and to identify the uncertainties of these projected water budget components."

4.1.1 Hydrology

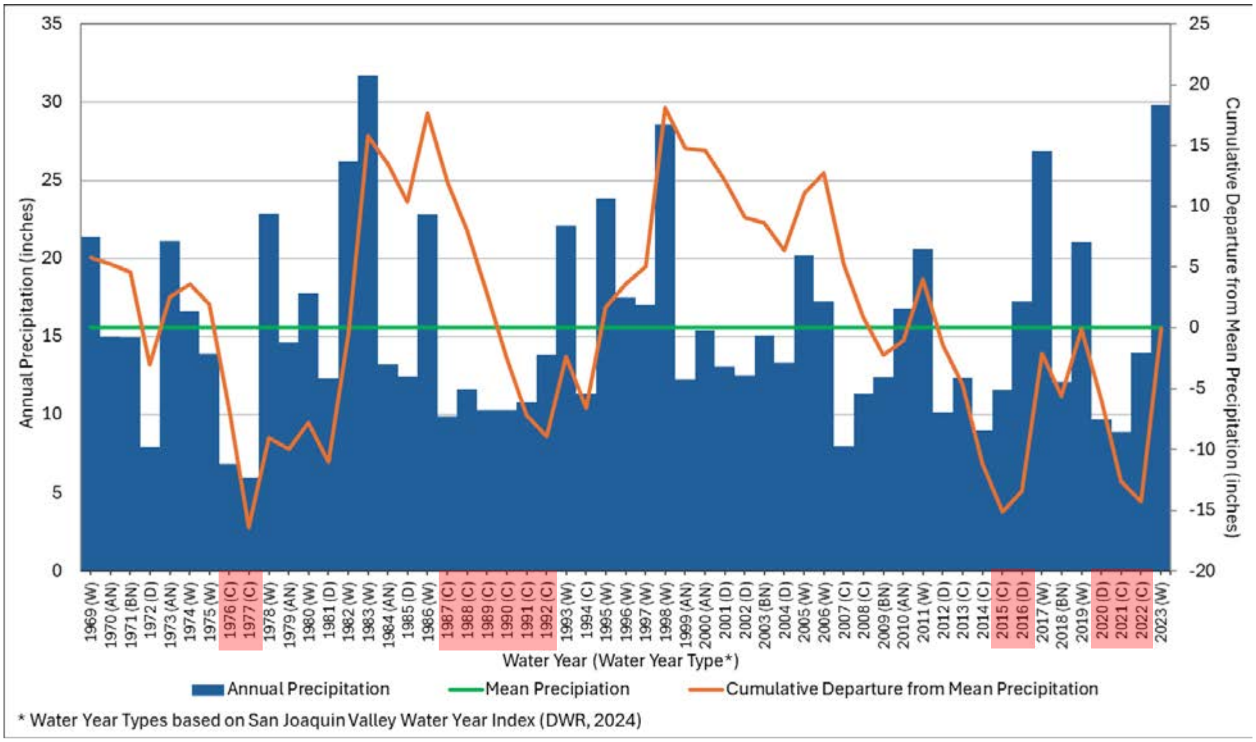
The GSP version of PCBL Version 1.0 included 50 years of hydrology data from water years 1969 through 2018 (October 1968 through September 30, 2018) and was documented in the ESJ Subbasin GSP (ESJGWA, 2019). The updated version PCBL Version 2.0 used 52 years of hydrology data from water years 1969 through 2020 (October 1968 through September 30, 2020) (Woodard & Curran, 2022a). PCBL Version 3.0 has 55 years of hydrology data from water years 1969 through 2023 (October 1968 through September 30, 2023). The projected 55 years of hydrology used in PCBL Version 3.0 meet the SGMA requirements to evaluate how the Subbasin's surface and groundwater systems may react in the future under representative hydrologic conditions.

4.1.1.1 Precipitation and Hydrologic Water Year Types

Historical precipitation or rainfall in the ESJ Subbasin was used to identify the hydrologic period that would provide a representation of wet, dry, and extreme periods needed for PCBL Version 3.0. Figure 18 shows the Subbasin annual precipitation (blue columns), average precipitation (green line) of approximately 16 inches, and cumulative departure from mean precipitation (orange line) for each water year from 1969 through 2023. This plot represents the spatially-averaged precipitation across ESJ Subbasin elements developed from PRISM precipitation data. The long-term average precipitation is subtracted from annual precipitation within each water year to develop the departure from average precipitation for each water year. Starting at the first year analyzed, the departures are added cumulatively for each subsequent year. Wet years have a positive departure and upward slopes, dry years have a negative departure and downward slopes, and a year with exactly average precipitation would have zero departure. More severe events are shown by steeper slopes and greater changes.

Each year on the x-axis in Figure 18 is indicated with the San Joaquin Valley Water Year Hydrologic Classification Index published by DWR. The 55 years of the PCBL, from WY 1969 through 2023, represent a range of hydrologic conditions, as identified by the water year types in the San Joaquin Valley Water Year Hydrologic Classification, which classifies water years 1901 through 2023 as Wet (W), Above Normal (AN), Below Normal (BN), Dry (D), and Critical (C) based on inflows to major reservoirs or lakes. A description of how this index is calculated and the specific data used to calculate this index is available online from CDEC at http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST (DWR CDEC). In the 55 years of hydrology used in the PCBL Version 3.0, there are 16 Critical years, 9 Dry years, 4 Below Normal years, 7 Above Normal years, and 19 Wet years.

Figure 18: Historical Precipitation in ESJ Subbasin in PCBL Version 3.0



To facilitate assumptions for baseline water supplies and demands, the five San Joaquin Valley water year types were aggregated into three water year type groups. Critical and Dry years are combined into one category in the baseline water year types (called Dry years), Above Normal and Below Normal years are also combined into one category (Normal years), and Wet years remain in one category (called Wet years). With this breakdown, the three baseline water year types have a distribution of 25 Dry years, 11 Normal years, and 19 Wet years. These baseline water year types (Table 8) are used in the remainder of the PCBL data development and results discussion.

As evident in Figure 18, there are four periods of extreme drought in which there are sequences of critical years where the cumulative departure from mean precipitation drops significantly in a steep slope. To capture future extreme dry year periods that may occur in the PCBL, the following 13 water years were designated as Drought periods: 1976-1977, 1987-1992, 2014-2015, and 2020-2022. Drought years are highlighted in red on the x-axis of Figure 18 and distinguished in Table 8.

An 11-year period (WY 2013-2023) of historical hydrology was selected to form the basis of projected data developed by averaging recent historical data. This period was selected because of the reliability of the historical data in Historical ESJWRM Version 3.0 during these years and because the distribution of water year types was relatively consistent with the overall PCBL hydrology. Precipitation data in the PCBL is reflective of historical actual precipitation. Precipitation will be modified under climate change scenarios, as described in Section 5.3.1 of this report.

Table 8: Baseline Hydrologic Water Year Types in PCBL Version 3.0

Baseline Year	Water Year	San Joaquin Valley Water Year Hydrologic Classification	Baseline Year Type	Baseline Year	Water Year	San Joaquin Valley Water Year Hydrologic Classification	Baseline Year Type
1	1969	Wet	Wet	29	1997	Wet	Wet
2	1970	Above Normal	Normal	30	1998	Wet	Wet
3	1971	Below Normal	Normal	31	1999	Above Normal	Normal
4	1972	Dry	Dry	32	2000	Above Normal	Normal
5	1973	Above Normal	Normal	33	2001	Dry	Dry
6	1974	Wet	Wet	34	2002	Dry	Dry
7	1975	Wet	Wet	35	2003	Below Normal	Normal
8	1976	Critical	Drought	36	2004	Dry	Dry
9	1977	Critical	Drought	37	2005	Wet	Wet
10	1978	Wet	Wet	38	2006	Wet	Wet
11	1979	Above Normal	Normal	39	2007	Critical	Dry
12	1980	Wet	Wet	40	2008	Critical	Dry
13	1981	Dry	Dry	41	2009	Below Normal	Normal
14	1982	Wet	Wet	42	2010	Above Normal	Normal
15	1983	Wet	Wet	43	2011	Wet	Wet
16	1984	Above Normal	Normal	44	2012	Dry	Dry
17	1985	Dry	Dry	45	2013	Critical	Dry
18	1986	Wet	Wet	46	2014	Critical	Drought
19	1987	Critical	Drought	47	2015	Critical	Drought
20	1988	Critical	Drought	48	2016	Dry	Dry
21	1989	Critical	Drought	49	2017	Wet	Wet
22	1990	Critical	Drought	50	2018	Below Normal	Normal
23	1991	Critical	Drought	51	2019	Wet	Wet
24	1992	Critical	Drought	52	2020	Dry	Drought
25	1993	Wet	Wet	53	2021	Critical	Drought
26	1994	Critical	Dry	54	2022	Critical	Drought
27	1995	Wet	Wet	55	2023	Wet	Wet

Baseline Year	Water Year	San Joaquin Valley Water Year Hydrologic Classification	Baseline Year Type		Baseline Year	Water Year	San Joaquin Valley Water Year Hydrologic Classification	Baseline Year Type
28	1996	Wet	Wet					

4.1.1.2 Evapotranspiration

No changes to evapotranspiration in ESJ Subbasin were implemented in PCBL Version 3.0. Historical ESJWM Version 3.0 evapotranspiration by land use type and by model subregion is assumed to be consistent into the future. The evapotranspiration will be modified under climate change scenarios, as described in Section 5.3.1 of this report.

4.1.1.3 Streamflow

No change was assumed in PCBL Version 3.0 to all stream inflows. Stream inflows will be modified under climate change scenarios, as described in Section 5.3.1 of this report

4.1.2 Land Use and Cropping Patterns

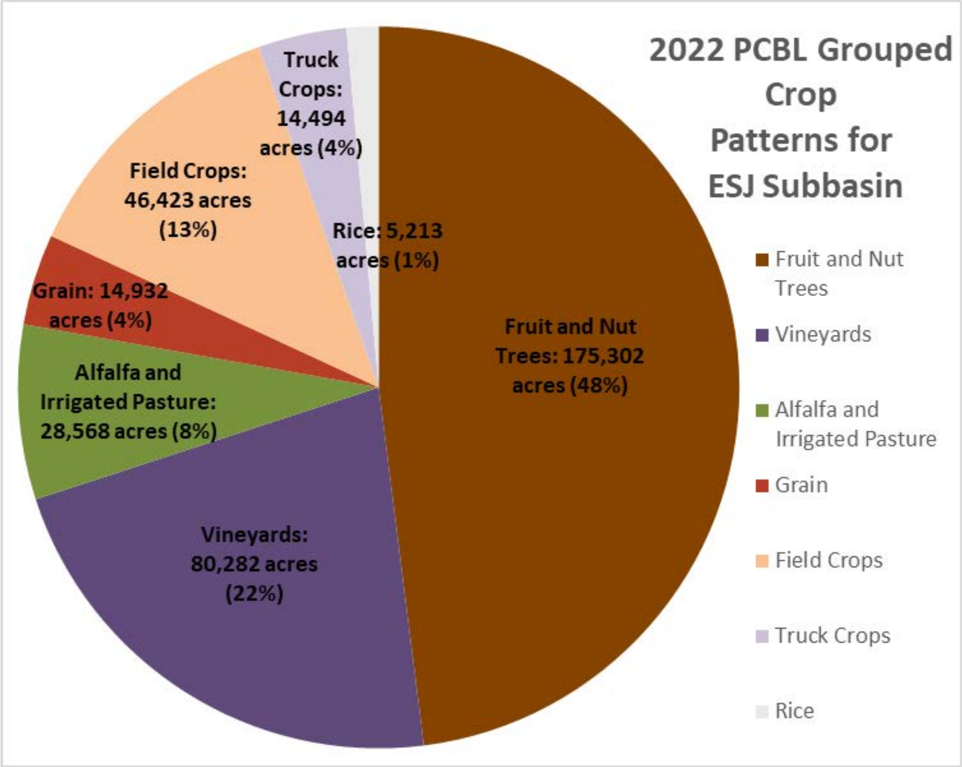
PCBL Version 3.0 used the latest land use dataset available and incorporated urban buildout to reflect the 2040 land use conditions. Land use and cropping patterns are based on the most recent, comprehensive, and model-wide land use survey from DWR (DWR, 2022), with adjustments based on local information and input. This spatial land use data was mapped to ESJWRM model elements and is used as the basis of the PCBL as the latest source of reliable land use data covering the entire model domain. The same edits were made to elements representing LCSD and LCWD to convert agricultural land to urban development, as described above for Historical ESJWRM Version 3.0 discussed in Section 3.2.5 and shown in Figure 2.

To represent the extent of urban buildout in 2040, the urban areas in the 2022 land use dataset were expanded to either the sphere of influence or general plan boundaries and are held constant during the 55 years of the PCBL Version 3.0 simulation. The areas with urban buildout include Lodi, Stockton, Lathrop, Manteca, Ripon, and Escalon. No growth was assumed for the Jenny Lind urban area. While there is agricultural growth anticipated in the eastern areas of the Subbasin and potential conversion of existing agricultural land to permanent irrigated crops, no reliable projections were available to include in the simulation; therefore, no additional agricultural land growth was added to the PCBL. Thus, cropping acreage is reduced only where urban expansion occurs. This means that due to projected urban growth of over 48,000 acres, agricultural acreage is expected to decrease by approximately 32,000 acres and undeveloped acreage decreases by under 16,000 acres. Table 9 shows the differences between the DWR 2022 data and the ultimate baseline acreage once urban buildout was incorporated. Figure 19 is a pie chart of the PCBL Version 3.0 cropping pattern.

Table 9: ESJ Subbasin Land Use Acreages by Land Use Type in PCBL Version 3.0

Land Use Type	DWR 2022 Survey (acres)	Baseline Model (acres)	Change from DWR 2022 Survey (acres)
Ag Acreage	397,749	365,213	-32,536
Urban Acreage	80,712	128,966	48,255
Undeveloped Acreage	274,874	259,155	-15,719
Riparian	11,356	11,356	0

Figure 19: 2022 Grouped Crop Acreage for ESJ Subbasin in PCBL Version 3.0



4.1.3 Water Supply and Demand

Urban water demand in the PCBL Version 3.0 is generally reflective of 2040 conditions. Demand and supply projections were generally available for 2040 or 2045 conditions from urban water management plans (UWMPs). Water demand and supply assumptions are based on the 2020 UWMPs, other planning documents, and the most current information provided by purveyors. Urban demand and supply projections were estimated for three water year types for wet, normal, and dry conditions, with drought periods assumed of critical water supply. Projections for wet years were assumed to be the same as normal conditions when wet year projections were unavailable. After the projected surface water supply and demand were pulled from the planning documents, the projected municipal pumping was calculated as the difference between surface water supply and demand. For modeling purposes, supply was assumed to meet the demand with no surplus.

Agricultural water supply largely used the 11-year averages of grouped water year types from recent historical data (WY 2013-2023). All PCBL annual average surface water diversion volumes are included in Table 4.

In each of the drought period years in the PCBL, it was assumed that the surface water supply delivered was at the 2015 level of supply if lower than the dry year supply. Pumping was increased accordingly if not calculated within the model. In this way, the PCBL is based on the most recent critical year actual historical delivery data and simulates periods of extreme stress on the groundwater system.

4.2 Projected Conditions Baseline Results

This section provides a summary of the ESJWRM PCBL Version 3.0 results.

4.2.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

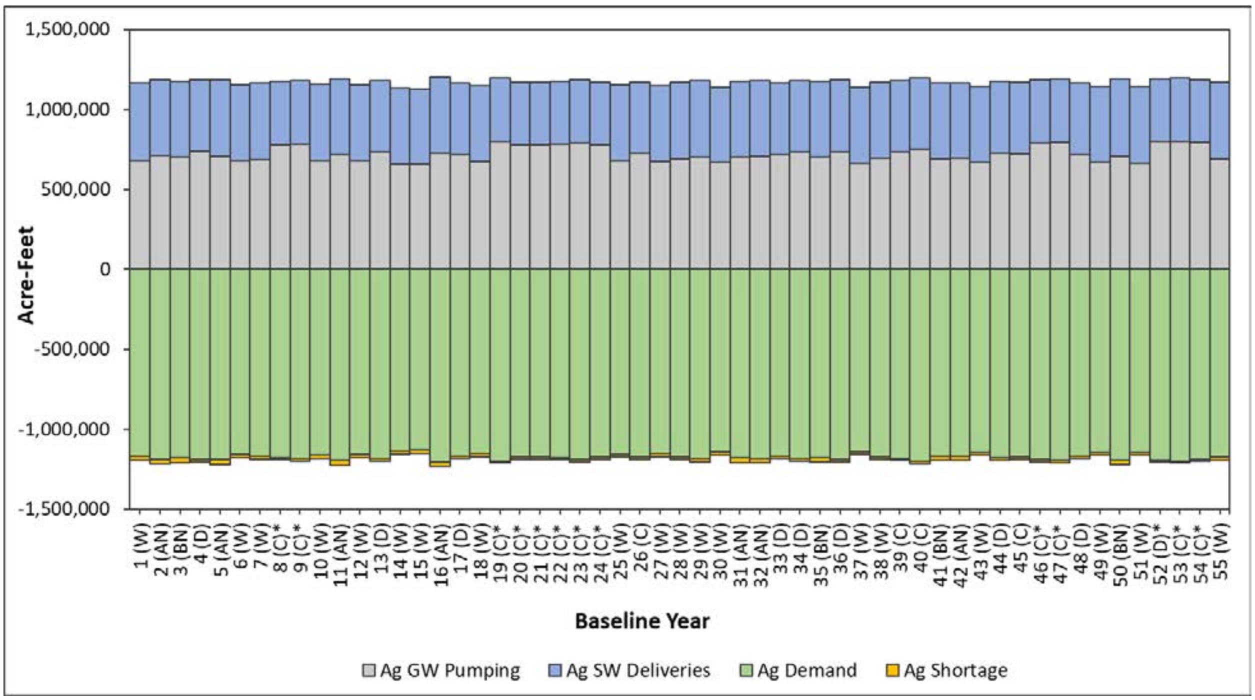
- Inflows:
    - Groundwater pumping
    - Surface water deliveries
    - Shortage (if applicable)
- Outflows:
    - Demand (either agricultural or urban)
    - Surplus (if applicable)

The average annual projected water demand for the Subbasin within the 55-year simulation period is 1,309 thousand acre-feet (TAF), consisting of approximately 1,153 TAF estimated agricultural demand and 156 TAF estimated urban demand. This demand is met by an annual average of 525 TAF of surface water deliveries (452 TAF of agricultural and 73 TAF of urban deliveries) and is supplemented by 788 TAF of groundwater production (721 TAF of agricultural and 67 TAF of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 19 TAF of agricultural surplus and 16 TAF urban shortage in the Subbasin scale water use budget, which is less than significant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 10. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 20 and Figure 21 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 10: ESJ Subbasin Land and Water Use Budget Annual Average of PCBL Version 3.0

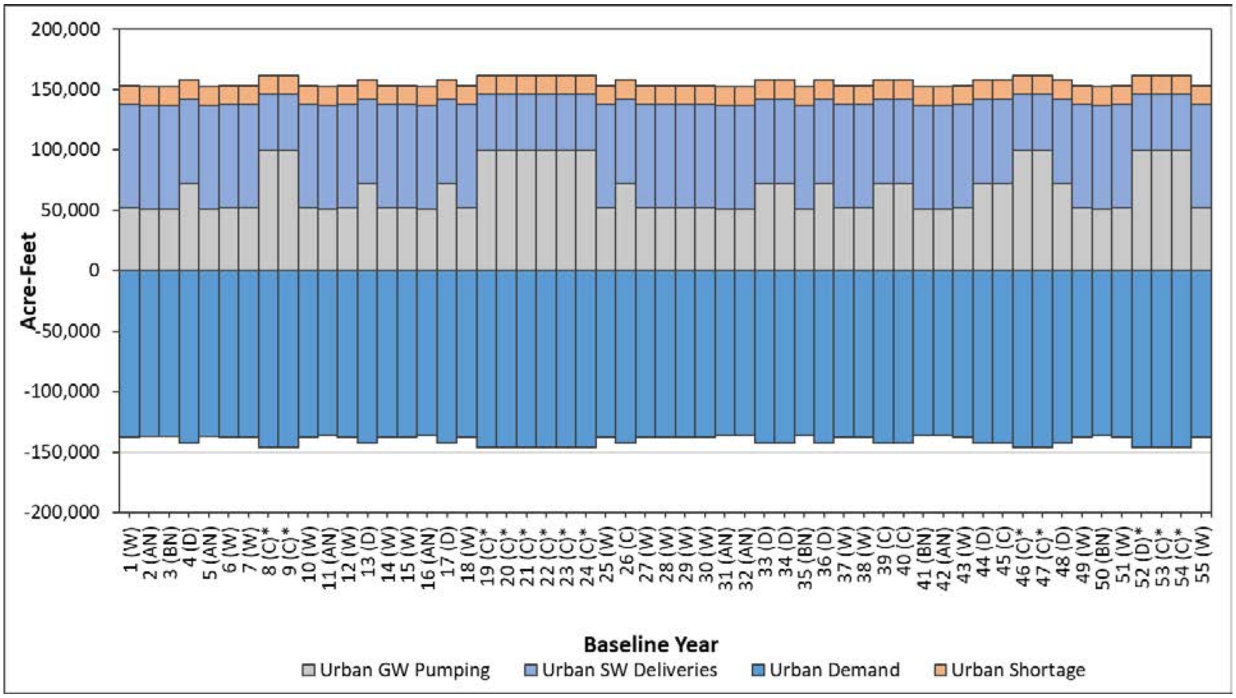
Land and Water Use Budget Component	PCBL Version 3.0 Annual Average
Agricultural Area (thousand acres)	365
Agricultural Demand (TAF)	1,153
Agricultural Groundwater Pumping (TAF)	721
Agricultural Surface Water Deliveries (TAF)	452
Agricultural Surplus (TAF)[1]	19
Urban Area (thousand acres)	129
Urban Demand (TAF)	156
Urban Groundwater Pumping (TAF)	67
Urban Surface Water Deliveries (TAF)	73
Urban Shortage (TAF)[1]	16

Figure 20: ESJ Subbasin Projected Agricultural Demand of PCBL Version 3.0



[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 21: ESJ Subbasin Projected Urban Demand of PCBL Version 3.0



4.2.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

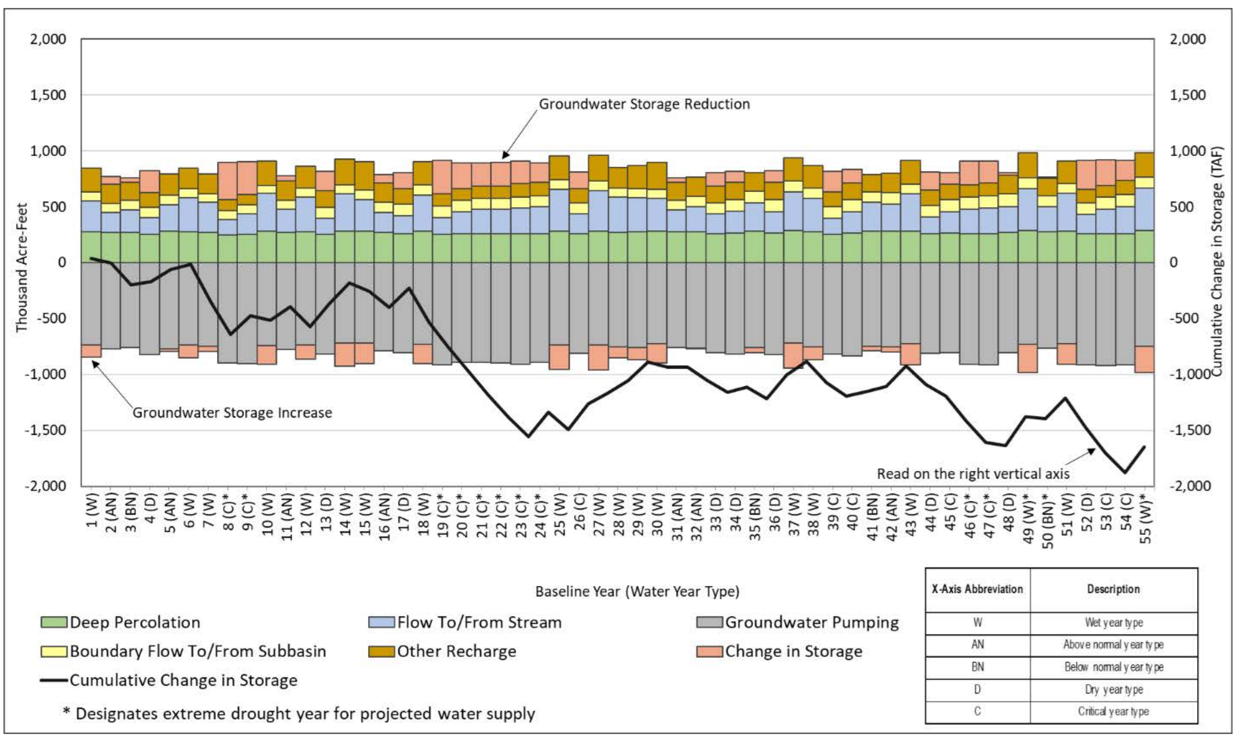
- Inflows:
  - Deep percolation (from rainfall and irrigation applied water)
  - Gain from stream (or recharge due to stream seepage)
  - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
  - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
  - Groundwater pumping
  - Loss to stream (or outflow to streams and rivers)
  - Boundary outflow (to surrounding groundwater subbasins)
  - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL Version 3.0 remains the largest component in the groundwater budget with an annual average 799 TAF. The PCBL offsets this pumping with 270 TAF of deep percolation, a net gain from stream of 240 TAF, 165 TAF of other recharge (includes recharge from unlined canals, reservoir seepage, managed aquifer recharge, and Sierra Nevada Mountain recharge), and a total subsurface inflow of 94 TAF annually. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL is 30 TAFY. These annual averages are shown in Table 11. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 22.

Table 11: ESJ Subbasin Hydrologic Groundwater Budget Annual Average of PCBL Version 3.0

Hydrologic Groundwater Budget Component	PCBL Version 3.0 Annual Average
Deep Percolation (TAF)	270
Deep Percolation of Precipitation (TAF)	*55*
Deep Percolation of Applied Water (TAF)	*215*
Other Recharge (TAF)	165
Net Stream Seepage (TAF)[1]	240
Net Boundary Inflow (TAF)	94
Groundwater Pumping (TAF)	799
Change in Groundwater Storage (TAF)	-30

Figure 22: ESJ Subbasin Projected Hydrologic Groundwater Budget of PCBL Version 3.0



[1] ESJGWA updates the ESJWRM approximately once per year as new data becomes available. Upon completion of the historical ESJWRM Version 3.0, comments regarding Calaveras River seepage were made that require further analysis and may require a recalibration of the model. This additional information on Calaveras River seepage will be considered during the next round of model updates and any edits may cause changes to PCBL Version 3.0.

5 Projected Conditions Baseline Update with Climate Change

With the update of the PCBL Version 3.0, the potential impact of climate change on the Subbasin in the future was also updated. The version of the Projected Conditions Baseline with Climate Change (PCBL-CC) presented in the GSP finalized in November 2019 is called PCBL-CC Version 1.0. The updated version of the PCBL-CC using PCBL Version 2.0 with hydrology perturbation factors was referred to as PCBL-CC Version 2.0. Now, PCBL Version 3.0 with historical perturbation factors is PCBL-CC Version 3.0. Largely, PCBL-CC Version 2.0 and Version 3.0 use the same perturbation factors, but PCBL-CC Version 3.0 extends the simulation time period by three years. This section presents the climate change methodology, data sources, and assumptions used to develop the PCBL-CC Version 3.0 and provides the model results.

In PCBL-CC Version 1.0, the ESJGWA decided to use 2070 Central Tendency perturbation factors as a reasonable estimation of the impact of climate change. PCBL-CC Version 3.0 also used 2070 Central Tendency climate change conditions. This decision may be re-evaluated if DWR updates its climate change methodology or if the Subbasin determines a need to plan for more extreme future scenarios.

5.1 Climate Change Background and Methods

SGMA requires taking into consideration uncertainties associated with climate change in the development of GSPs. Consistent with Section 354.18(d)(3) and Section 354.18(e) of the GSP Regulations, an analysis was performed for the Subbasin evaluating the projected water budget with and without climate change conditions.

Section 354.18(d)(3) of the GSP Regulations states:

"(d) The Agency shall utilize the following information provided, as available, by the Department pursuant to Section 353.2, or other data of comparable quality, to develop the water budget:

(1) Historical water budget information for mean annual temperature, mean annual precipitation, water year type, and land use.

(2) Current water budget information for temperature, water year type, evapotranspiration, and land use.

(3) Projected water budget information for population, population growth, climate change [emphasis added], and sea level rise."

Section 354.18(e) states:

"(e) Each Plan shall rely on the best available information and best available science to quantify the water budget for the basin in order to provide an understanding of historical and projected hydrology, water demand, water supply, land use, population, climate change [emphasis added], sea level rise, groundwater and surface water interaction, and subsurface groundwater flow. If a numerical groundwater and surface water model is not used to quantify and evaluate the projected water budget conditions and the potential impacts to beneficial uses and users of groundwater, the Plan shall identify and describe an equally effective method, tool, or analytical model to evaluate projected water budget conditions."

5.1.1 DWR Guidance

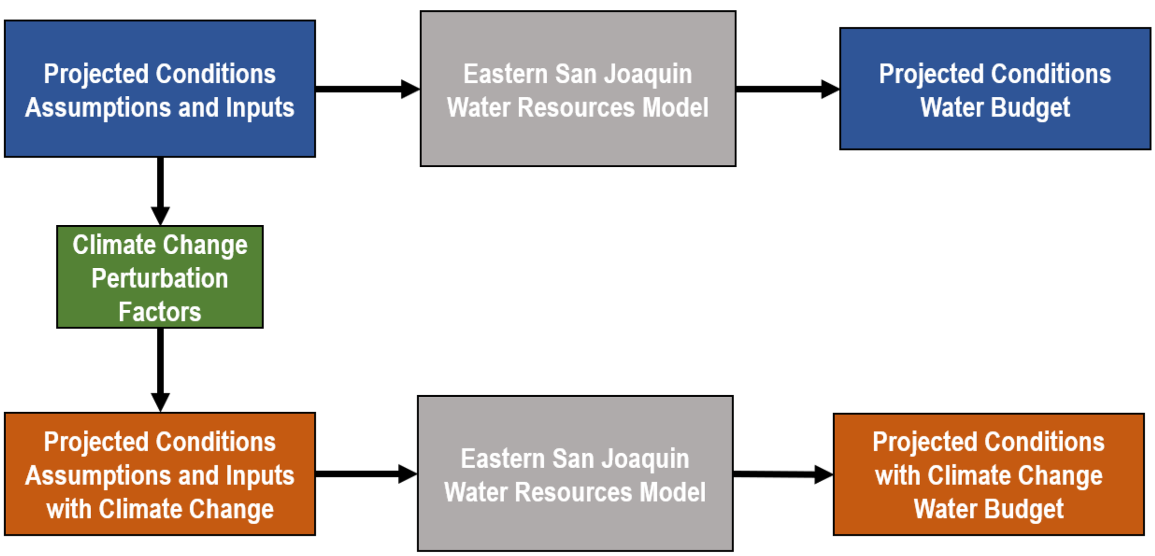
Climate change analysis is an area of continued evolution in terms of methods, tools, forecasted datasets, and the predictions of greenhouse gas concentrations in the atmosphere. The approach developed for this GSP is based on the methodology in DWR's guidance document (DWR, 2018a). The "best available information" related to climate change in the ESJ Subbasin was deemed to be the information provided by DWR combined with basin-specific modeling tools. The following resources from DWR were used in the climate change analysis:

- SGMA Data Viewer
- Guidance for Climate Change Data Use During Sustainability Plan Development and Appendices (Guidance Document)
- Water Budget BMP
- Climate Change Desktop IWFM Tools

The SGMA Data Viewer contains climate change forecast datasets for download (DWR, 2018b). The guidance document details the approach, development, applications, and limitations of the datasets available from the SGMA Data Viewer (DWR, 2018b). The Water Budget BMP describes in greater detail how DWR recommends projected water budgets with climate change be estimated (DWR, 2016). The Desktop IWFM Tools are available to estimate the projected precipitation and evapotranspiration inputs under climate change conditions (DWR, 2018a).

The methods suggested by DWR in the above resources were used, with modifications where needed, to ensure the results would be reasonable for the Eastern San Joaquin Subbasin and align with the assumptions of the ESJWRM. Figure 23 shows the overall process developed for the Subbasin consistent with the Climate Change Resource Guide (DWR, 2018a) and describes workflow beginning with projected conditions inputs and assumptions to perturbed 2070 conditions for the projected conditions.

Figure 23: ESJWRM Climate Change Analysis Process for PCBL-CC Version 3.0



The process described in Figure 23 of developing a projected water budget with and without climate change was discussed with DWR staff before the 2020 GSP was created and is consistent with the regulations. Further, it enables the analysis to account for variability in demand and supply separate from the uncertainty associated with climate change forecasts. Table 12 summarizes the forecasted variable datasets provided by DWR that were used to carry out the climate change analysis (DWR, 2018a). The Variable Infiltration Capacity (VIC) model referred to in Table 12 is the fully mechanistic hydrologic model used by DWR to derive hydrographs under standard and climate change conditions.

Table 12: DWR-Provided Datasets for PCBL-CC Version 3.0

Input Variable	DWR-Provided Dataset
Unimpaired Streamflow	Combined VIC model runoff and baseflow to generate change factors, provided by HUC 8 watershed geometry
Impaired Streamflow (Ongoing Operations)	CalSim II time series outputs
Precipitation	VIC model-generated GIS grid with associated change factor time series for each cell
Reference ETo	VIC model-generated GIS grid with associated change factor time series for each cell

5.1.2 Climate Change Methodology

Accepted methods for estimating climate change impacts on groundwater are based on the assessment of impacts on the individual water resource system elements that directly link to groundwater. These elements include precipitation, streamflow, evapotranspiration and, for coastal aquifers, sea level rise as a boundary condition. For the Subbasin, sea level rise was not included.

The method for perturbing the streamflow, precipitation, and evapotranspiration input files is described in the following sections. A future scenario of 2070 climate forecasts was evaluated in this analysis, consistent with DWR guidance. DWR combined 10 global climate models (GCMs) for two different representative climate pathways (RCPs) to generate the central tendency scenarios in the datasets used in this analysis. The "local analogs" method (LOCA) was used to downscale these 20 different climate projections to a scale usable for California (DWR, 2018a). The 2070 central tendency among these projections serves to assess impacts of climate change over the long-term planning and implementation period.

Model simulation results reported in the published GSP have been updated in this section using the updated PCBL Version 3.0 completed as part of the 2024 update of the historical and projected conditions model. This PCBL Version 3.0 has a 55-year simulation baseline period with hydrology through WY 2023 incorporated. Updates to the PCBL are documented in Section 4. Model results from the updated PCBL-CC Version 3.0 are reported in Section 5.3.

5.2 Projected Conditions Baseline with Climate Change Hydrology

This section provides a summary of the data sources, methodology, and summarized results of the updates to the hydrology under climate change conditions.

5.2.1 Streamflow under Climate Change

Hydrologic forecasts for streamflow under various climate change scenarios are available from DWR as either a flow-based timeseries or a series of perturbation factors applicable to local data. DWR simulates volumetric flow in most regional surface water bodies by utilizing the Water Resource Integrated Modeling System (WRIMS, formally named CalSim II). While river flows and surface water diversions in the Calaveras, San Joaquin, and Stanislaus Rivers are simulated in CalSim II, there are significant variations when compared to local historical data. Due to the uncertainty in reservoir operations, flows from CalSim II provided by the state are not used directly. Instead, relative perturbation factors were used to derive surface water inflows and diversions for use in ESJWRM.

Local tributaries and smaller streams within ESJ Subbasin are not simulated in CalSim II and must be simulated using adjustment factors developed by DWR for unregulated stream systems. Dry Creek flows were perturbed using this method. The resolution of these perturbation factors is at the Hydrologic Unit Code 8 watershed scale. CalSim II model runs are not available for the Mokelumne River, according to Appendix B, Table B-2 of DWR's Climate Change Document (DWR, 2018a). Therefore, Mokelumne River flows used the perturbation factor method for consistency with the methodology applied to smaller streams. Though Mokelumne River is regulated by Camanche Reservoir, the climate change methodology available at the time did not make it possible to treat the river as impaired; this assumption will be revisited in future updates to climate change factors and methodology. The remaining streams simulated in the ESJWRM utilize the IWFM small watershed package, whose climate change impacts are calculated internally dependent on both precipitation and evapotranspiration refinement. Table 13Table 13: ESJWRM Stream Inflows presents the impaired and unimpaired streams in the ESJWRM for the Subbasin.

Table 13: ESJWRM Stream Inflows in PCBL-CC Version 3.0

Modeled Stream	Impaired	Unimpaired
Within ESJ Subbasin		
Dry Creek		X
Mokelumne River		X
Calaveras River	X	
San Joaquin River	X	
Stanislaus River	X	
Within Model Area, Outside ESJ Subbasin		
Tuolumne River	x	
Cosumnes River	x	

5.2.1.1 Unimpaired Flows

Change factors for unimpaired streams (Dry Creek and Mokelumne River) were downloaded from SGMA Data Viewer and multiplied by the projected conditions input streamflow data to calculated perturbed flows. DWR change factors are available through 2011; however, the model hydrologic period runs from WY 1969-2023. Flows for the remaining model years beyond 2011 were synthesized using the change factor from the most recent matching water year type in the available dataset. Water Year types are designated for each year based on the San Joaquin Valley Runoff WY year type index (DWR CDEC). DWR uses five designations ranging from driest to wettest conditions: Critical, Dry, Below Normal, Above Normal, and Wet. Table 14Table 14: San Joaquin Valley Water Year Type Designations below shows the year type designations used to synthesize the remaining years (2011-2023).

The PCBL-CC Version 1.0 reported in the GSP only used hydrology baseline years through 2018. In the updated PCBL-CC Version 2.0, WY 2019 and WY 2020 were incorporated. In PCBL-CC Version 3.0, WY 2021, 2022, and 2023 were incorporated and added to Table 14 below. The climate change perturbation was carried out for the additional years of simulation using methods consistent with how the rest of the synthesized years were calculated in the GSP for unimpaired streamflows.

As part of the update to the PCBL Version 2.0, South San Joaquin Irrigation District (SSJID) outflows were incorporated as a new stream inflow to the model. However because these are operationally dependent flows, they were not perturbed in this climate change scenario.

Table 14: San Joaquin Valley Water Year Type Designations

Water Year	Year Type
2003	Below Normal
2004	Dry
2005	Wet
2006	Wet
2007	Critical
2008	Critical
2009	Below Normal
2010	Above Normal
2011	Wet
2012	Dry
2013	Critical
2014	Critical
2015	Critical
2016	Dry
2017	Wet
2018	Below Normal
2019	Wet
2020	Dry
2021	Critical
2022	Critical
2023	Wet

Figure 24 shows the perturbed time series against the projected conditions scenario time series for Dry Creek through the 55-year simulation period and Figure 25 presents the exceedance probability curve. Figure 26 and Figure 27 show the same perturbed time series and exceedance curves, but for Mokelumne River. The exceedance curves are provided because they more clearly show the differences between the projected conditions scenario and the with-climate-change scenario. Generally, flows under the climate change scenario are slightly higher.

Figure 24: Dry Creek Hydrograph for PCBL-CC Version 3.0

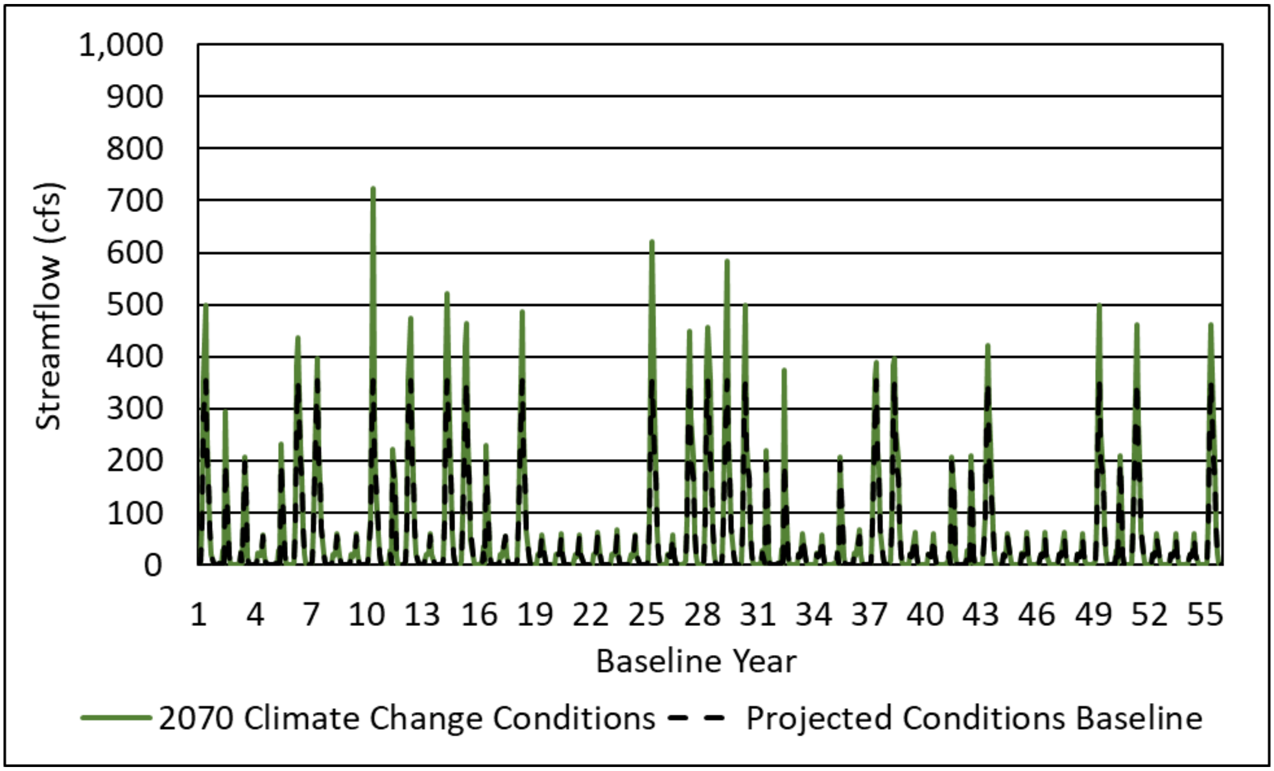


Figure 25: Dry Creek Exceedance Curve for PCBL-CC Version 3.0

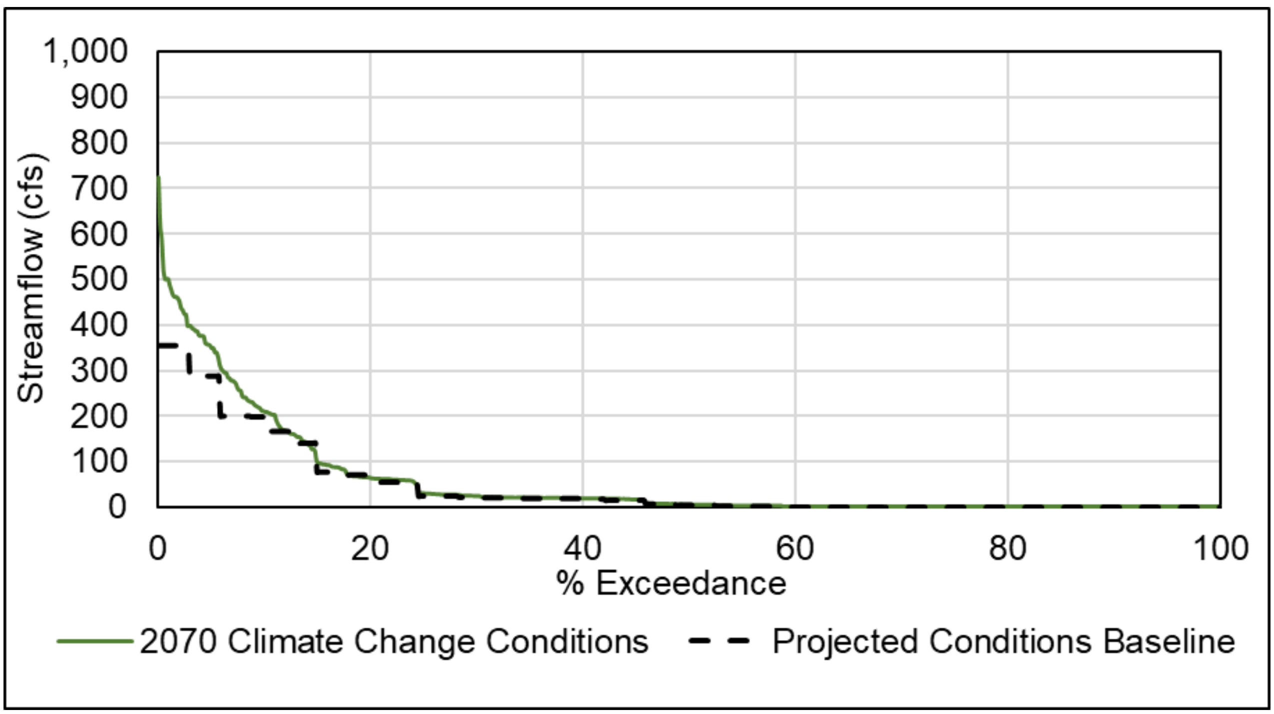


Figure 26: Mokelumne River Hydrograph for PCBL-CC Version 3.0

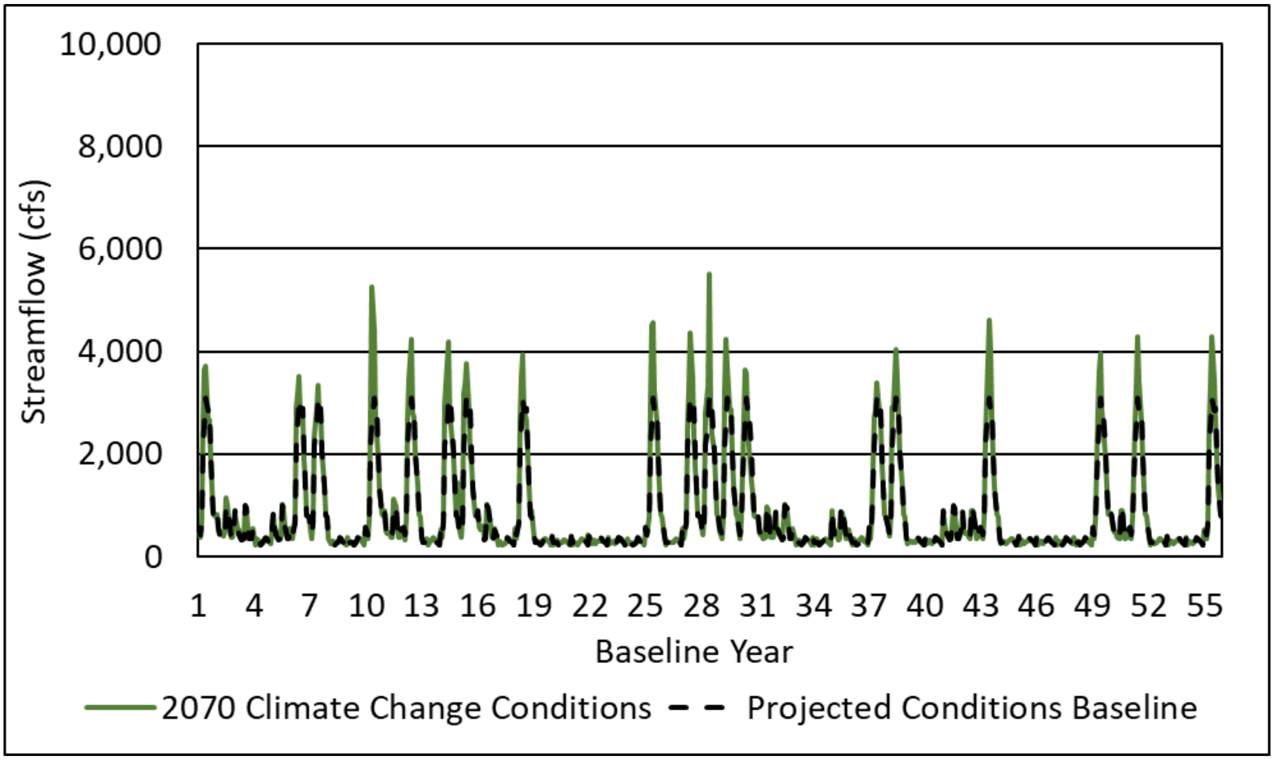
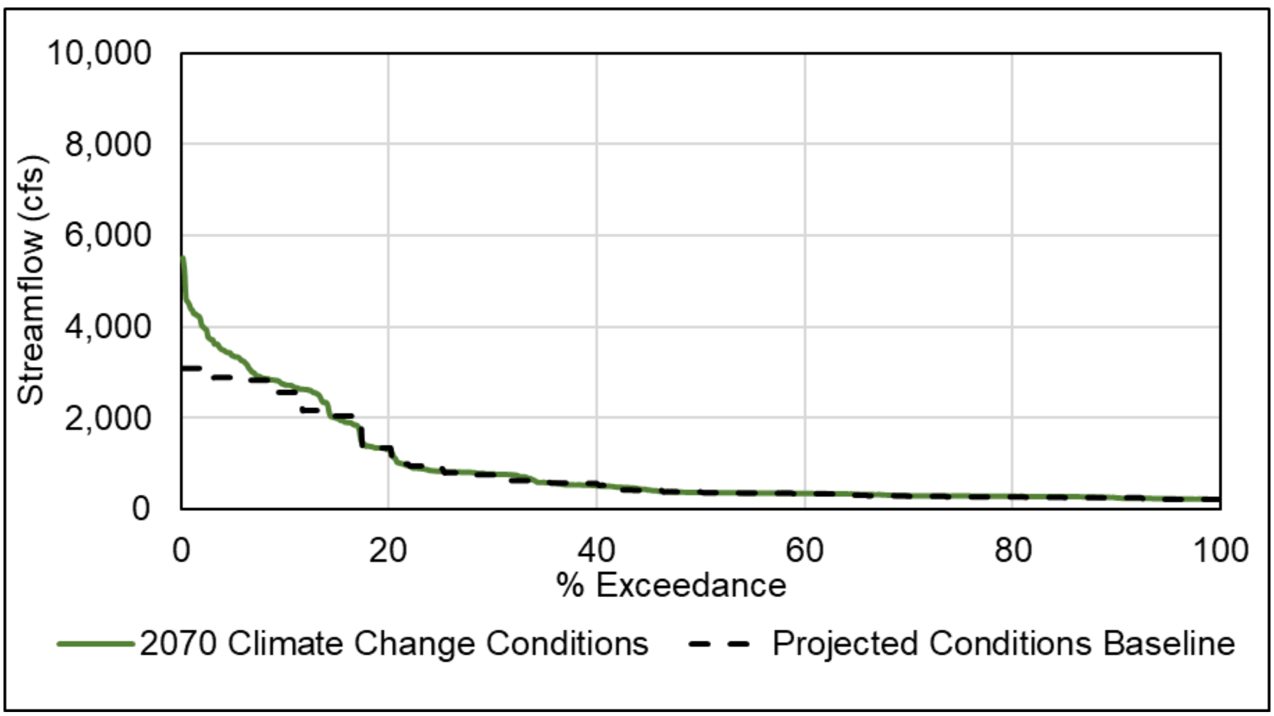


Figure 27: Mokelumne River Exceedance Curve for PCBL-CC Version 3.0



5.2.1.2 Impaired Flows

CalSim II-estimated flows for point locations on the Calaveras River, San Joaquin River, and Stanislaus River were downloaded from DWR. These points obtained from CalSim II include:

- Calaveras River: New Hogan Reservoir Outflow
- San Joaquin River: San Joaquin River at Vernalis
- Stanislaus River: New Melones Reservoir Outflow

These flows represent projected hydrology based on reservoir outflow, operational constraints, and diversions and deliveries of water for the State Water Project and the Central Valley Project. CalSim II data from WY 1969-2003 were available. For the years 2003-2023, streamflow was synthesized based on flows from WY 1969-2003 and the DWR year type index shown in Table 14. For example, the total monthly streamflow for October 2003 was calculated as the average of the monthly streamflows from October 1966 and October 1971 because they are the same water year type.

CalSim II simulated flows were compared with flows generated using the DWR-provided unimpaired perturbation factors. Streamflows simulated in CalSim II and those derived using the unimpaired adjustment factors did not present similar trends, particularly in dry years, due to CalSim II's simulation of reservoir operations. DWR-provided unimpaired change factors do not account for variations in the operation of the reservoirs that would result from climate change conditions. Therefore, CalSim II outputs were considered a more appropriate starting dataset for regulated streams given that downstream flow is driven by surface water demand rather than natural flow.

The team explored a hybrid approach to improve upon the discrepancy between flows produced using CalSim II and perturbation factors, while accounting for some change in reservoir operations. In this approach, change factors are generated from the difference between the simulated future climate change CalSim II scenario for 2070 climate conditions and a "without climate change" CalSim II run. This "without climate change" run is the CalSim II 1995 Historical Detrended simulation run. The generated change factors from these two runs were then used to perturb the regulated river inflows simulated in the ESJWRM projected conditions scenario. For the purposes of simplicity, this method is referred to throughout the rest of the document as CalSim II Generated Perturbation Factors (CGPF). The CGPF method presents limitations given that the resulting flows are not directly obtained from an operations model. The actual mass balance on the reservoirs is not tracked in the estimates of the flows and, instead, the method relies on CalSim II tracking storage and managing the reservoir based on the appropriate rule curves.

The climate change perturbation was carried out for the additional years of simulation using methods consistent with how the rest of the synthesized years were calculated in the GSP for impaired streamflows.

Figure 28 through Figure 33 provide a comparison of project baseline condition and the results of the CGPF method described above for each stream within the ESJ Subbasin, updated for the 55-year simulation. Figure 34 through Figure 37 show the same hydrographs for streams within the model area, but outside of the ESJ Subbasin. Exceedance curves are included for each of the CGPF flows against the project baseline flows.

Figure 28: Calaveras River Hydrograph for PCBL-CC Version 3.0

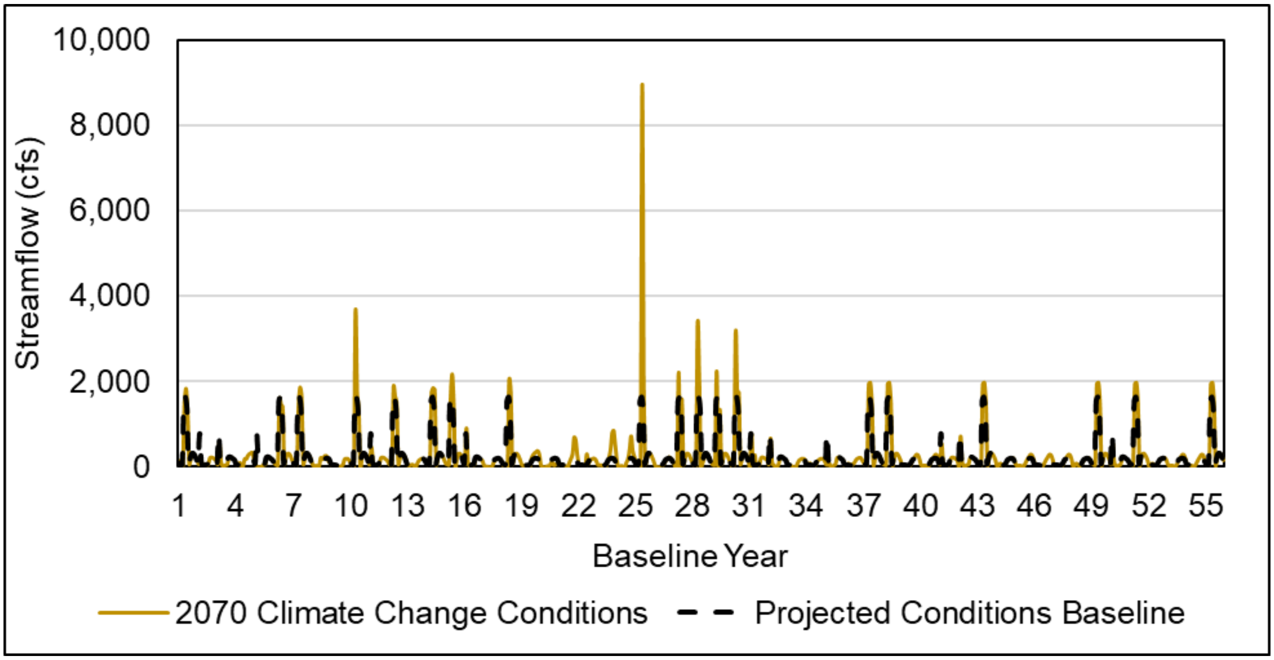


Figure 29: Calaveras River Exceedance Curve for PCBL-CC Version 3.0

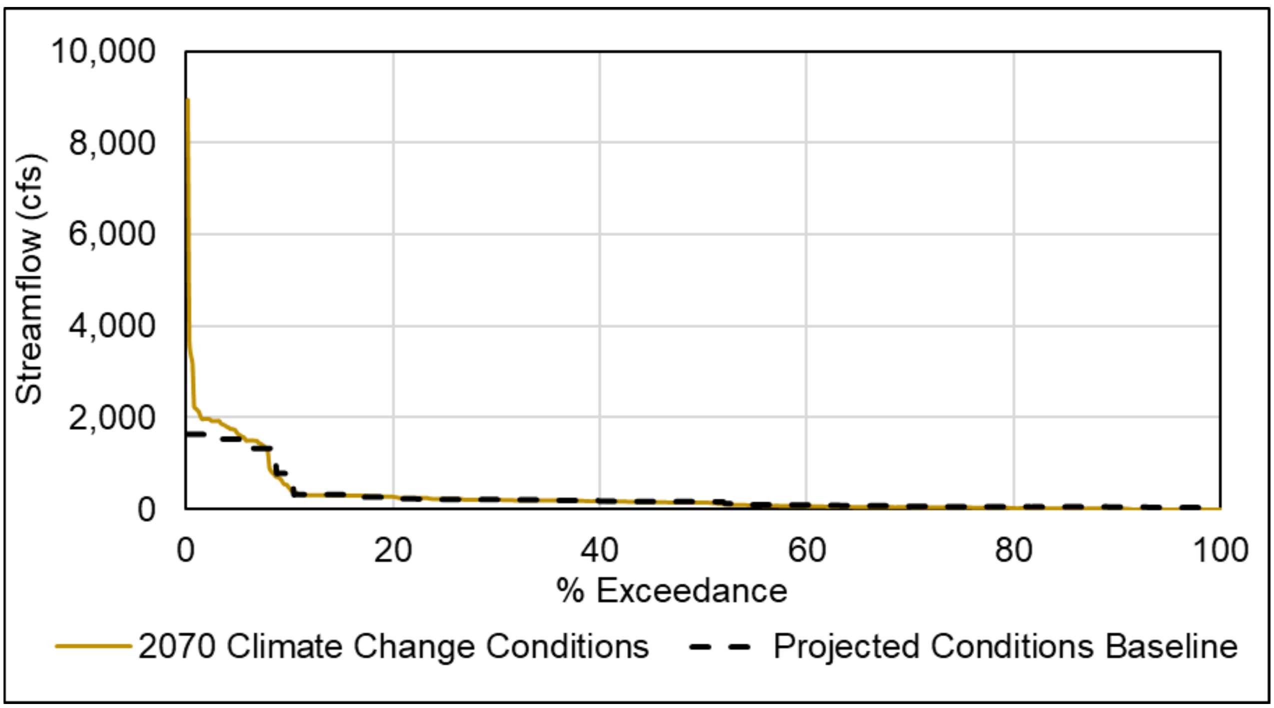


Figure 30: Stanislaus River Hydrograph for PCBL-CC Version 3.0

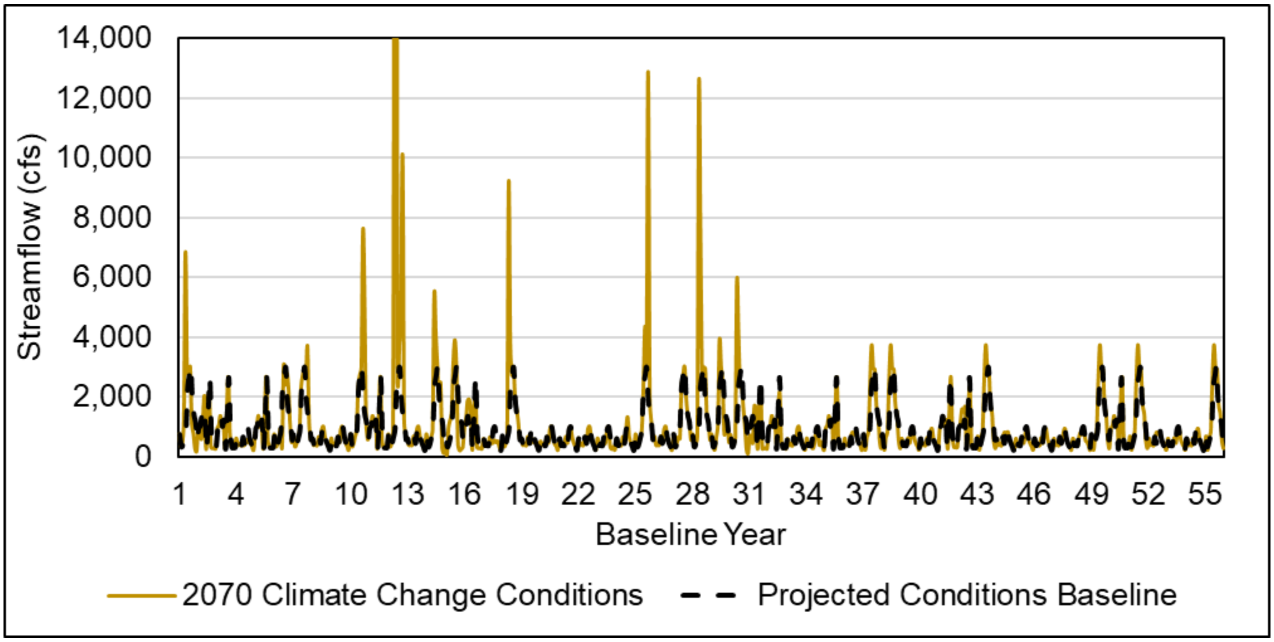


Figure 31: Stanislaus River Exceedance Curve for PCBL-CC Version 3.0

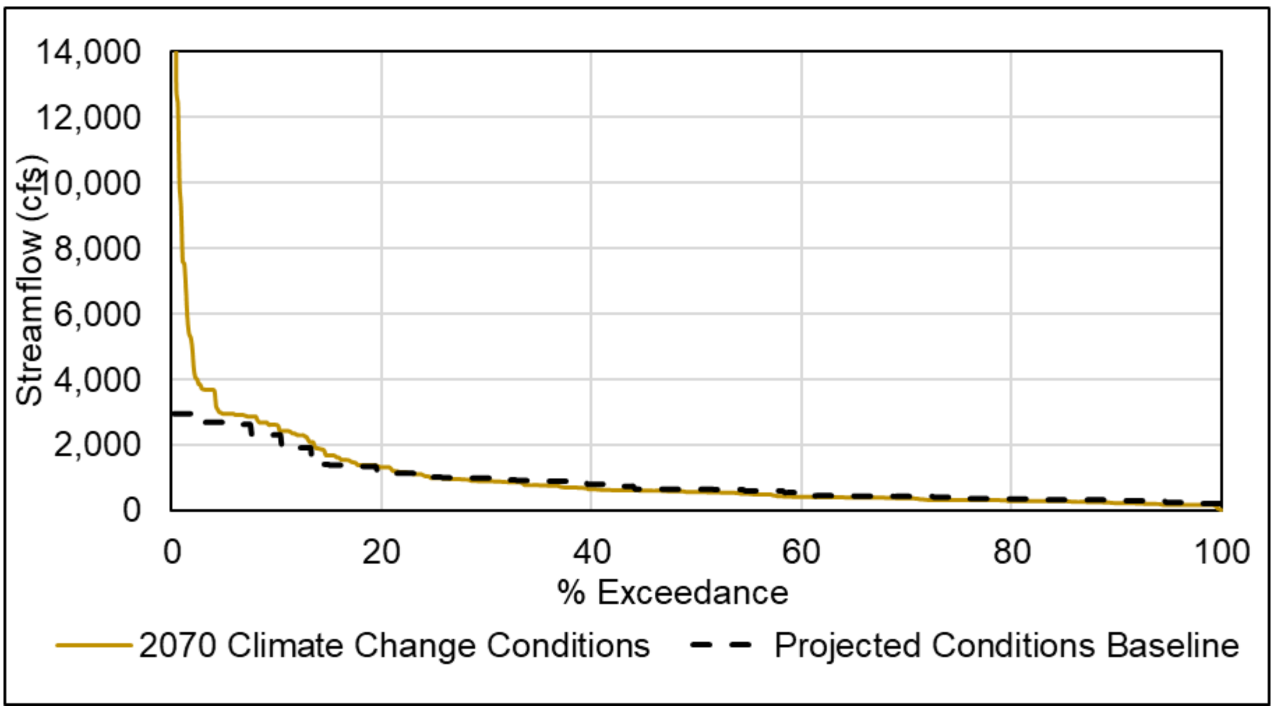


Figure 32: San Joaquin River Hydrograph for PCBL-CC Version 3.0

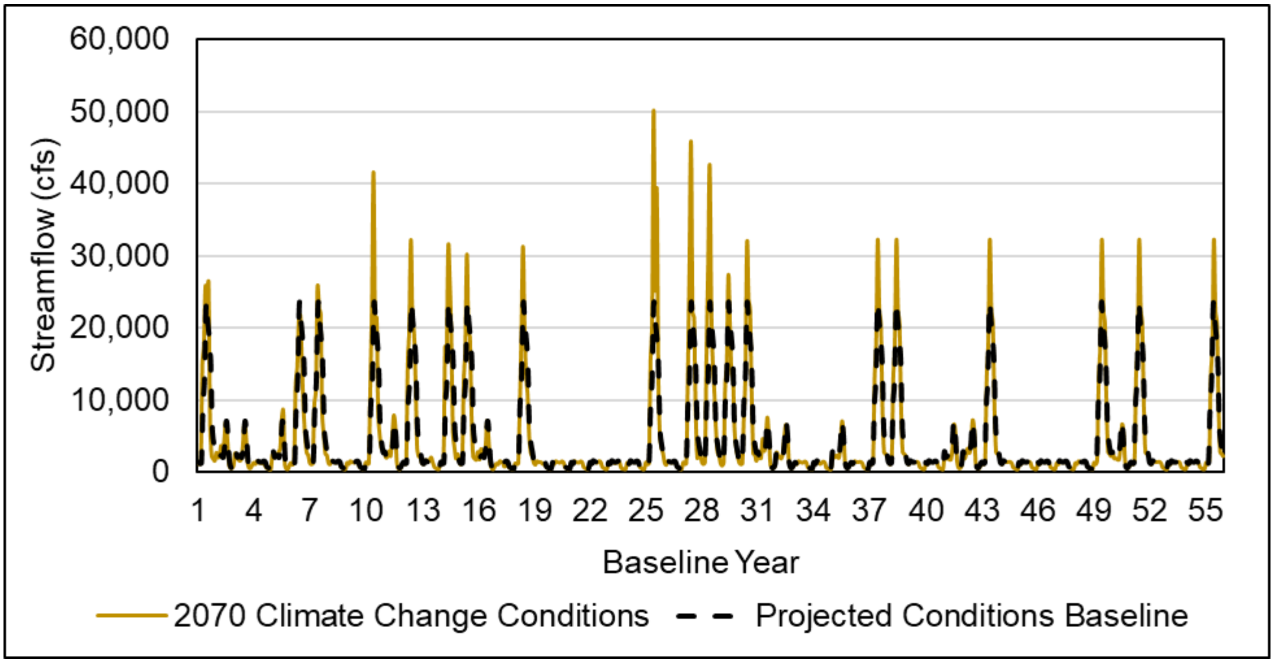


Figure 33: San Joaquin River Exceedance Curve for PCBL-CC Version 3.0

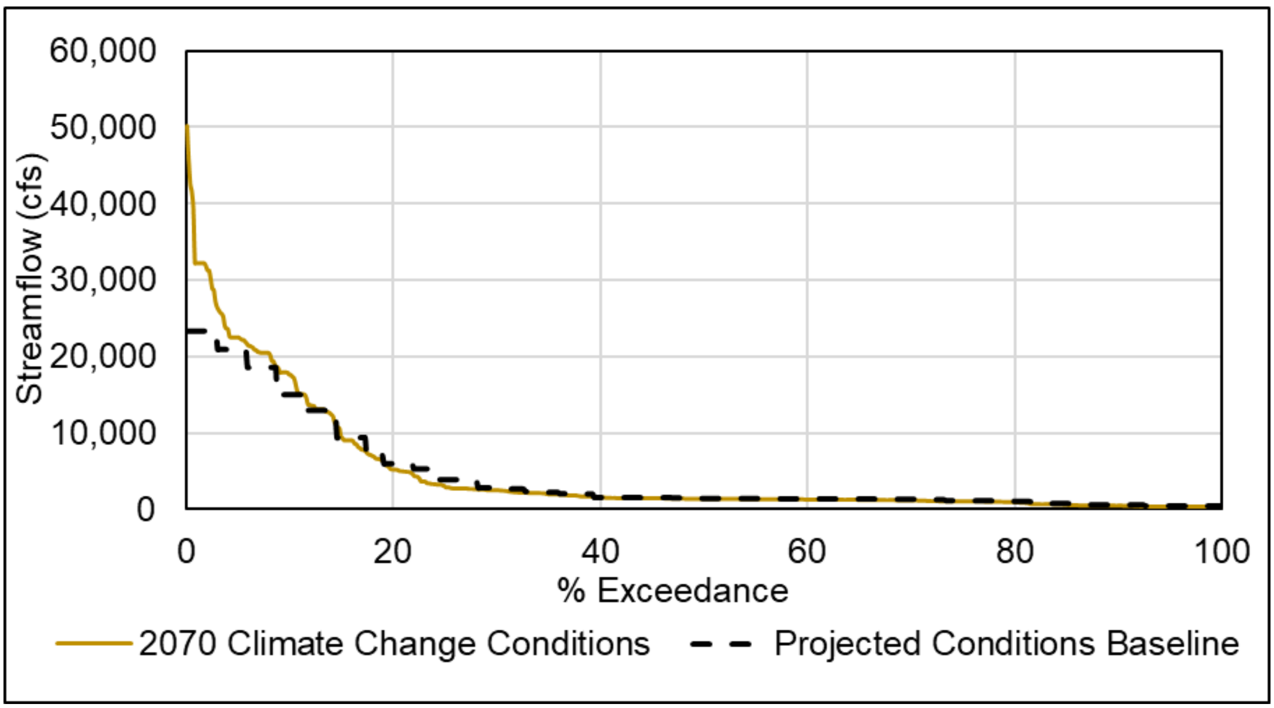


Figure 34: Tuolumne River Hydrograph for PCBL-CC Version 3.0

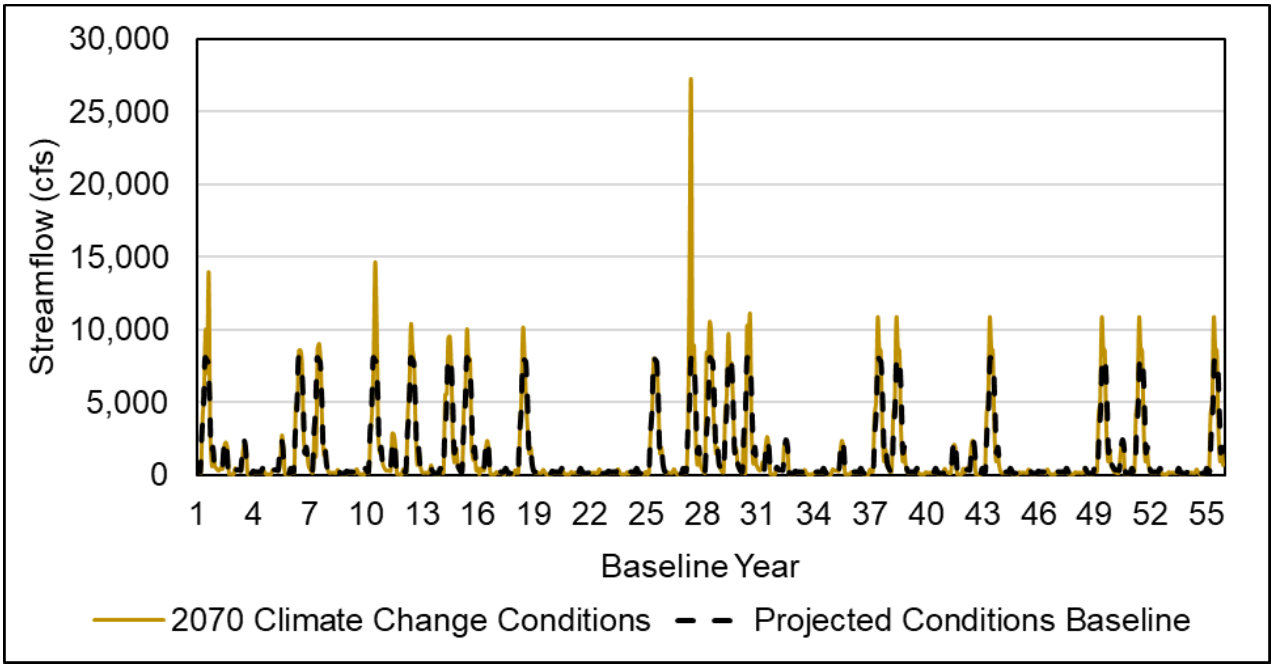


Figure 35: Tuolumne River Exceedance Curve for PCBL-CC Version 3.0

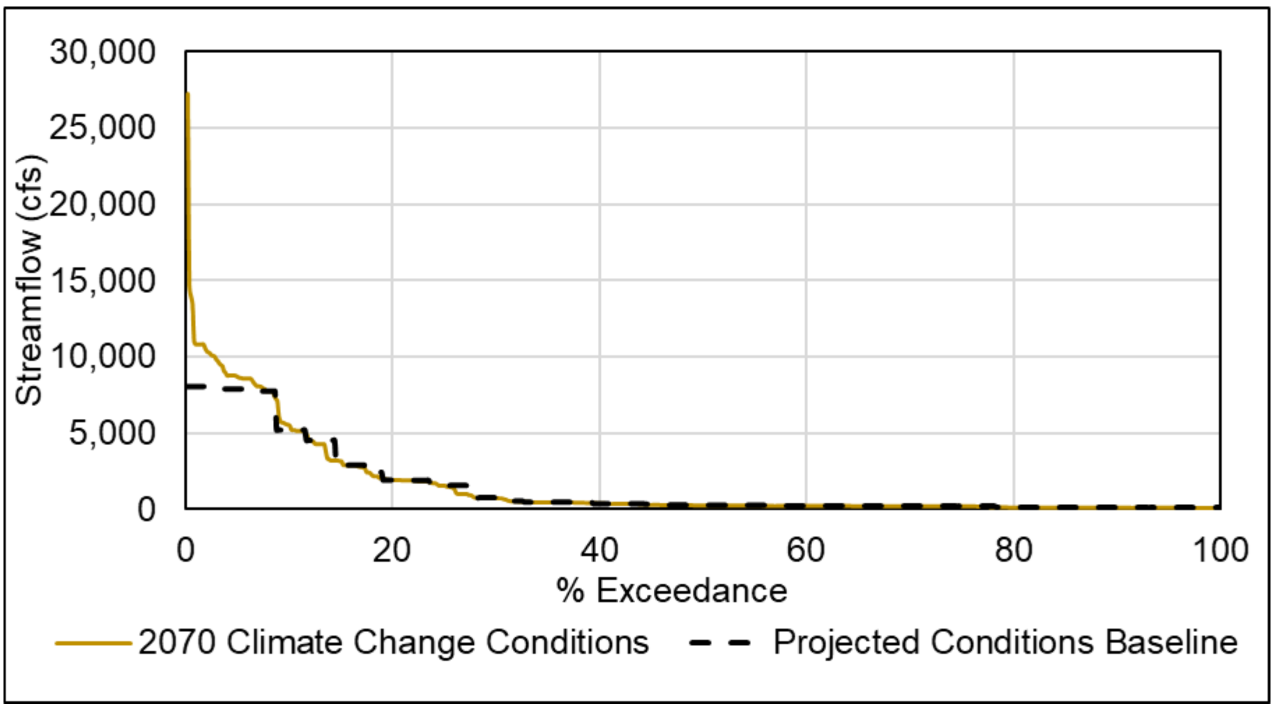


Figure 36: Cosumnes River Hydrograph for PCBL-CC Version 3.0

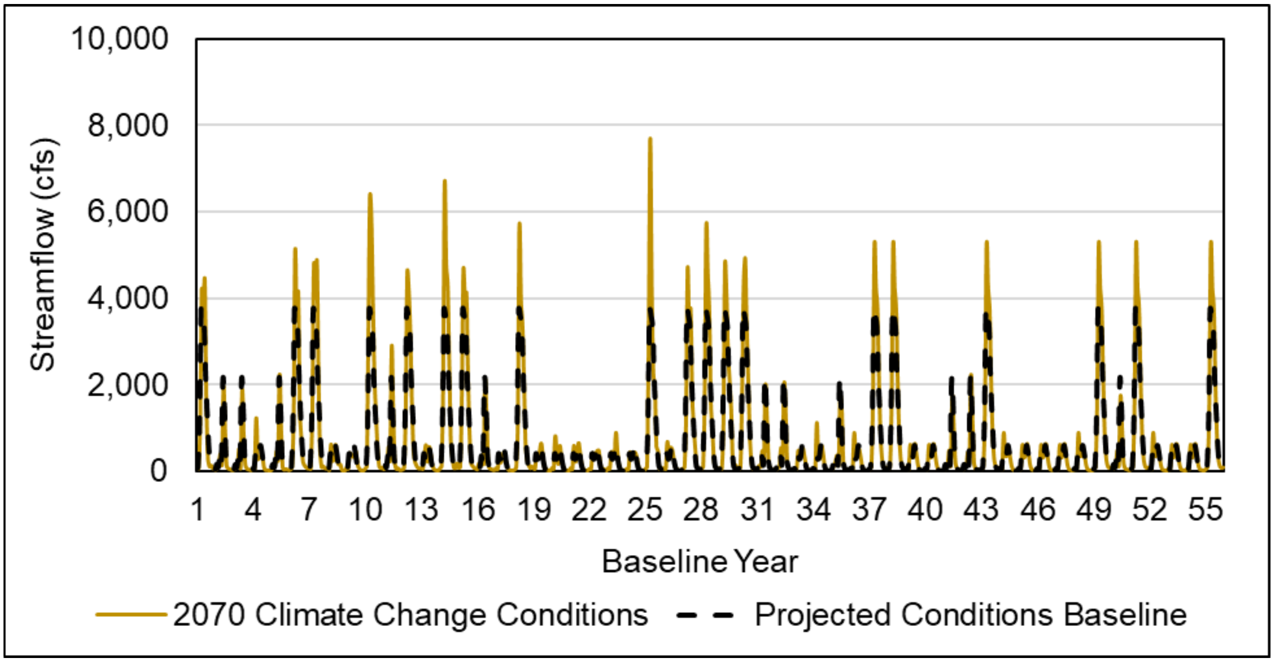
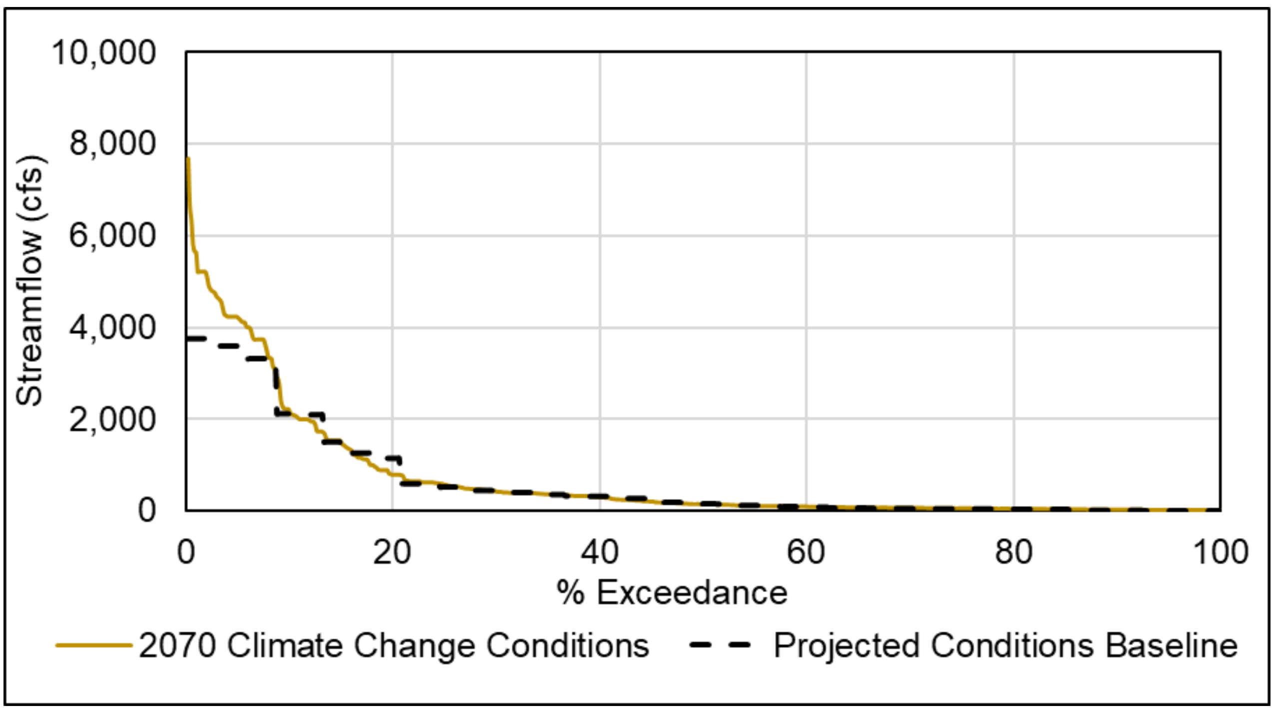


Figure 37: Cosumnes River Exceedance Curve for PCBL-CC Version 3.0



5.2.2 Precipitation and Evapotranspiration under Climate Change

Projected precipitation and evapotranspiration (ETo) change factors were calculated using a climate period analysis based on historical precipitation and ETo from January 1915 to December 2011 (DWR, 2018a). DWR used a macroscale hydrologic model that solves the water balance of a watershed, called the VIC Model. Change factors provided by DWR were calculated as a ratio of the value of a variable under a “future scenario” divided by a baseline. That baseline data is the 1995 Historical Temperature Detrended scenario downscaled from GCM climate data. The “future scenario” corresponds to VIC outputs of the simulation of future conditions using GCM forecasted hydroclimatic variables as inputs. These change factors are thus a simple perturbation factor that corresponds to the ratio of a future with climate change divided by the past without it. Change factors are available on a monthly time step and are spatially defined by the VIC model grid. Supplemental tables with the time series of perturbation factors are available from DWR for each grid cell. DWR has made accessible a Desktop GIS tool for both IWFM and MODFLOW to process these change factors (DWR, 2018b).

5.2.2.1 Applying Change Factors to Precipitation

DWR change factors were multiplied by historical precipitation to generate projected precipitation under the 2070 central tendency future scenario using the Desktop IWFM GIS tool (DWR, 2018b). The tool calculates an area weighted precipitation change factor for each model grid geometry. This model grid geometry was based on polygons generated around the PRISM nodes within the model region used to specify rainfall depths.

However, the DWR tool only includes change factors through 2011. The remaining years of the time series were synthesized according to historically comparable water years. The perturbation factor from the corresponding month of the comparable year was applied to the baseline of the missing years (2012-2023) to generate projected values. Months with no precipitation in the baseline were assumed to have a monthly precipitation of 1 mm under climate change to account for increased precipitation that cannot be calculated from a baseline of 0 mm for these synthesized years. The comparable years that were used can be found in Table 15. These comparable years were determined by comparing total San Joaquin Valley runoff, DWR year type index, and total annual Subbasin precipitation.

Table 15: Comparable Water Years (based on Precipitation) for PCBL-CC Version 3.0

Water Year Not Available in DWR Tool	Comparable Water Year
2012	2001
2013	1991
2014	1987
2015	1977
2016	2002
2017	1983
2018	1983
2019	2016
2020	2013
2021	2014
2022	2013
2023	2017

The resulting perturbed precipitation values and the baseline precipitation values for the representative historical period can be found in Figure 38. The exceedance plot for these two times series can be found in Figure 39, both updated for 55 years of projected conditions simulation. The absolute difference between the PCBL-CC Version 3.0 and the PCBL Version 3.0 are shown in Figure 40.

Figure 38: Perturbed Precipitation Under Climate Change for PCBL-CC Version 3.0

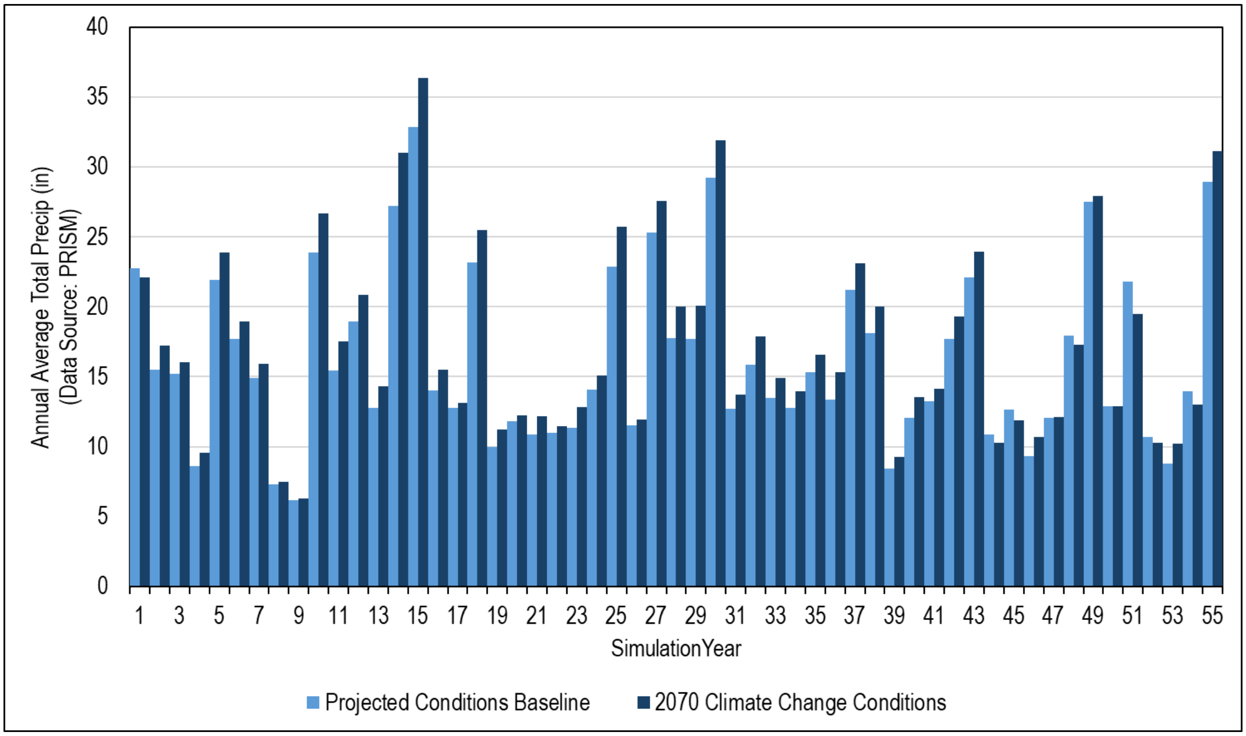


Figure 39: Perturbed Precipitation Exceedance Curve for PCBL-CC Version 3.0

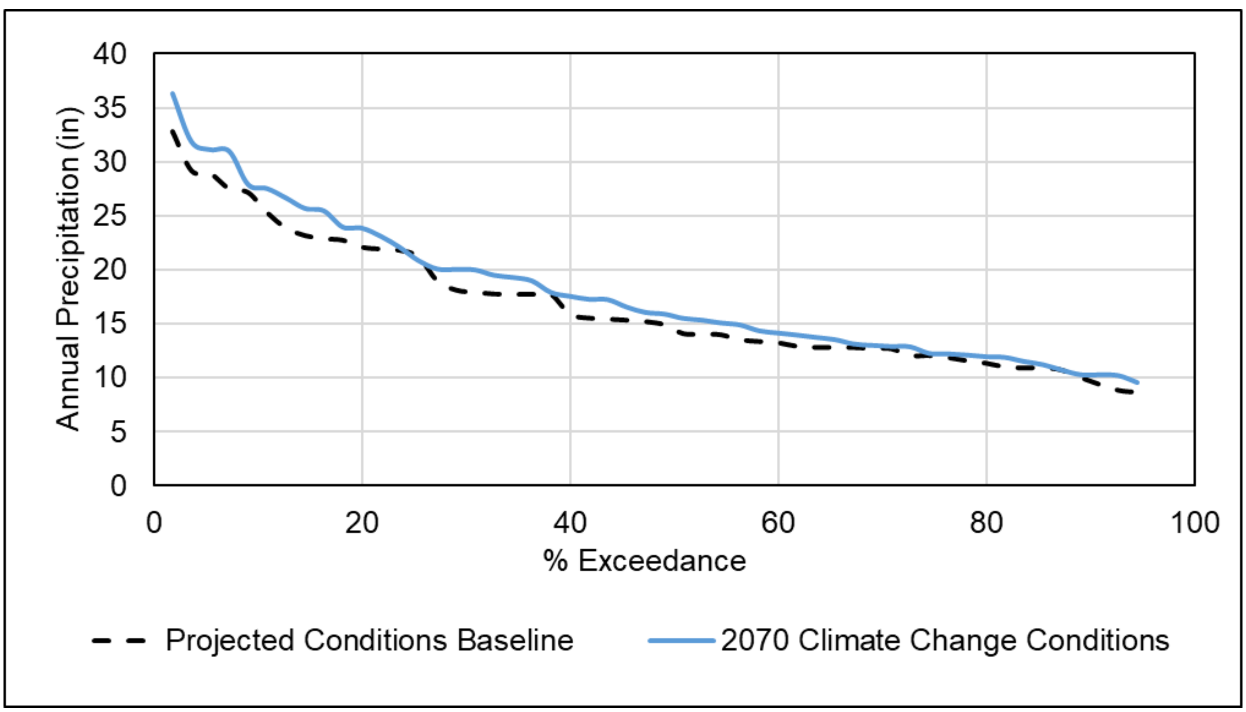
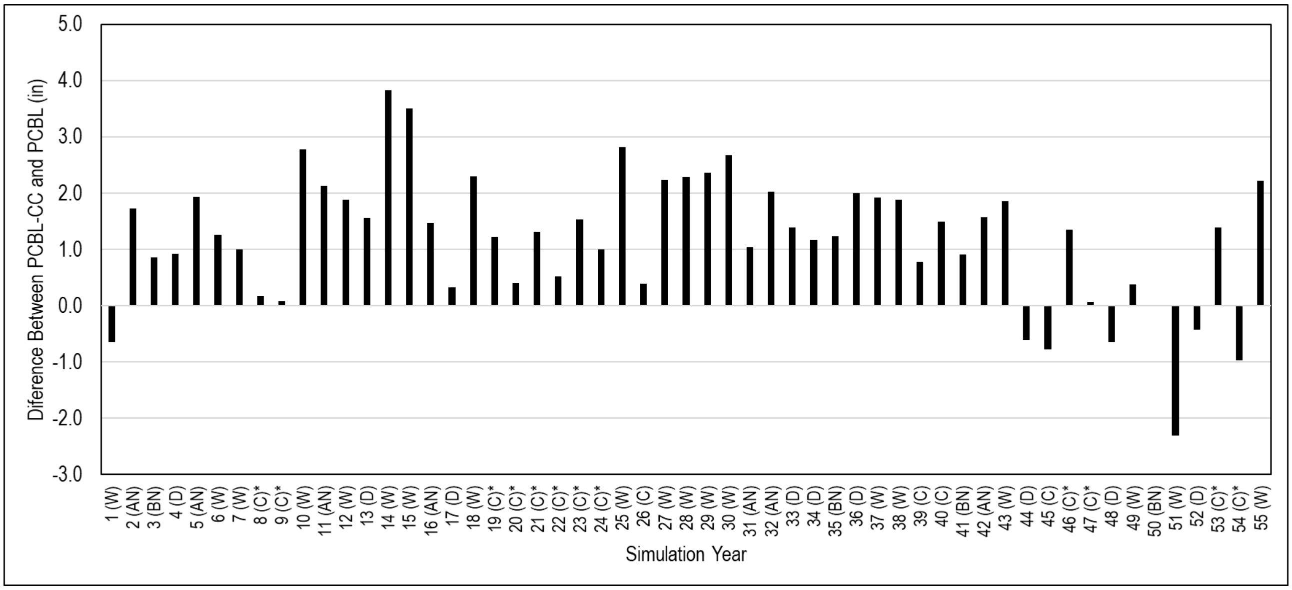


Figure 40: Subbasin Precipitation Difference with Climate Change Conditions for PCBL-CC Version 3.0



5.2.2.2 Applying Change Factors to Evapotranspiration

Potential ETo in the Subbasin varies geographically and by land use. The tool provided by DWR to process ETo was not used because of the minimal spatial variation in ETo in the Subbasin. DWR provides change factors for ETo that vary spatially based on the VIC model grid as described above. Change factors for November 1, 1964 through December 1, 2011 were averaged. For the purposes of this analysis, a localized averaged change factor of 1.082 or 1.084 was used depending on the crop type and where in the Subbasin that crop can be found. All ETo in the Subbasin is expected to increase. However, almonds, pistachios, walnuts, cherries, pasture, corn, and rice ETo are expected to increase more with climate change in the South of the Subbasin in comparison to the North. All land uses in the South and the remaining crops in the North are perturbed with a single average change factor of 1.084.

This average ETo change factor was then applied to the historical ETo time series for each crop type. Because there is currently no interannual variability in ETo in ESJWRM, the same perturbed time series was applied across all simulation years. Refinement to the simulated evapotranspiration of almonds, walnuts, and cherries under 2070 climate conditions is shown in Figure 41 through Figure 43.

There were no changes made to the projected conditions simulation for evapotranspiration in the PCBL Version 3.0 model update. Additionally, as is currently set up in the model, there is no variation by year, only by month. Therefore, there were no adjustments made to the evapotranspiration model input under the projected conditions with climate change scenario while extending the model through the 55 year simulation.

Figure 41: Monthly Evapotranspiration Variability for Almonds for PCBL-CC Version 3.0

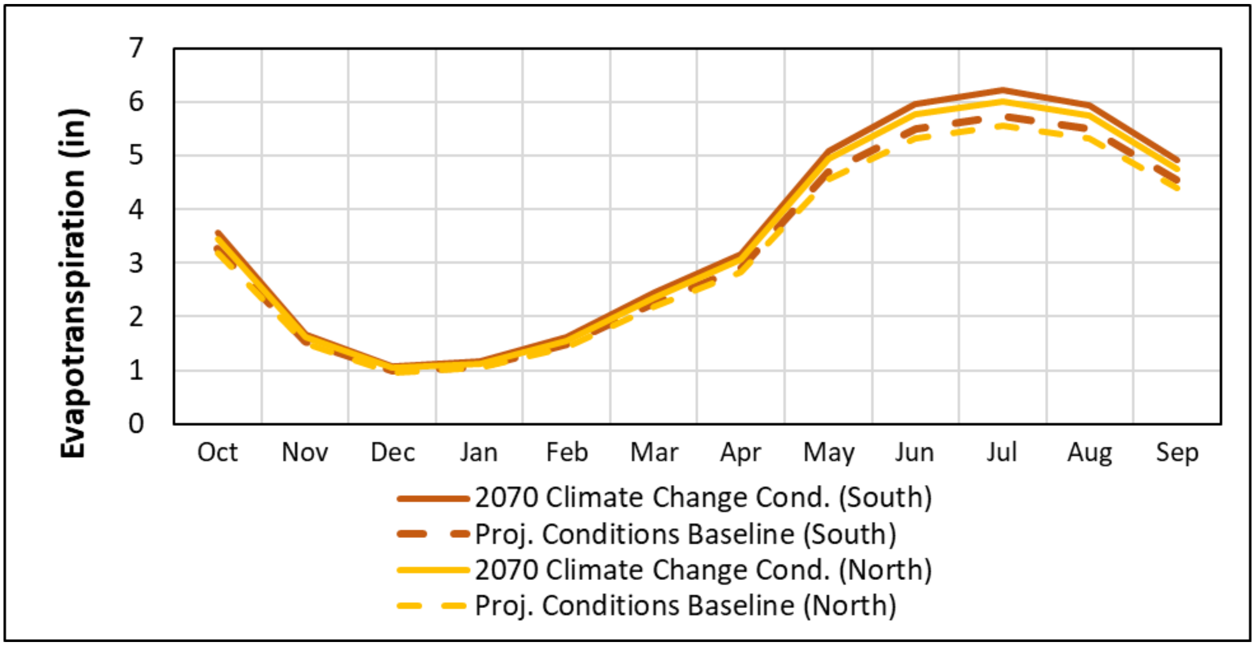


Figure 42: Monthly Evapotranspiration Variability for Walnuts for PCBL-CC Version 3.0

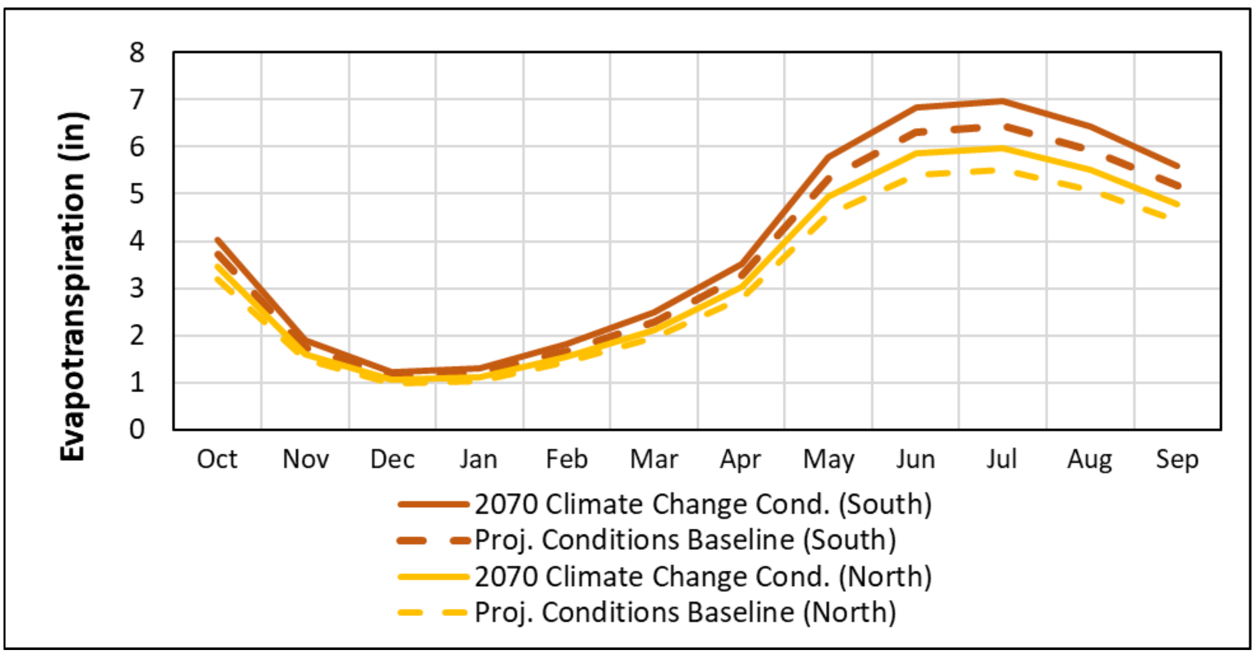


Figure 43: Monthly Evapotranspiration Variability for Cherries for PCBL-CC Version 3.0

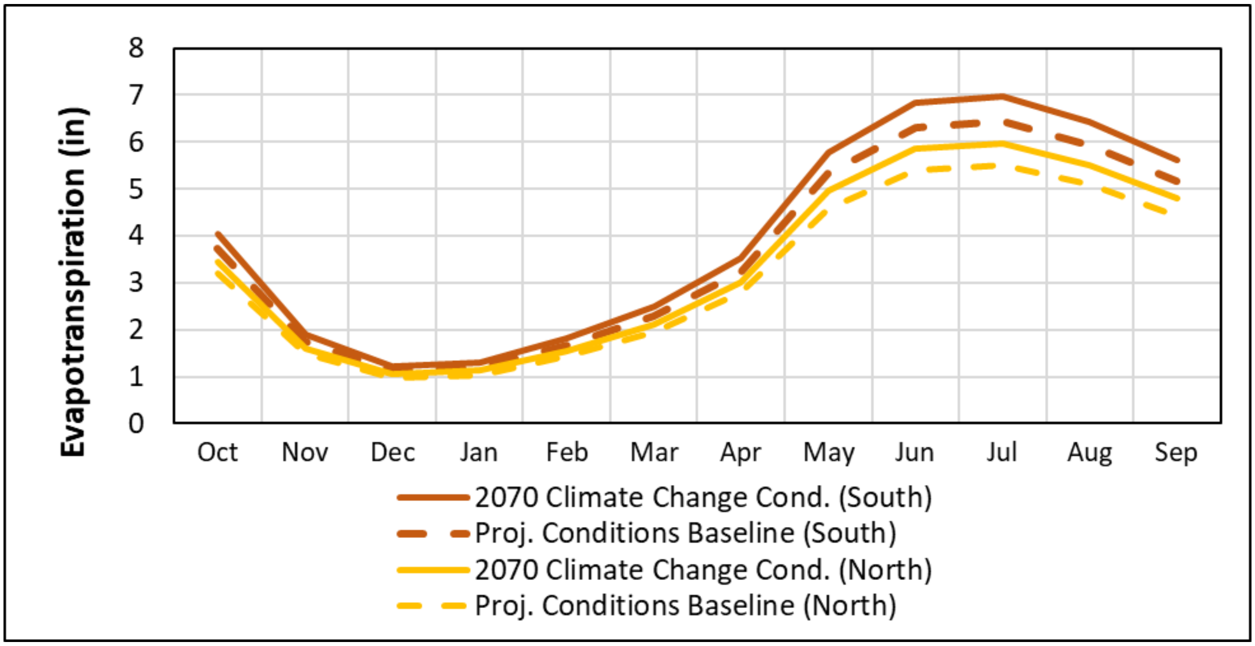
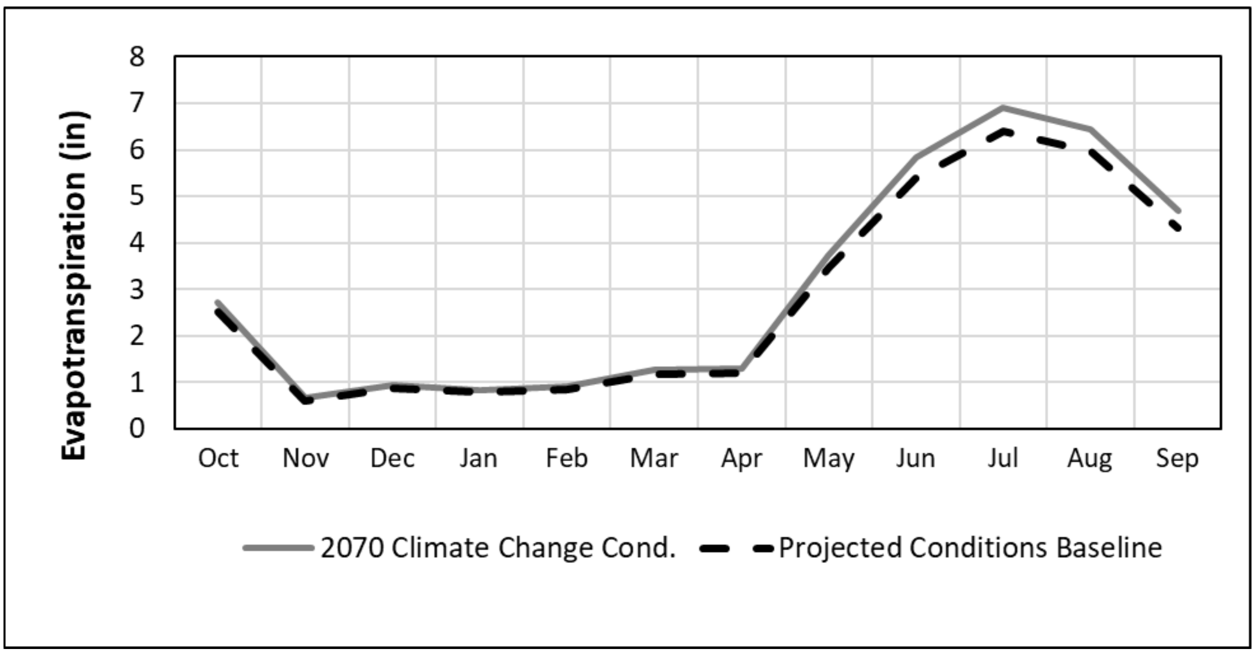


Figure 44: Monthly Evapotranspiration Variability for Vineyards for PCBL-CC Version 3.0



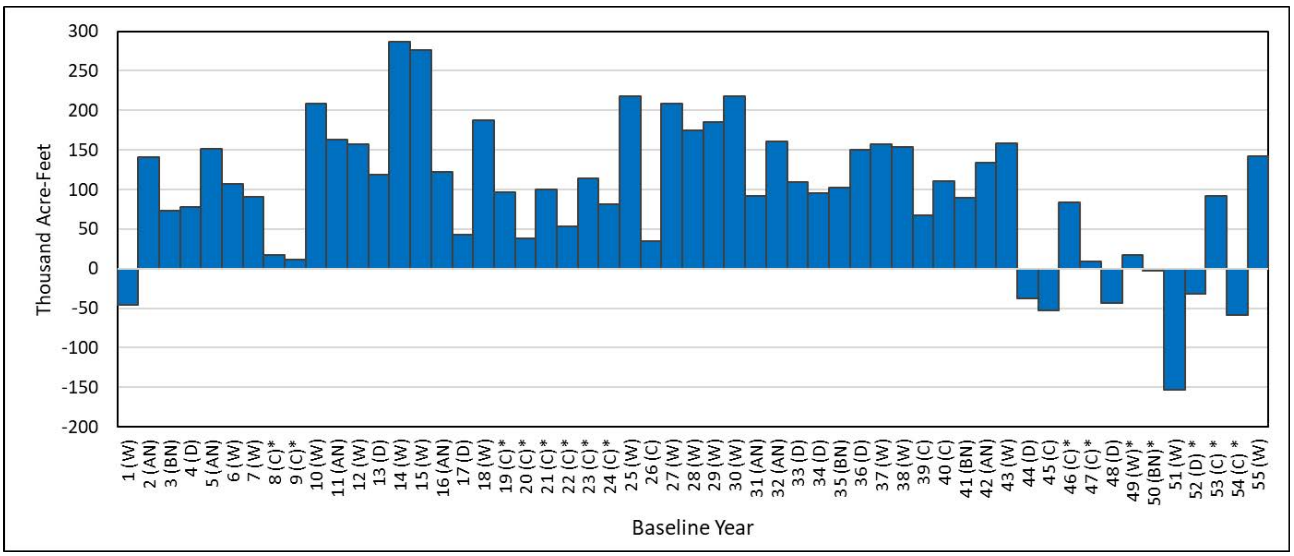
5.3 Projected Conditions Baseline with Climate Change Results

This section provides a summary of the ESJWRM PCBL-CC Version 3.0 results.

5.3.1 Differences in Precipitation, Evapotranspiration, and Streamflow under Climate Change

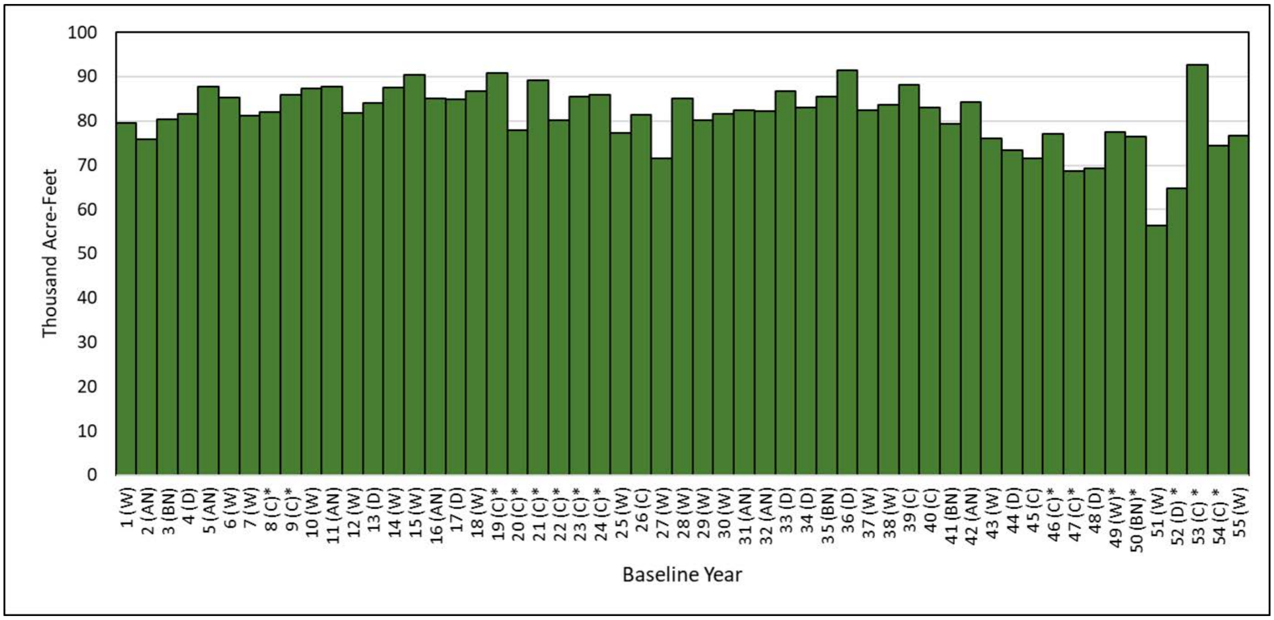
Under the climate change scenario (PCBL-CC Version 3.0), the average annual precipitation is overall 10 percent higher than the projected conditions scenario (PCBL Version 3.0), increasing from 992,000 AFY to 1,087,000 AFY or from about 15.6 in/year to 17.0 in/year. Similarly, the average annual volume of evapotranspiration in PCBL-CC Version 3.0 is 6 percent higher than the PCBL Version 3.0, increasing from 1,302,000 AFY to 1,384,000 AFY . Despite there being higher flows in streams in PCBL-CC Version 3.0, the anticipated surface water diversions were not expected to change in PCBL-CC Version 3.0 due to both availability of water in the stream and water rights agreements limiting diversion months. With a similar surface water supply and increased water demands under the PCBL-CC Version 3.0, private groundwater production is simulated to increase by approximately 10 percent, from 799,000 AFY to 879,000 AFY. Under climate change conditions, due to increased groundwater use driven by higher agricultural demands, the depletion in aquifer storage is expected to increase by about 87 percent to an average annual storage change of -56,000 AFY in the PCBL-CC Version 3.0, from -30,000 AFY in the PCBL Version 3.0. A graphical representation of simulated changes to precipitation, evapotranspiration, and groundwater pumping are presented in Figure 45 though Figure 47. Full water budgets for the land surface and groundwater systems are discussed in Sections 5.3.2 and 5.3.3.

Figure 45: Simulated Changes in Precipitation due to Climate Change in PCBL-CC Version 3.0



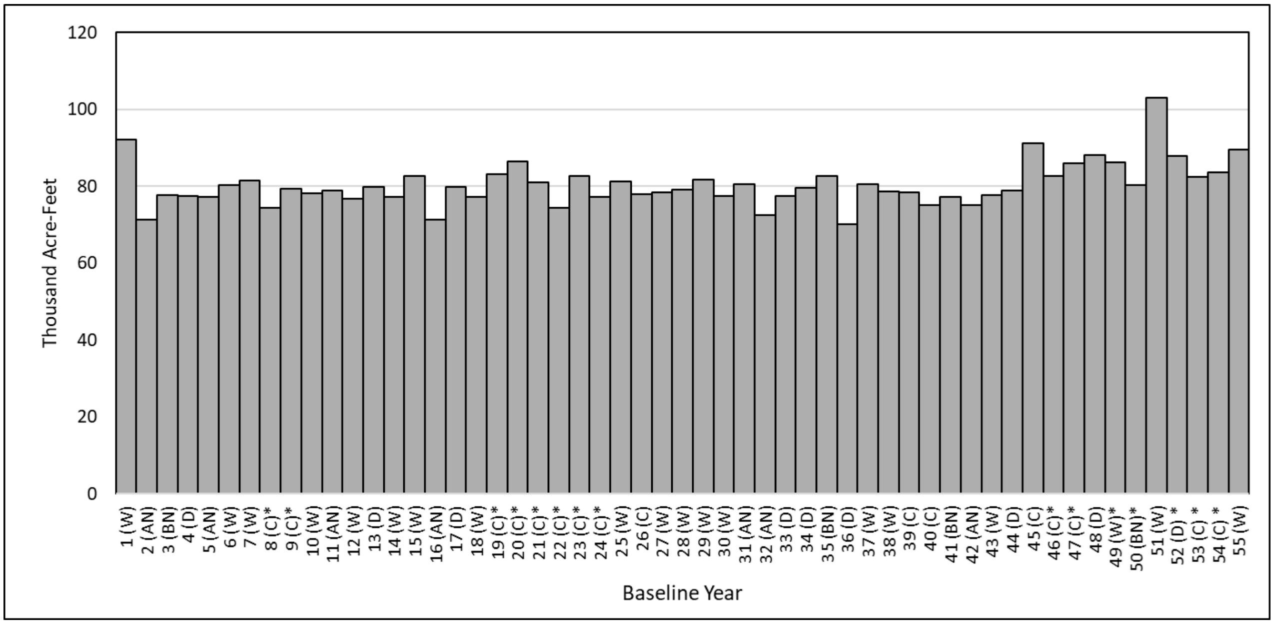
Note: Negative indicates PCBL Version 3.0 value was larger and positive indicates PCBL-CC Version 3.0 was larger. The climate change scenario largely has more precipitation than the projected conditions scenario.

Figure 46: Simulated Changes in Evapotranspiration due to Climate Change in PCBL-CC Version 3.0



Note: PCBL-CC Version 3.0 evapotranspiration is always larger than the PCBL Version 3.0 for all simulated years.

Figure 47: Simulated Changes in Groundwater Pumping due to Climate Change in PCBL-CC Version 3.0



Note: PCBL-CC Version 3.0 groundwater pumping is always larger than the PCBL Version 3.0 for all simulated years.

5.3.2 Land and Water Use Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
    - Groundwater pumping
    - Surface water deliveries
    - Shortage (if applicable)
- Outflows:
    - Demand (either agricultural or urban)
    - Surplus (if applicable)

The average annual PCBL-CC Version 3.0 demand for the Subbasin within the 55-year simulation period is 1,396 thousand acre-feet (TAF), consisting of approximately 1,240 TAF expected agricultural demand and 156 TAF expected urban demand. This demand is met by an annual average of 525 TAF of surface water deliveries (452 TAF of agricultural and 73 TAF of urban deliveries) and is supplemented by 868 TAF of groundwater production (801 TAF of agricultural and 67 TAF of urban pumping). Due to uncertainties in the estimation of PCBL-CC Version 3.0 agricultural demand and historical supply records, there is 14 TAF of agricultural surplus and 16 TAF of urban shortage in the Subbasin scale water use budget, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 16. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 48 and Figure 49 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

A comparison between the PCBL Version 3.0 and the PCBL-CC Version 3.0 is included in Table 17. As shown in Section 5.3.1 and Figure 46, evapotranspiration is higher in the PCBL-CC Version 3.0 compared to the PCBL Version 3.0 in every year of the simulation. This higher evapotranspiration translates to a higher agricultural demand in the PCBL-CC Version 3.0 of 86,100 AFY, which must be met by increased groundwater pumping of 80,300 AFY. The slight difference between the demand increase and the groundwater pumping increase is due to a decrease in 100 AFY of agricultural surface water deliveries. Small changes in surface water availability in streams occurred in the PCBL-CC Version 3.0 compared to the PCBL Version 3.0 due to the impact of perturbation factors on monthly stream flows. On the urban demand side, there were no differences built into the assumptions for climate change for urban entities, so there were no changes to the urban areas in the PCBL-CC Version 3.0 versus the PCBL Version 3.0.

Table 16: ESJ Subbasin Land and Water Use Budget Annual Average for PCBL-CC Version 3.0

Land and Water Use Budget Component	PCBL-CC Version 3.0 Annual Average
Agricultural Area (thousand acres)	365
Agricultural Demand (TAF)	1,240
Agricultural Groundwater Pumping (TAF)	801
Agricultural Surface Water Deliveries (TAF)	452
Agricultural Surplus (TAF)	14
Urban Area (thousand acres)	129
Urban Demand (TAF)	156
Urban Groundwater Pumping (TAF)	67
Urban Surface Water Deliveries (TAF)	73
Urban Shortage (TAF)	16

Table 17: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between the PCBL Version 3.0 and the PCBL-CC Version 3.0

	Annual Average		
Land and Water Use Budget Component	**PCBL Version 3.0**	**PCBL-CC Version 3.0**	**Climate Change Impact (PCBL-CC Version 3.0 minus PCBL Version 3.0)**
Agricultural Area (thousand acres)	365	365	0
Agricultural Demand (TAF)	1,153	1,240	86
Agricultural Groundwater Pumping (TAF)	721	801	80
Agricultural Surface Water Deliveries (TAF)	452	452	0
Agricultural Surplus (TAF)	19	14	-5
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	156	0
Urban Groundwater Pumping (TAF)	67	67	0
Urban Surface Water Deliveries (TAF)	73	73	0
Urban Shortage (TAF)	16	16	0

Figure 48: ESJ Subbasin Projected Agricultural Demand in the PCBL-CC Version 3.0

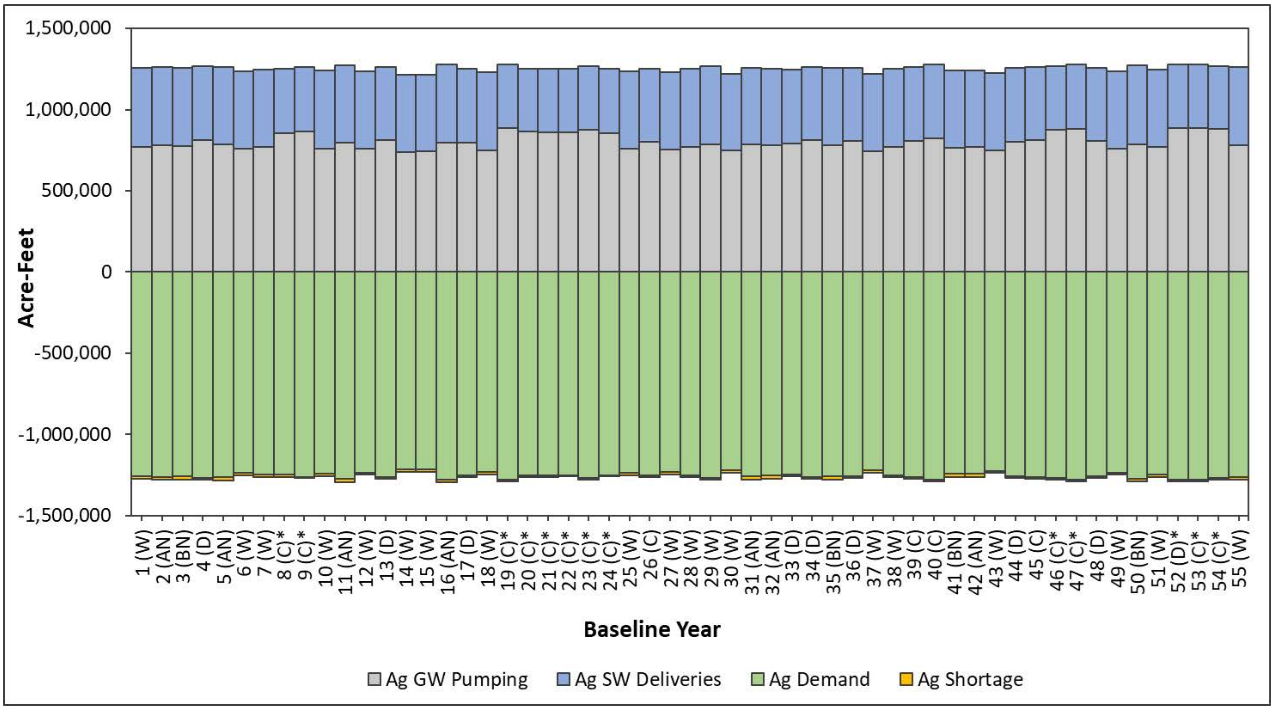
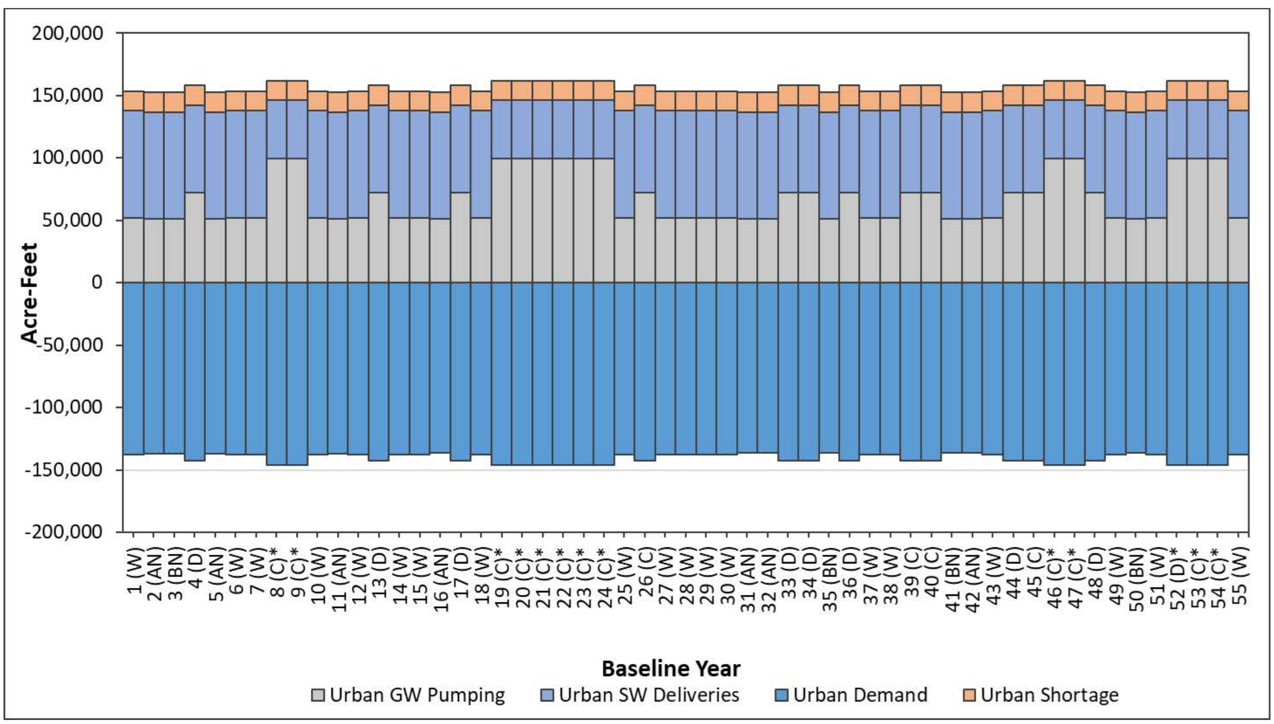


Figure 49: ESJ Subbasin Projected Urban Demand in the PCBL-CC Version 3.0



5.3.3 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
  - Deep percolation (from rainfall and irrigation applied water)
  - Gain from stream (or recharge due to stream seepage)
  - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
  - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
  - Groundwater pumping
  - Loss to stream (or outflow to streams and rivers)
  - Boundary outflow (to surrounding groundwater subbasins)
  - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL-CC Version 3.0 remains the largest component in the groundwater budget with an annual average 879 TAF. The PCBL-CC Version 3.0 offsets this pumping with 268 TAF of deep percolation, a net gain from stream of 276 TAF, 168 TAF of other recharge (includes recharge from unlined canals, reservoir seepage, managed aquifer recharge, and Sierra Nevada Mountain recharge), and a total subsurface inflow of 111 TAF annually. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-CC Version 3.0 is 56 TAFY. These annual averages are shown in Table 18. The groundwater budget, with cumulative change in storage, is shown for the ESJ Subbasin in Figure 50.

A comparison of the PCBL Version 3.0 and the PCBL-CC Version 3.0 is shown in Table 19. The increase in groundwater pumping of 80,300 AFY is due to the increase in evapotranspiration and therefore increased agricultural demand as discussed above in Section 5.3.2 and Table 17. Additionally, increased precipitation in most years as shown in Figure 45 and discussed in Section 5.3.1, leads to overall increased deep percolation from precipitation and other recharge (specifically the ungauged watershed drainage component). The increased groundwater pumping causes groundwater levels to be lower, which then causes increased stream seepage, boundary inflow, and change in groundwater storage. The streamflow is overall higher in the PCBL-CC Version 3.0, which may also allow for more stream seepage into the groundwater system.

Table 18: ESJ Subbasin Hydrologic Groundwater Budget Annual Average in PCBL-CC Version 3.0

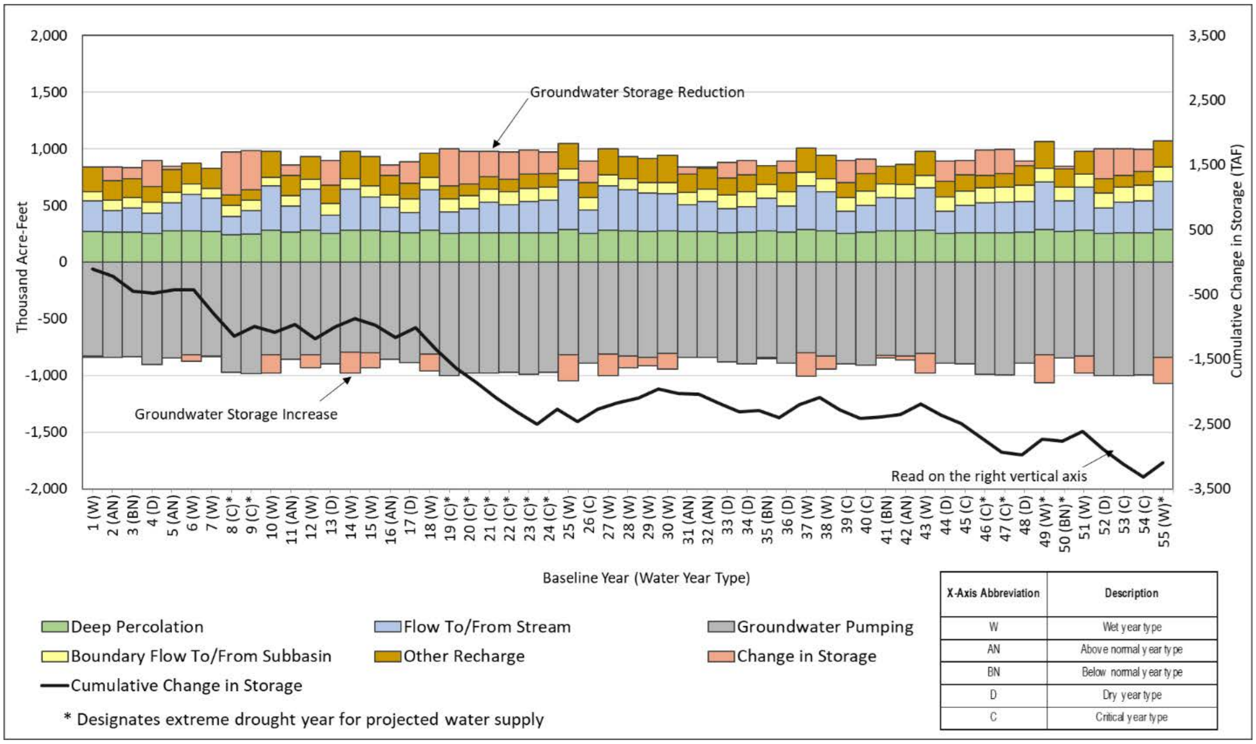
Hydrologic Groundwater Budget Component	PCBL-CC Annual Average
Deep Percolation (TAF)	268
Deep Percolation of Precipitation (TAF)	*52*
Deep Percolation of Applied Water (TAF)	*216*
Other Recharge (TAF)	168
Net Stream Seepage (TAF)[1]	276
Net Boundary Inflow (TAF)	111
Groundwater Pumping (TAF)	879
Change in Groundwater Storage (TAF)	-56

Table 19: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL Version 3.0 and the PCBL-CC Version 3.0

	Annual Average		
Hydrologic Groundwater Budget Component	PCBL Version 3.0	PCBL-CC Version 3.0	Climate Change Impact (PCBL-CC Version 3.0 minus PCBL Version 3.0)
Deep Percolation (TAF)	270	268	-2
Deep Percolation of Precipitation (TAF)	*55*	*52*	*-3*
Deep Percolation of Applied Water (TAF)	*215*	*216*	*1*
Other Recharge (TAF)	165	168	3
Net Stream Seepage (TAF)[1]	240	276	36
Net Boundary Inflow (TAF)	94	111	17
Groundwater Pumping (TAF)	799	879	80
Change in Groundwater Storage (TAF)	-30	-56	-26

[1] ESJGWA updates the ESJWRM approximately once per year as new data becomes available. Upon completion of the historical ESJWRM Version 3.0, comments regarding Calaveras River seepage were made that require further analysis and may require a recalibration of the model. This additional information on Calaveras River seepage will be considered during the next round of model updates and any edits may cause changes to PCBL-CC Version 3.0.

Figure 50: ESJ Subbasin Projected Hydrologic Groundwater Budget in PCBL-CC Version 3.0



6 Projected Conditions Baseline Scenarios with Demand Reduction

The goal of this section is to document the sustainable yield analysis in the ESJWRM, the methodologies used in the model development, and results of the demand reduction scenario model runs.

The sustainability goal description for the Subbasin is to maintain groundwater for the beneficial use of the people of the Subbasin by operating the Subbasin within its sustainable yield or by modification of existing management to address future conditions. This section focuses on the former option, which is to calculate the sustainable yield for the Subbasin to achieve the goal of generating a long-term (55-year) change in Subbasin groundwater storage of zero, a conservative approach, as a change in storage of greater than zero could occur without causing undesirable results. The latter option of modification of existing is discussed in the following section (Section 0).

The demand reduction actions, focusing on reduced groundwater production for simulation purposes to calculate the Subbasin sustainable yield, are added to the two existing model runs: PCBL Version 3.0 and PCBL-CC Version 3.0. This section is adapted from what was originally developed as a technical memorandum attached to the 2022 Revised GSP (Woodard & Curran, 2022c).

6.1 Assumptions Used to Develop Projected Conditions Baseline Scenarios with Demand Reduction

The versions of the model with demand reduction are the Projected Condition BaseLine with Demand Reduction (PCBL-DR) and Projected Condition BaseLine with Climate Change and Demand Reduction (PCBL-CC-DR). These two model runs were developed based on the original projected conditions baseline scenario with demand reduction in the 2019 GSP (PCBL-DR Version 1.0), which estimated future conditions of reduced supply, reduced demand, and the resulting aquifer response to implementation of sustainable conditions in the Subbasin, in order to bring the long-term (50-year) average change in groundwater storage to close to zero (ESJGWA, 2019). The same methodologies and similar demand reduction estimations were used in the development of the PCBL-DR Version 3.0 and the PCBL-CC-DR Version 3.0 to achieve the goal of generating a long-term (55-year) change in Subbasin groundwater storage that is close to zero.

There are uncertainties associated with projections scenarios of the ESJWRM due to the sequence of the hydrologic period, population projection, future cropping patterns, and irrigation practices and technologies, as well as uncertainties inherent in the representation of the groundwater and surface water system by the model. Therefore, to account for these uncertainties, a range of assumptions are used in running model scenarios to estimate the sustainable yield and an initial estimate of the demand reduction that may be required to achieve the sustainable yield over the 55-year planning period. Assumptions used in the PCBL-DR Version 3.0 and the PCBL-CC-DR Version 3.0 are discussed in detail in the following sections.

6.1.1 Projected Conditions Baseline with Demand Reduction

The PCBL-DR Version 3.0 was developed based on the PCBL Version 3.0 with simulated reduction in urban and agricultural demand.

Urban Demand Reduction

Urban demand decreases by percentage across all major urban agencies in the Subbasin, including:

- City of Escalon
- City of Lathrop

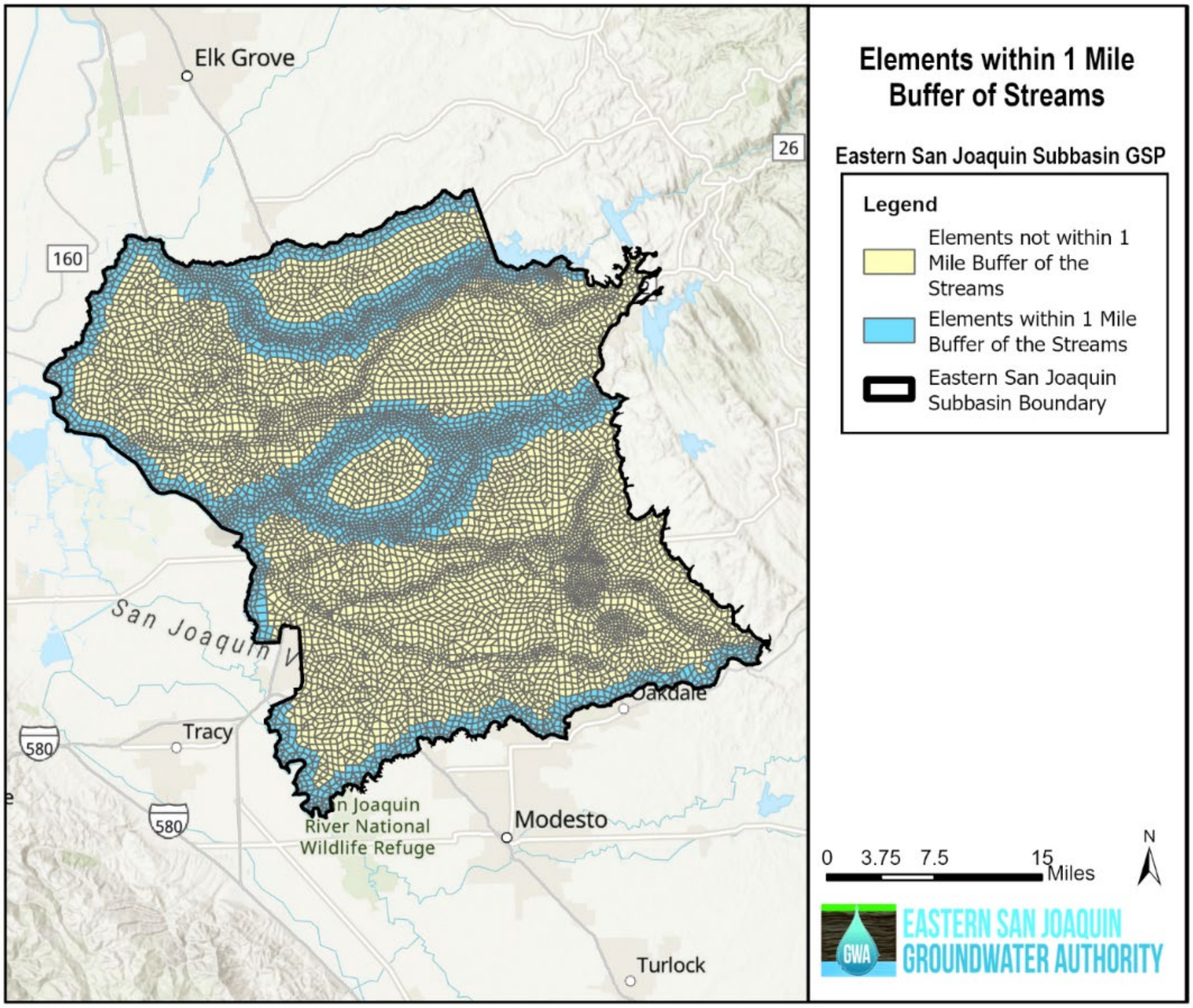
- City of Lodi
- City of Manteca
- City of Ripon
- City of Stockton
- Cal Water
- San Joaquin County in Stockton

PCBL-DR Version 1.0 assumed the urban groundwater pumping was cutback by 10%. The PCBL-DR Version 3.0 increased the assumption to a 15% reduction in urban demand. This was achieved in the model by reducing the per capita water use for the agencies above by 15% (i.e., setting them to 85% of the demand in the PCBL).

Agricultural Demand Reduction

In order to achieve a reduction in agricultural demand in the ESJWRM-DR, agricultural acreage is reduced by converting a portion of irrigated land to native vegetation. The agricultural demand decreases by percentage is based on the agricultural groundwater pumping by element and limited to elements at least 1 mile from major streams crossing the Subbasin. Figure 51 shows the model elements not within the 1-mile buffer of the major streams in the Subbasin. The reduction is applied only in the core area of the Subbasin (e.g., not to Cosumnes or Modesto Subbasins) and to the elements outside of the 1-mile buffer from the major streams.

Figure 51: ESJWRM Elements in ESJ Subbasin not Within 1-Mile Buffer of the Major Streams for PCBL-DR and PCBL-CC-DR



The agricultural groundwater pumping reduction percentage applied to agricultural land is assumed based on the agricultural pumping density of each element in the Subbasin. The pumping reduction percentage is higher for the elements with higher agricultural pumping density. Under the PCBL-DR Version 3.0, if the agricultural groundwater pumping density is less than or equal to 2 acre-feet/acre (AF/acre), the pumping reduction percentage is assumed to be 0%; if the agricultural groundwater pumping density is greater 2 AF/acre and less than 3 AF/acre, the pumping reduction percentage is assumed to be 15%; if the agricultural groundwater pumping density is equal to or greater than 3 AF/acre, the pumping reduction percentage is assumed to be 27.5%, in order to achieve an average change in groundwater storage of zero over the 55-year planning period. The comparison of the agricultural groundwater pumping percent reduction between the GSP scenario (PCBL-DR Version 1.0) and the PCBL-DR Version 3.0 is shown in Table 20. Since the storage deficit of the PCBL Version 3.0 is slightly higher than it was in the PCBL Version 1.0, the agricultural demand reduction is more in the PCBL-DR Version 3.0.

Figure 52 and Figure 53 show the agricultural groundwater pumping density for the PCBL Version 3.0 and the PCBL-DR Version 3.0, respectively. Compared to the PCBL Version 3.0, the agricultural groundwater pumping density in the PCBL-DR Version 3.0 is reduced in the elements with pumping density greater than 2 AF/acre and at least 1 mile from major streams in the Subbasin.

Table 20: Agricultural Groundwater Pumping Percent Reduction Comparison Between the GSP Scenario (PCBL-DR Version 1.0) and PCBL-DR Version 3.0

Percent Reduction	PCBL-DR Version 1.0	PCBL-DR Version 3.0
Ag GW Pumping <=2 AF/acre	0%	0%
Ag GW Pumping 2-3 AF/acre	15%	15%
Ag GW Pumping >=3 AF/acre	25%	27.5%
Urban Demand	10%	15%

Figure 52: Agricultural Groundwater Pumping Density for PCBL Version 3.0

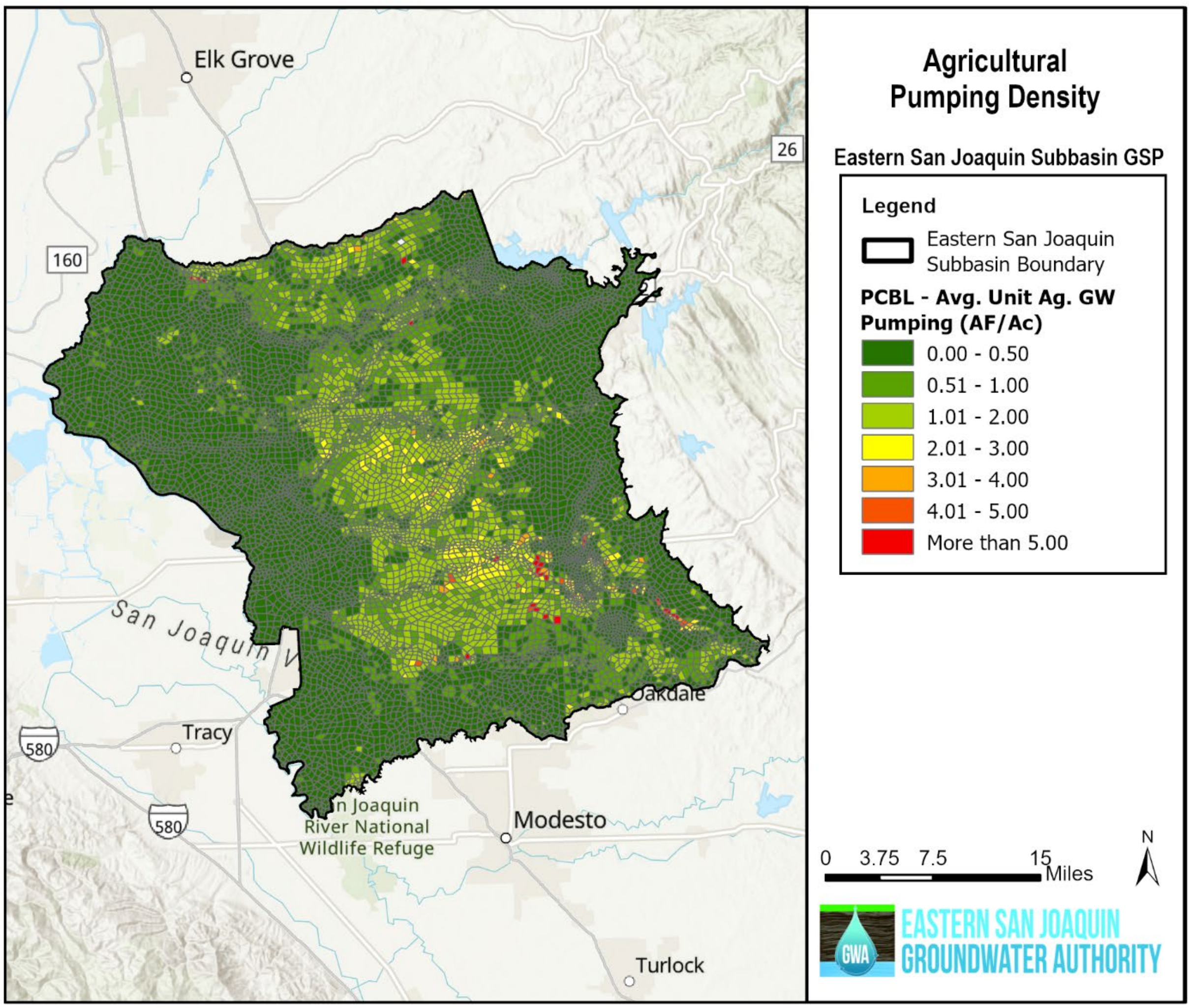
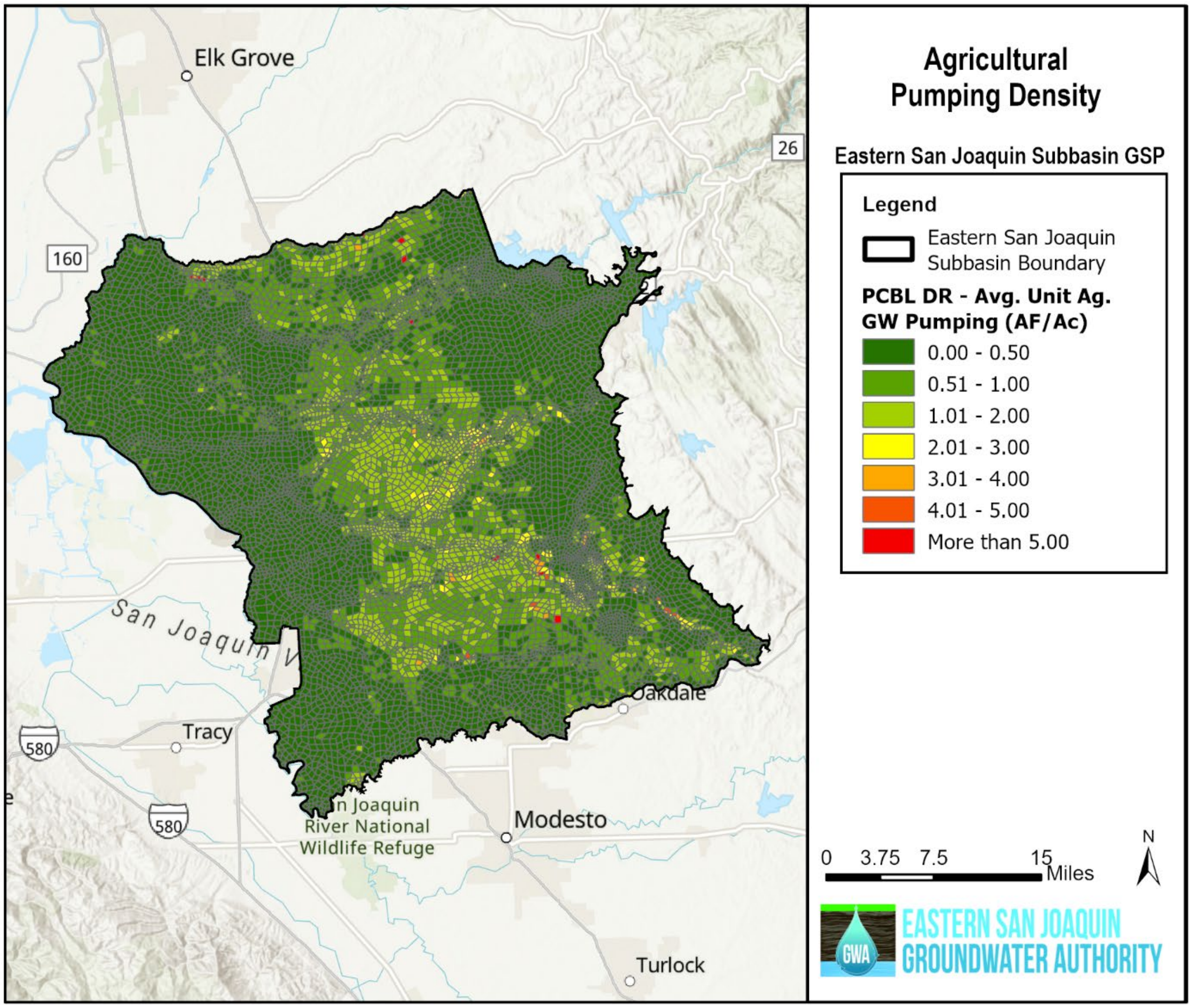


Figure 53: Agricultural Groundwater Pumping Density for PCBL-DR Version 3.0



6.1.2 Projected Conditions Baseline with Climate Change and Demand Reduction

The PCBL-CC-DR Version 3.0 was developed based on the PCBL-CC Version 3.0 with simulated reduction in urban and agricultural demand.

Urban Demand Reduction

Urban demand decreases by percentage across all major urban agencies in the Subbasin, including:

- City of Escalon
- City of Lathrop
- City of Lodi
- City of Manteca
- City of Ripon
- City of Stockton
- Cal Water

- San Joaquin County in Stockton

There was no PCBL-CC-DR Version 1.0 scenario, but the PCBL-CC-DR Version 2.0 scenario had an urban demand reduction of 10%. The PCBL-CC-DR Version 3.0 increased the assumption to a 15% reduction in urban demand. This was achieved in the model by reducing the per capita water use for the agencies above by 15% (i.e., setting them to 85% of the demand in the PCBL-CC).

<u>Agricultural Demand Reduction</u>

In order to achieve a reduction in agricultural demand in the ESJWRM-CC-DR, agricultural acreage is reduced by converting a portion of irrigated land to native vegetation The agricultural demand decreased by percentage using the same methodology as the PCBL-DR Version 3.0, and is based on the agricultural groundwater pumping by element and limited to elements at least 1 mile from the major streams crossing the Subbasin. The reduction is again applied only to the core area of the Subbasin and to elements outside of the 1-mile buffer from the major streams, as shown in Figure 51.

Under the PCBL-CC-DR Version 3.0, if the agricultural groundwater pumping density is less than or equal to 2 acre-feet/acre (AF/acre), the pumping reduction percentage is assumed to be 0%; if the agricultural groundwater pumping density is greater 2 AF/acre and less than 3 AF/acre, the pumping reduction percentage is assumed to be 25%; if the agricultural groundwater pumping density is equal to or greater than 3 AF/acre, the pumping reduction percentage is assumed to be 37.5% to achieve an average change in storage of zero over the 55-year planning period. Since there was no PCBL-CC-DR Version 1.0 scenario in the original GSP, the comparison of the agricultural groundwater pumping percent reduction is between PCBL-CC-DR Version 2.0 and the PCBL-CC-DR Version 3.0. This is presented in Table 21. Since the storage deficit of the PCBL-CC Version 3.0 is higher than it was in the PCBL-CC Version 2.0, the agricultural demand reductions (i.e., percent decrease of agricultural land) are greater in the PCBL-CC-DR Version 3.0.

Figure 54 and Figure 55 show the agricultural groundwater pumping density for the PCBL-CC Version 3.0 and the PCBL-CC-DR Version 3.0, respectively. Compared to the PCBL-CC Version 3.0, the agricultural groundwater pumping density in the PCBL-CC-DR Version 3.0 is reduced in the elements with pumping density greater than 2 AF/acre and at least 1 mile from major streams in the Subbasin.

Table 21: Agricultural Groundwater Pumping Percent Reduction Comparison Between the PCBL-CC-DR Version 2.0 and PCBL-CC-DR Version 3.0

Percent Reduction	PCBL-CC-DR Version 2.0	PCBL-CC-DR Version 3.0
Ag GW Pumping <=2 AF/acre	0%	0%
Ag GW Pumping 2-3 AF/acre	20%	25%
Ag GW Pumping >=3 AF/acre	30%	37.5%
Urban Demand	10%	15%

Figure 54: Agricultural Groundwater Pumping Density for PCBL-CC Version 3.0

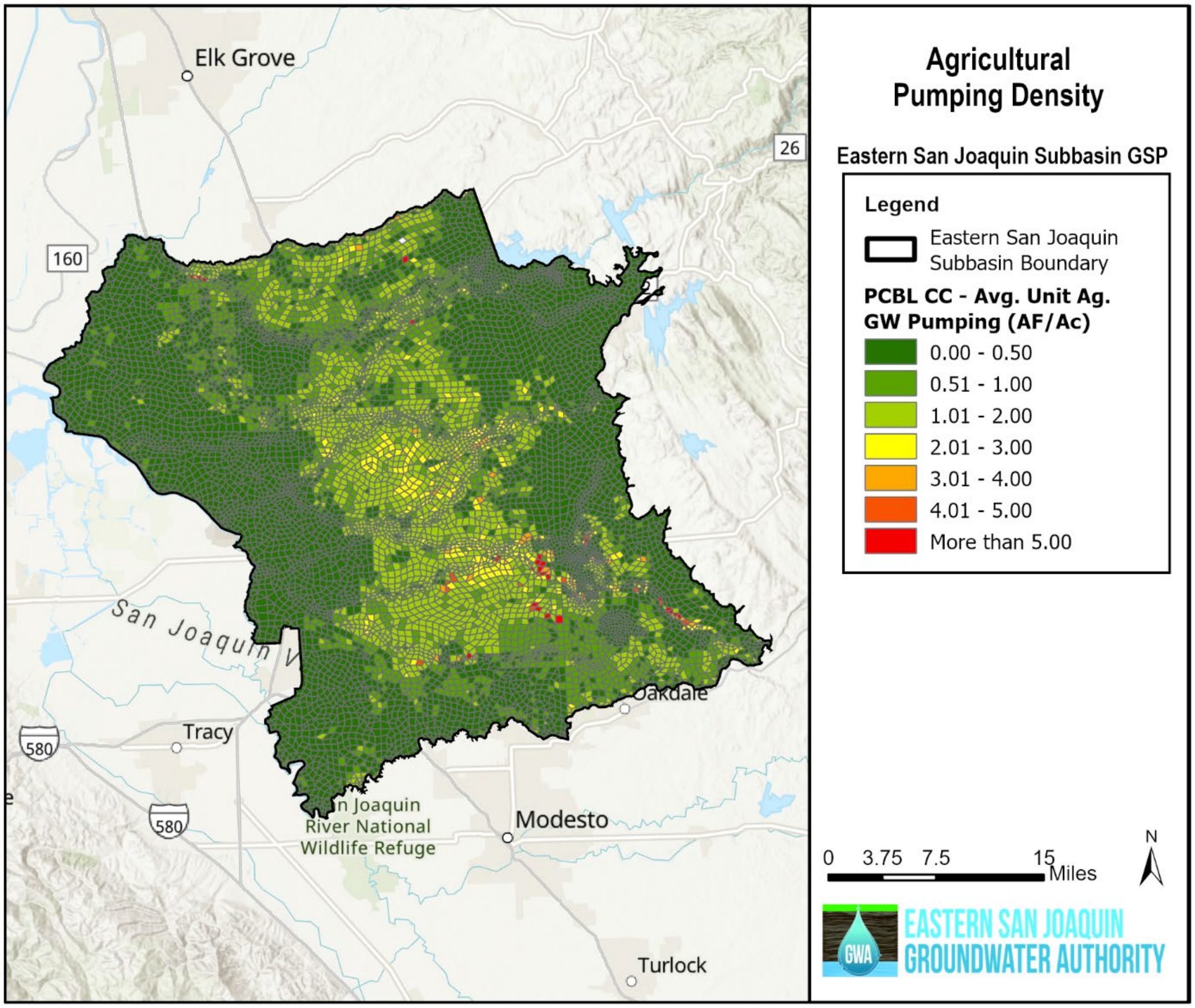
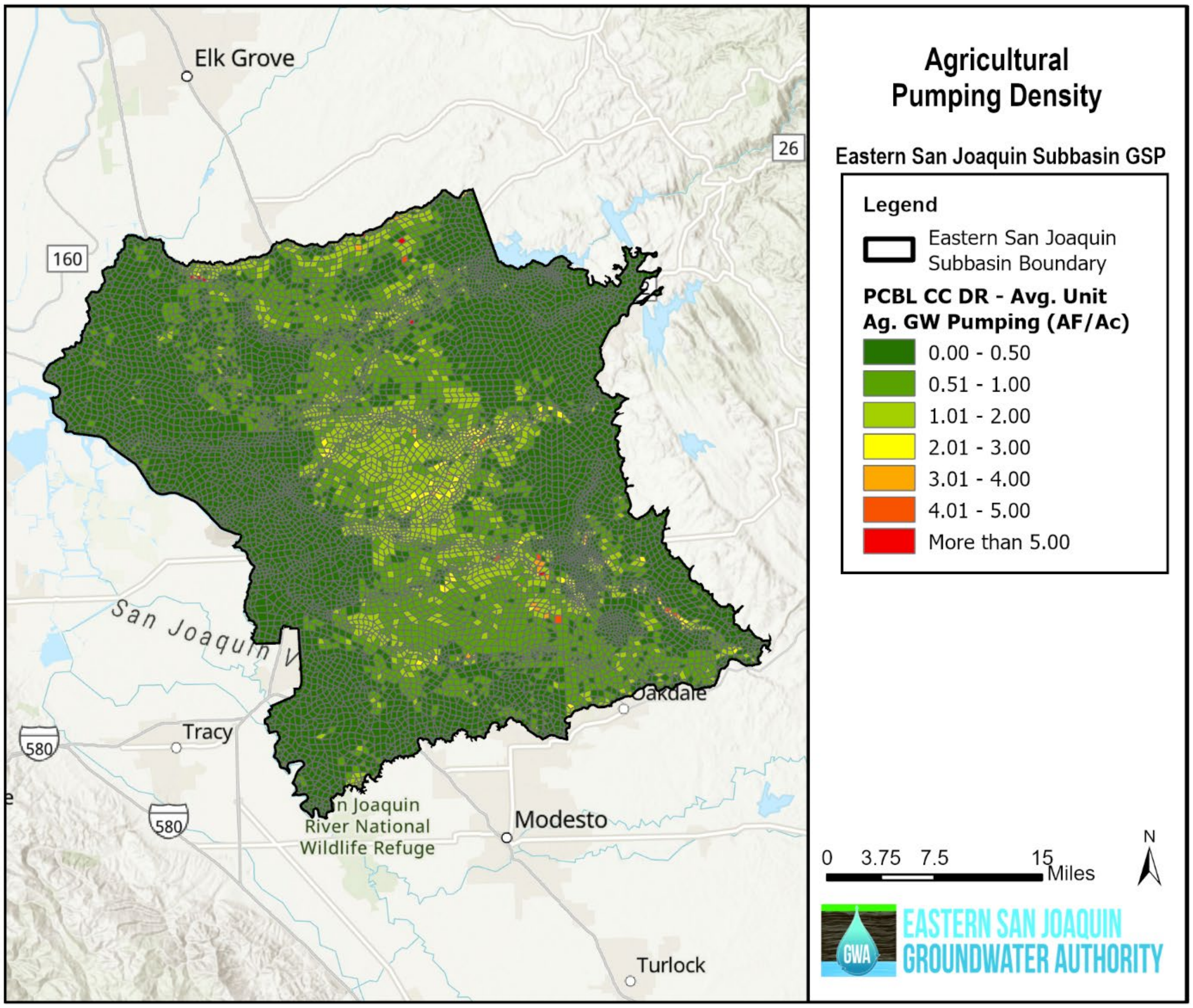


Figure 55: Agricultural Groundwater Pumping Density for PCBL-CC-DR Version 3.0



6.2 Projected Conditions Baseline Scenarios with Demand Reduction Results

This section provides a summary of the ESJ Subbasin ESJWRM PCBL-DR Version 3.0 PCBL-CC-DR Version 3.0 model results. Both models share the same input files, except for the files related to climate change (stream inflows, evapotranspiration, and precipitation) and the files related to agricultural demand reduction. Agricultural demand reduction is simulated by reducing non-ponded and ponded crop areas files and the files are different in the two models due to differences in the agricultural groundwater pumping reduction percentages calculated from the agricultural pumping density in the PCBL Version 3.0 compared to the PCBL-CC Version 3.0. The area taken out of the non-ponded and ponded crop areas are added to the native vegetation areas in the two models. The files relating to the urban demand reduction simulated as per capita water use data are identical between the two models because the percent reduction is identical for urban areas between PCBL-DR Version 3.0 and PCBL-CC-DR Version 3.0.

6.2.1 Projected Conditions Baseline with Demand Reduction

The section below summarizes the results for the PCBL-DR Version 3.0 as compared to the PCBL Version 3.0. Neither of these runs include climate change.

6.2.1.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
  - Groundwater pumping
  - Surface water deliveries
  - Shortage (if applicable)
- Outflows:
  - Demand (either agricultural or urban)
  - Surplus (if applicable)

The average annual PCBL-DR Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,199 thousand acre-feet per year (TAFY), consisting of approximately 1,059 TAFY of agricultural demand and 140 TAFY of urban demand. This demand is met by an annual average of 526 TAFY of surface water deliveries (452 TAFY of agricultural and 73 TAFY of urban deliveries) and is supplemented by 693 TAFY of groundwater production (628 TAFY of agricultural and 65 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 21 TAFY of surplus in the Subbasin-scale agricultural water supply, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 22. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 56 and Figure 57 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 22 also includes the PCBL Version 3.0 results and a demand reduction benefit calculated as the PCBL-DR Version 3.0 results minus the PCBL Version 3.0 results. For urban areas, the 15% reduction in urban demand that was applied to the PCBL-DR Version 3.0 across all major agencies in the Subbasin is reflected in the reduction in urban demand of 16 TAFY compared to the PCBL Version 3.0. For agricultural areas, the PCBL-DR Version 3.0 has 26 thousand acres less of agricultural area, which results in 95 TAFY reduction in agricultural demand compared the PCBL Version 3.0. This represents a comparable reduction in agricultural groundwater pumping of 93 TAFY.

Table 22: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-DR Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-DR Version 3.0	DR Benefit (PCBL-DR Version 3.0 minus PCBL Version 3.0)
Agricultural Area (thousand acres)	365	340	-26
Agricultural Demand (TAF)	1,153	1,059	-95
Agricultural Groundwater Pumping (TAF)	721	628	-93
Agricultural Surface Water Deliveries (TAF)	452	452	0
Agricultural Surplus (TAF)[1]	19	21	2
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	140	-16
Urban Groundwater Pumping (TAF)	67	64	-3
Urban Surface Water Deliveries (TAF)	73	73	0
Urban Shortage (TAF)[1]	16	2	-14

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 56: ESJ Subbasin Projected Agricultural Demand in PCBL-DR Version 3.0

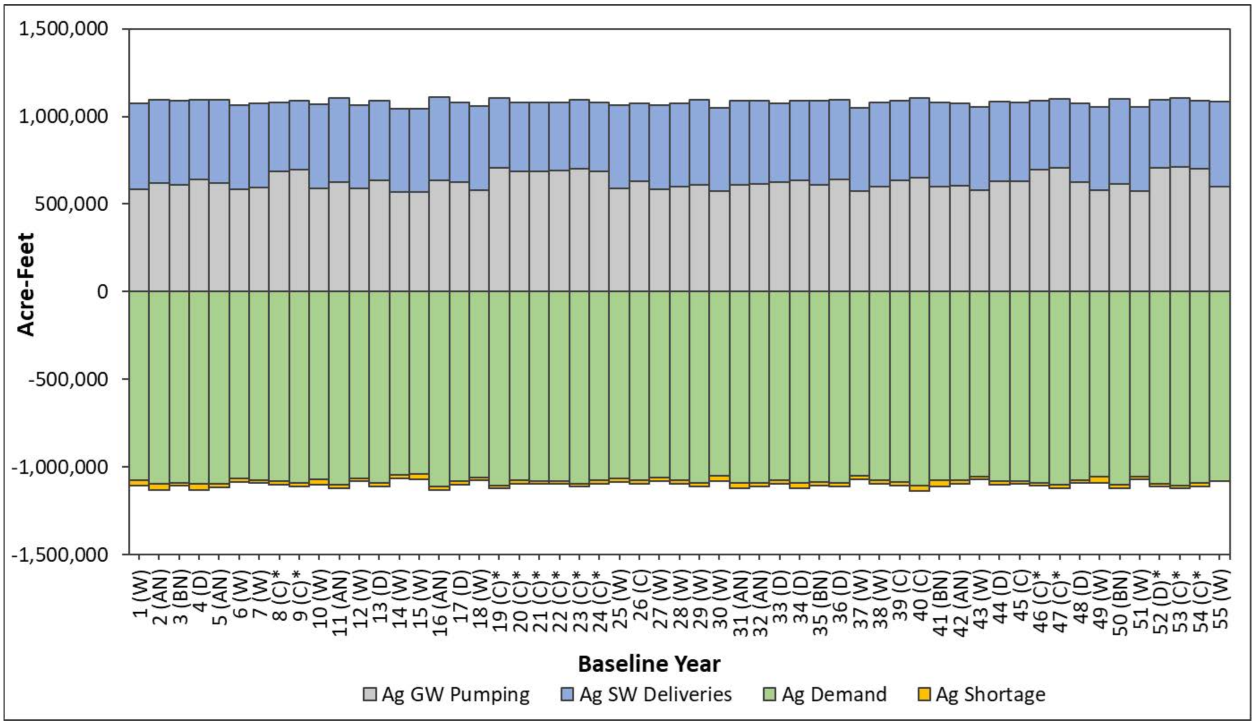
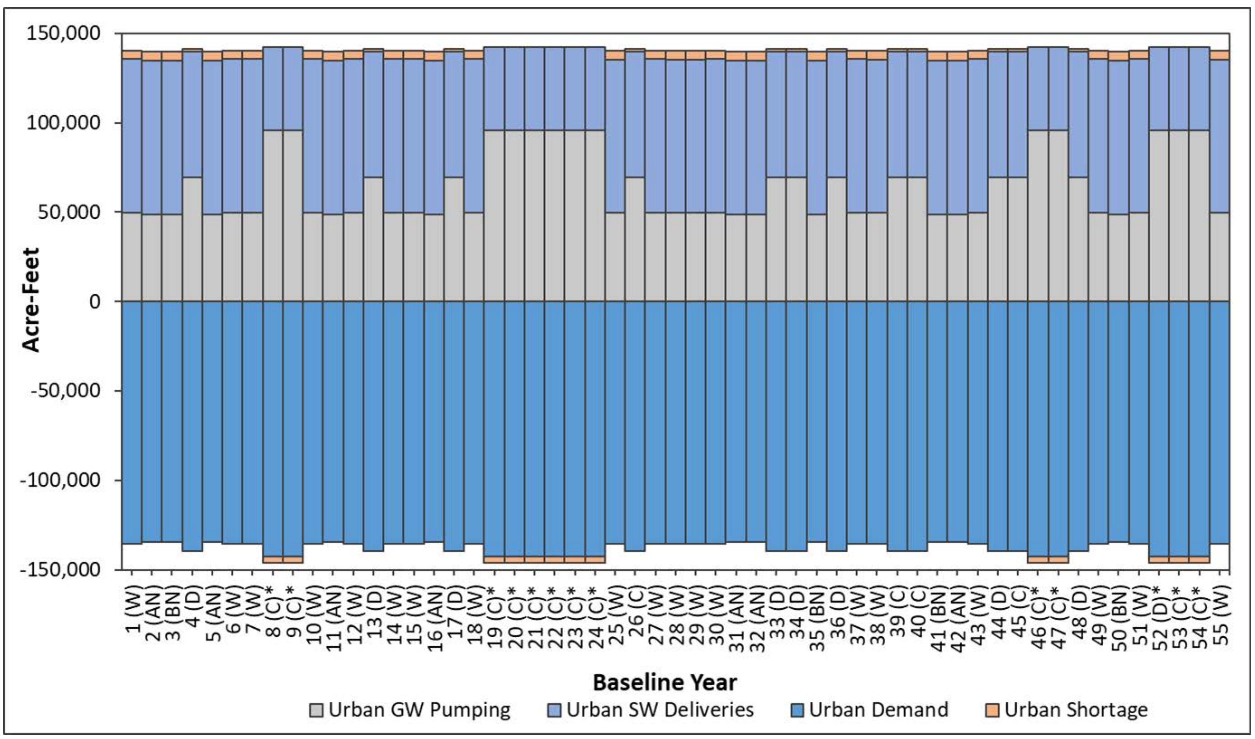


Figure 57: ESJ Subbasin Projected Urban Demand in PCBL-DR Version 3.0



6.2.1.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
    - Deep percolation (from rainfall and irrigation applied water)
    - Gain from stream (or recharge due to stream seepage)
    - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
    - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
    - Groundwater pumping
    - Loss to stream (or outflow to streams and rivers)
    - Boundary outflow (to surrounding groundwater subbasins)
    - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL-DR Version 3.0 remains the largest component in the groundwater budget with an annual average 704 TAFY. The PCBL-DR Version 3.0 offsets this pumping with 247 TAFY of deep percolation, a net gain from stream of 211 TAFY, 165 TAFY of other recharge (includes recharge from unlined canals, reservoir seepage, managed aquifer recharge, and Sierra Nevada Mountain recharge), and a total subsurface inflow of 81 TAFY. The cumulative change in groundwater storage can be calculated from the average annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-DR Version 3.0 is -200 AFY, with the negative sign actually indicating an absence of groundwater overdraft and an increase in storage over the 55 years of the PCBL-DR Version 3.0. These annual averages are shown in Table 23. The groundwater budget, with cumulative change in storage, is shown for the ESJ Subbasin in Figure 58.

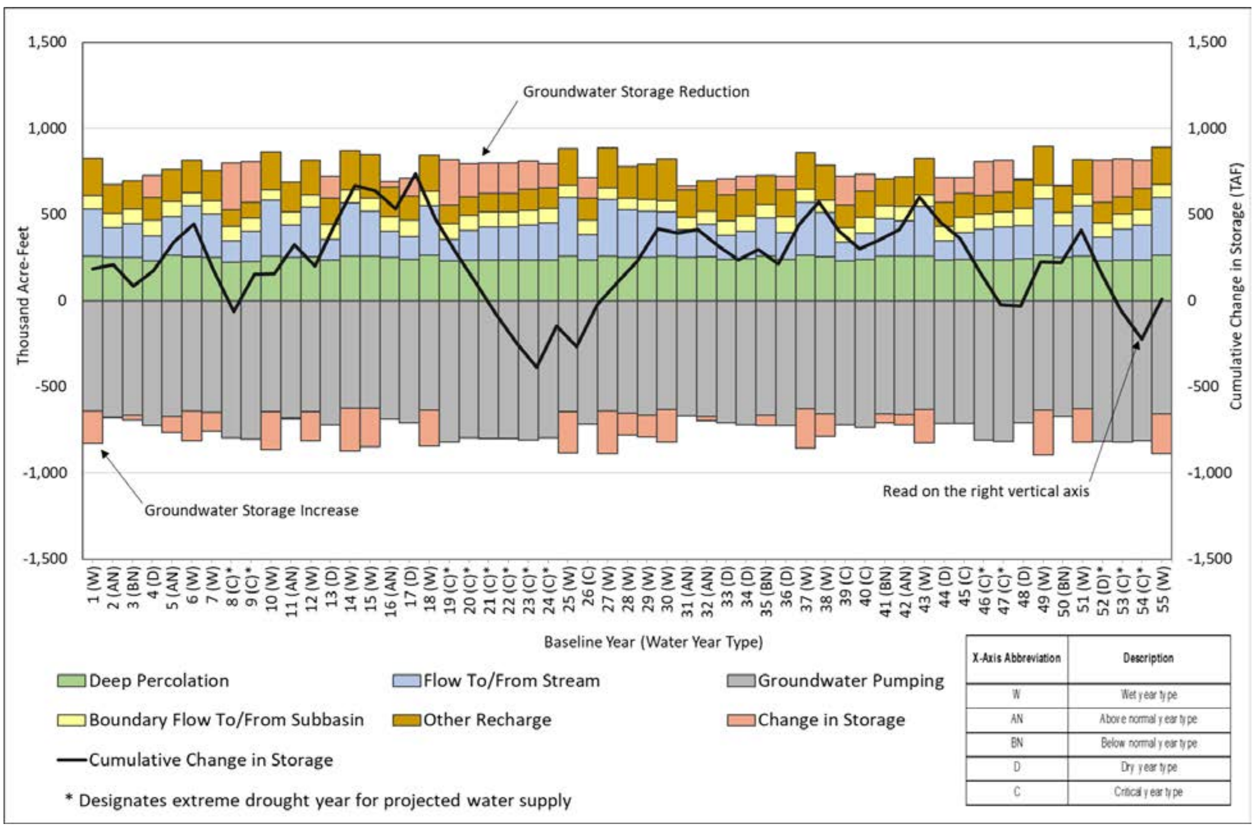
Table 23 also includes the PCBL Version 3.0 results and a demand reduction benefit calculated as PCBL-DR Version 3.0 results minus the PCBL Version 3.0 results. The results indicate that the demand reduction will resolve the PCBL Version 3.0 Subbasin overdraft condition when impacts due to climate change are not included. Without the demand reduction, the modeling shows an average overdraft of 30 TAFY over the 55 years of the PCBL Version 3.0 simulation. With the demand reduction in place, the modeling shows a projected overdraft of -200 AFY on average in the PCBL-DR Version 3.0. The PCBL-DR Version 3.0 shows an average increase of 30,200 AFY of groundwater in storage when compared to the PCBL.

Compared to PCBL Version 3.0, the PCBL-DR Version 3.0 has 95 TAFY less groundwater pumping due to the percentage reduction in urban per capita water use and agricultural areas, and 29 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL Version 3.0 and PCBL-DR Version 3.0.

Table 23: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-DR Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-DR Version 3.0	DR Benefit (PCBL-DR Version 3.0 minus PCBL Version 3.0)
Deep Percolation (TAF)	270	247	-23
Deep Percolation of Precipitation (TAF)	*55*	*54*	*-1*
Deep Percolation of Applied Water (TAF)	*215*	*193*	*-22*
Other Recharge (TAF)	165	165	0
Net Stream Seepage (TAF)	240	211	-29
Net Boundary Inflow (TAF)	94	81	-13
Groundwater Pumping (TAF)	799	704	-95
Change in Groundwater Storage (TAF)	-30	0	30

Figure 58: ESJ Subbasin Projected Hydrologic Groundwater Budget in PCBL-DR Version 3.0



6.2.2 Projected Conditions Baseline with Climate Change and Demand Reduction

The section below summarizes the results for the PCBL-CC-DR Version 3.0 as compared to the PCBL-CC Version 3.0.

6.2.2.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
    - Groundwater pumping
    - Surface water deliveries
    - Shortage (if applicable)
- Outflows:
    - Demand (either agricultural or urban)
    - Surplus (if applicable)

The average annual PCBL-CC-DR Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,214 TAFY, consisting of approximately 1,074 TAFY of agricultural demand and 140 TAFY of urban demand. This demand is met by an annual average of 526 TAFY of surface water deliveries (453 TAFY of agricultural and 73 TAFY of urban deliveries) and is supplemented by 702 TAFY of groundwater production (637 TAFY of agricultural and 65 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is about 16 TAFY of surplus in the Subbasin scale agricultural water use budget, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 24. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 59 and Figure 60 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 24 also includes the PCBL-CC Version 3.0 results and a demand reduction benefit calculated as PCBL-CC-DR Version 3.0 results minus PCBL-CC Version 3.0 results. For urban areas, the 15% reduction in urban demand that applied to the PCBL-CC-DR Version 3.0 across all major agencies in the Subbasin is reflected in the reduction in urban demand of 17 TAFY compared to the PCBL-CC Version 3.0. For agricultural areas, the PCBL-CC-DR Version 3.0 has 44 thousand acres less agricultural area, which results in 166 TAFY less agricultural demand compared the PCBL-CC. This represents a comparable reduction in agricultural groundwater pumping of 164 TAFY.

Table 24: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL-CC Version 3.0 and PCBL-CC-DR Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL-CC Version 3.0	PCBL-CC-DR Version 3.0	DR Benefit (PCBL-CC-DR Version 3.0 minus PCBL-CC Version 3.0)
Agricultural Area (thousand acres)	365	321	-44
Agricultural Demand (TAF)	1,240	1,074	-166
Agricultural Groundwater Pumping (TAF)	801	637	-164
Agricultural Surface Water Deliveries (TAF)	452	453	1
Agricultural Surplus (TAF)[1]	14	16	2
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	140	-16
Urban Groundwater Pumping (TAF)	67	65	-3
Urban Surface Water Deliveries (TAF)	73	73	0
Urban Shortage (TAF)[1]	16	2	-14

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 59: ESJ Subbasin Projected Agricultural Demand in the PCBL-CC-DR Version 3.0

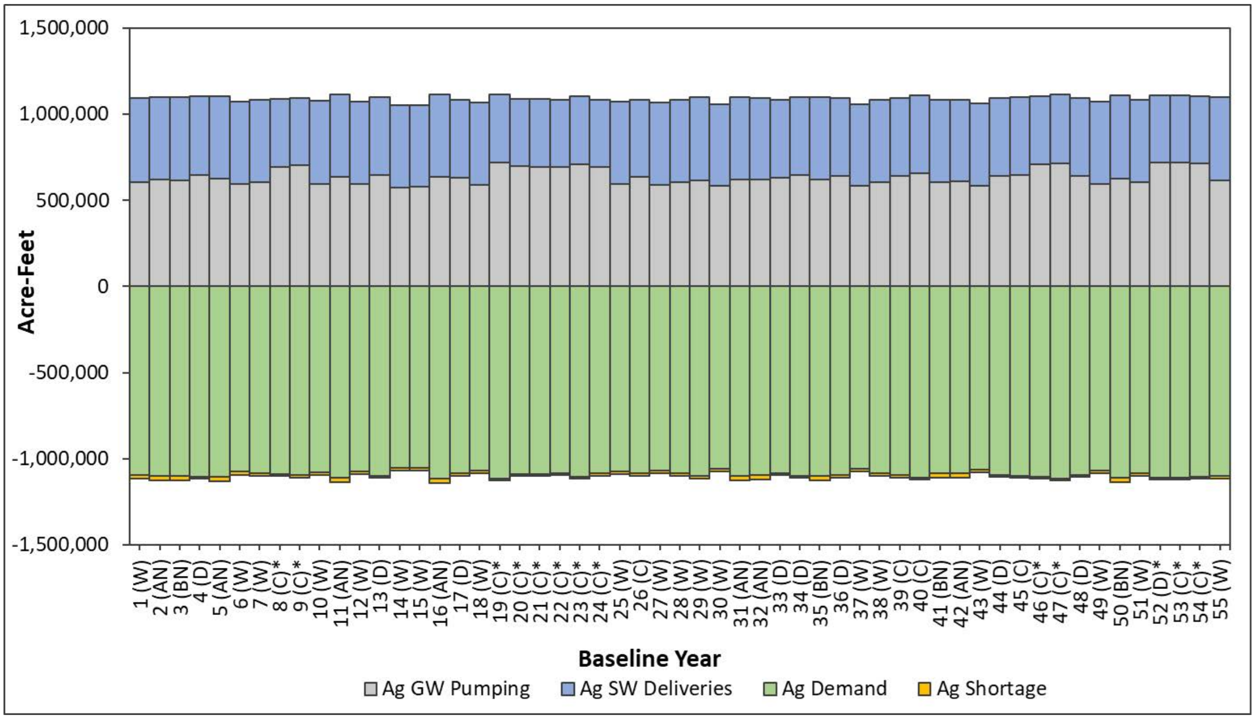
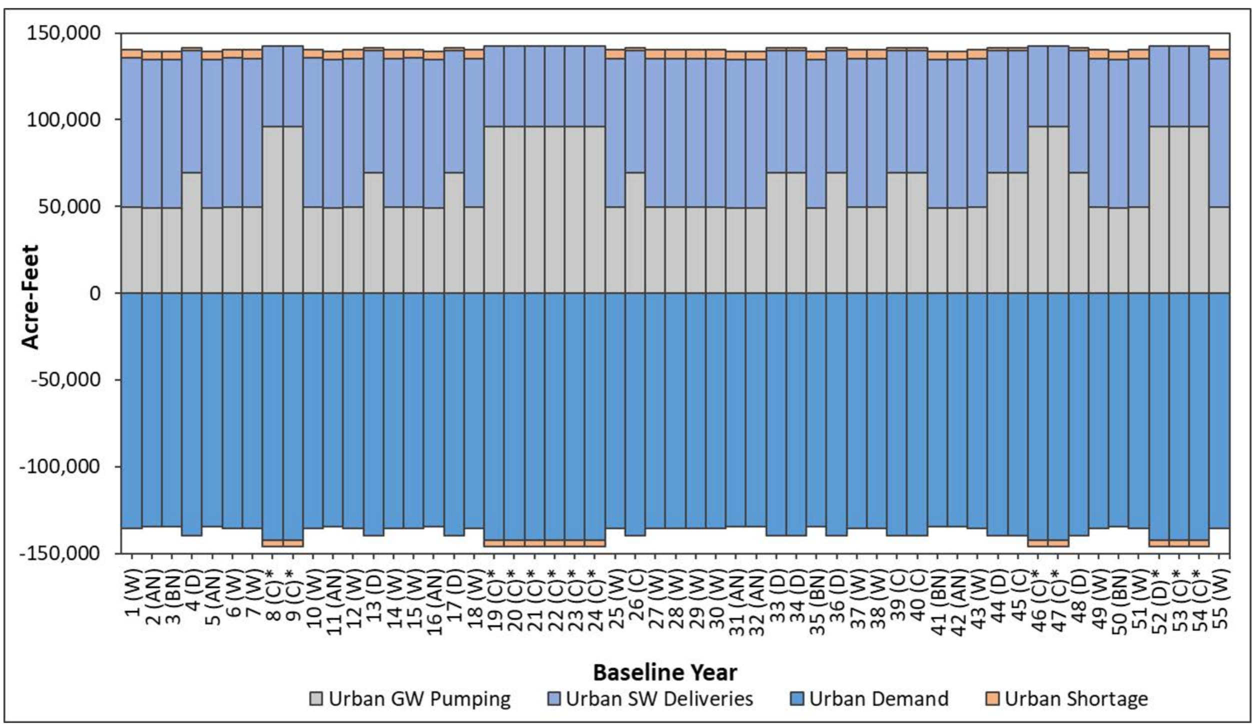


Figure 60: ESJ Subbasin Projected Urban Demand in the PCBL-CC-DR Version 3.0



6.2.2.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
    - Deep percolation (from rainfall and irrigation applied water)
    - Gain from stream (or recharge due to stream seepage)
    - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
    - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
    - Groundwater pumping
    - Loss to stream (or outflow to streams and rivers)
    - Boundary outflow (to surrounding groundwater subbasins)
    - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL-CC-DR Version 3.0 remains the largest component in the groundwater budget with an annual average 713,200 AFY. The PCBL-CC-DR Version 3.0 offsets this pumping with 233,600 AFY of deep percolation, a net gain from stream of 223,200, 167,700 AFY of other recharge (includes recharge from unlined canals, reservoir seepage, managed aquifer recharge, and Sierra Nevada Mountain recharge), and a total subsurface inflow of 88,600 AFY annually. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Even with this uncertainty, the projected long-term average annual groundwater storage deficit in ESJ Subbasin in the PCBL-CC-DR Version 3.0 is 0 AFY. These annual averages are shown in Table 25. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 61.

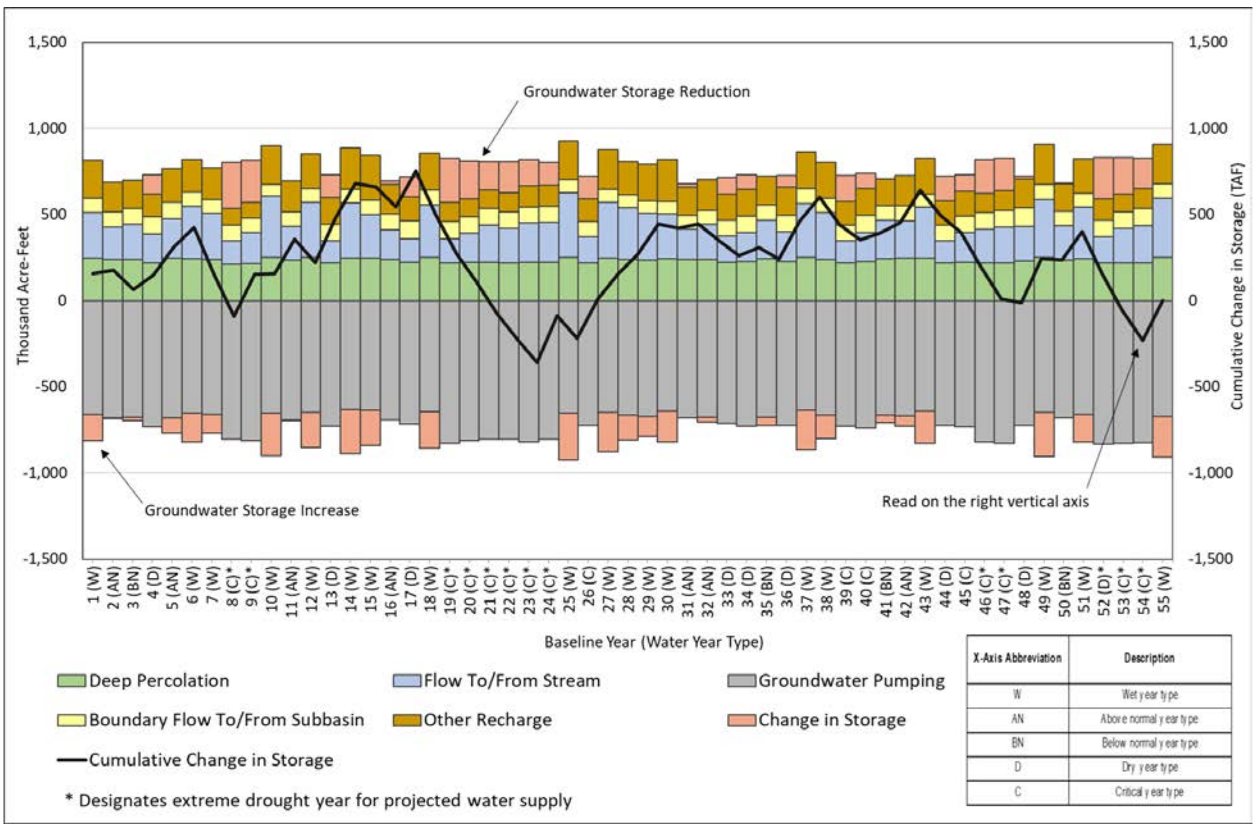
Table 25 also includes the PCBL-CC results and a demand reduction benefit calculated as the PCBL-CC-DR Version 3.0 results minus the PCBL-CC results. The results indicate that the demand reduction will resolve the PCBL-CC Subbasin overdraft condition when impacts due to climate change are included. Without the demand reduction, the modeling shows an average overdraft of 56,200 AFY over the 55 years of the PCBL-CC simulation. With the demand reduction in place, the modelling shows a projected overdraft of 0 AFY on average in the PCBL-CC-DR Version 3.0. The PCBL-CC-DR Version 3.0 shows an average increase of 56,200 AFY of groundwater in storage when compared to the PCBL-CC.

Compared to the PCBL-CC, with the demand reduction modeled, the PCBL-CC-DR Version 3.0 has 166,200 AFY less groundwater pumping due to the percentage reduction in urban per capita water use and agricultural areas, and 53,000 AFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL-CC and PCBL-CC-DR Version 3.0 simulations.

Table 25: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL-CC and the PCBL-CC-DR Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL-CC	PCBL-CC-DR Version 3.0	DR Benefit (PCBL-CC-DR Version 3.0 minus PCBL-CC)
Deep Percolation (TAF)	268	234	-34
Deep Percolation of Precipitation (TAF)	*52*	*52*	*0*
Deep Percolation of Applied Water (TAF)	*216*	*182*	*-34*
Other Recharge (TAF)	168	168	0
Net Stream Seepage (TAF)	276	223	-53
Net Boundary Inflow (TAF)	111	89	-22
Groundwater Pumping (TAF)	879	713	-166
Change in Groundwater Storage (TAF)	-56	0	56

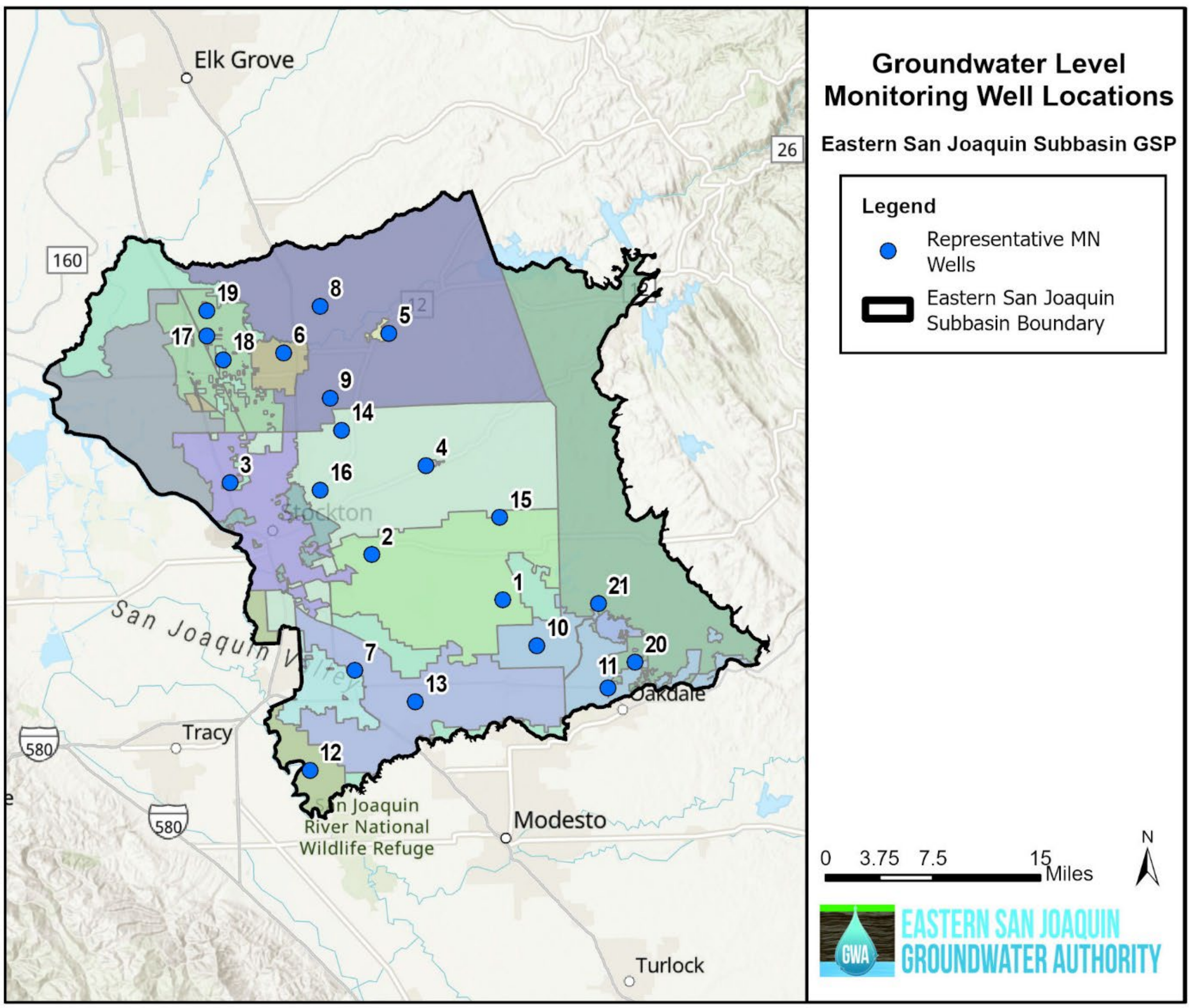
Figure 61: ESJ Subbasin Projected Hydrologic Groundwater Budget in the PCBL-CC-DR Version 3.0



6.3 Projected Conditions Baseline Scenarios with Demand Reduction Groundwater Level Hydrographs

In order to evaluate how the chronic lowering of groundwater levels sustainability indicator might be impacted by Subbasin projected conditions, including climate change and demand reduction, groundwater hydrographs were analyzed for the 21 representative monitoring network wells selected in the GSP to monitor Subbasin groundwater levels. The goal of this analysis was to see where, when, and how often these groundwater hydrographs exceeded the minimum thresholds (MTs) established in the GSP. An undesirable result for groundwater levels as established in the GSP and refined in 2022 edits is when at least 25 percent of representative monitoring network wells (5 out of 21 wells) for the Subbasin are projected to exceed established MTs for two consecutive years. Figure 62 shows the location of the 21 representative monitoring network wells identified in the GSP as the monitoring network for the chronic lowering of groundwater levels.

Figure 62: ESJ Subbasin Groundwater Level Representative Monitoring Well Locations



Groundwater level hydrographs at the 21 representative monitoring network wells were used to evaluate the impacts of the demand reductions under the PCBL-DR Version 3.0 and PCBL-CC-DR Version 3.0 as compared to the PCBL Version 3.0 and PCBL-CC Version 3.0, respectively. Two representative monitoring network wells

(Well Swenson-3 and Well 01S10E04C001) reported groundwater levels below their MTs for at least one month in any of the models evaluated (PCBL Version 3.0, PCBL-DR Version 3.0, PCBL-CC Version 3.0, and PCBL-CC-DR Version 3.0). The hydrographs of these two representative monitoring network wells are shown and discussed in Sections 6.3.1 and 6.3.2. Subbasin undesirable results for groundwater levels are discussed in Section 6.3.3.

6.3.1 Projected Conditions Baseline without and with Demand Reduction

Figure 63 shows the location of the representative monitoring network well (Well 01S10E04C001) with groundwater levels below its MT at any point in the 55-year projection of the PCBL Version 3.0 (without climate change or demand reduction). Figure 64 shows the locations of the same representative monitoring network wells with groundwater levels below their MTs in the PCBL without climate change but with demand reductions (PCBL-DR Version 3.0).

Figure 65 shows the hydrograph of Well 01S10E04C001. The hydrographs have horizontal lines representing the representative monitoring network well's minimum threshold (red) and measurable objective (green). The ESJWRM model results are shown for the PCBL Version 3.0 (solid blue line), PCBL-DR Version 3.0 (dashed blue line), PCBL-CC Version 3.0 (solid brown line), PCBL-CC-DR Version 3.0 (dashed brown line). Any point these lines cross the red minimum threshold line represents an exceedance in at least one month of the simulation. The hydrographs are discussed in further detail after the figures.

Figure 63: Groundwater Level Representative Monitoring Network Wells with MT Exceedances in PCBL Version 3.0

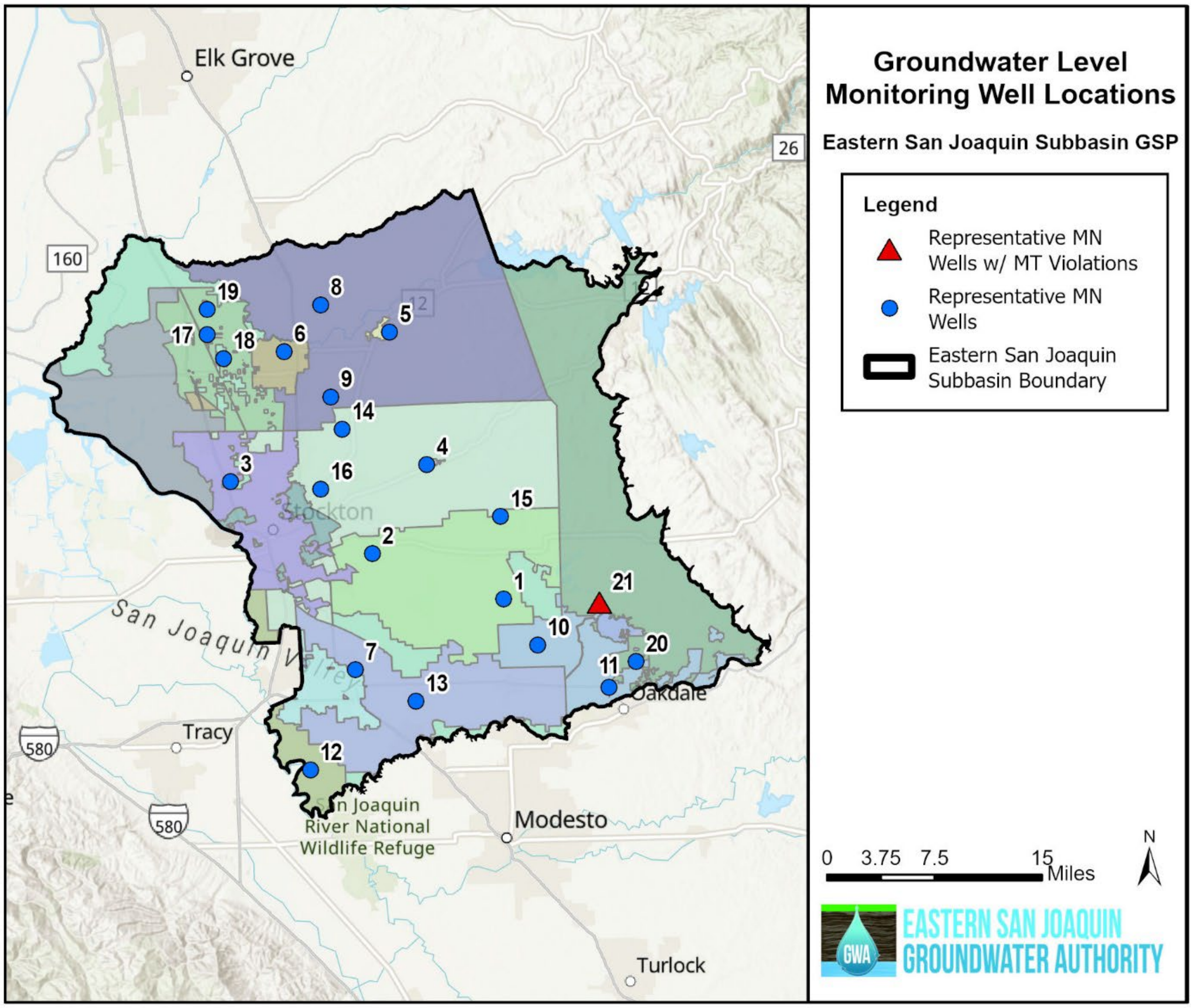


Figure 64: Groundwater Level Representative Monitoring Network Wells with MT Exceedances in PCBL-DR Version 3.0

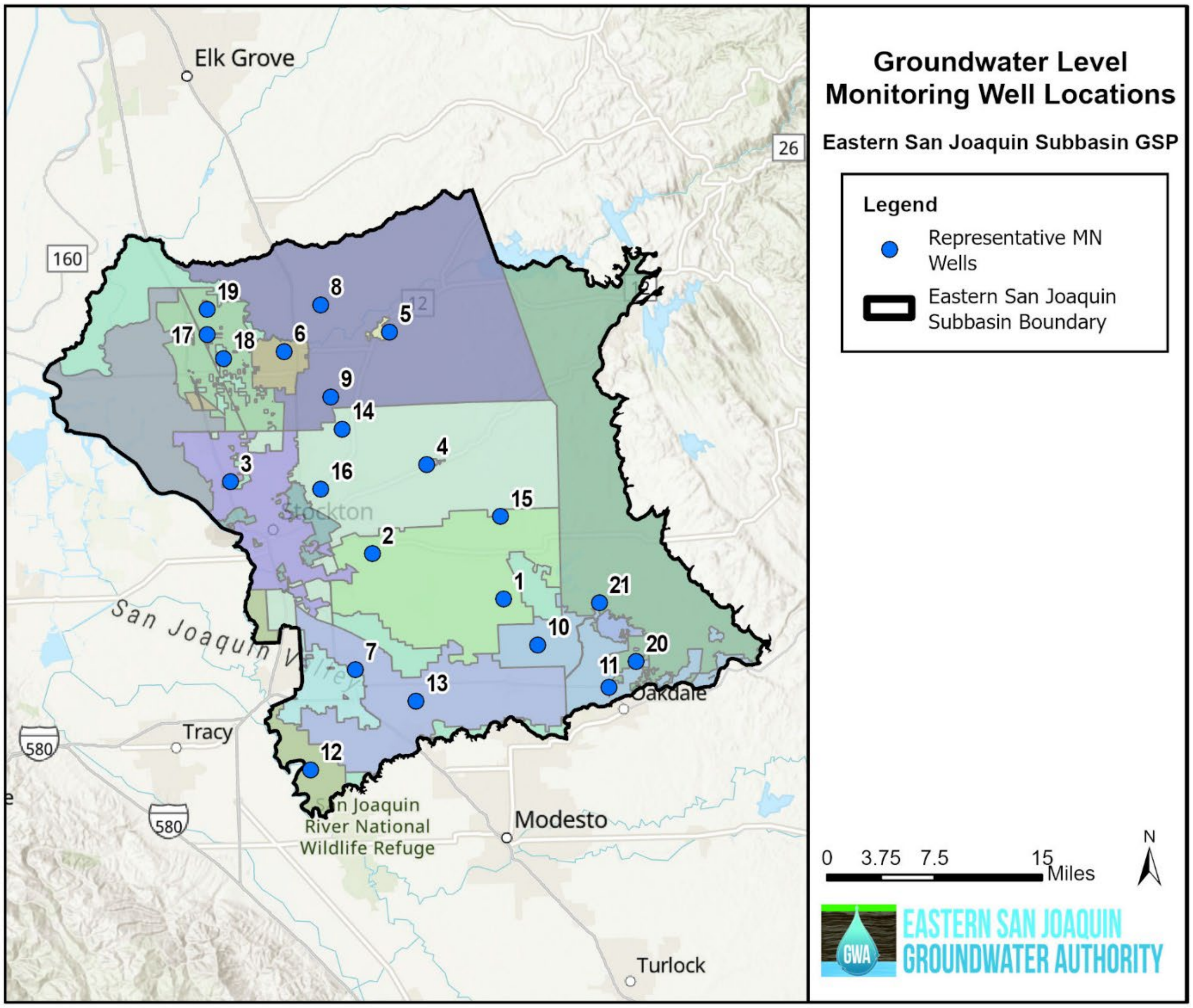
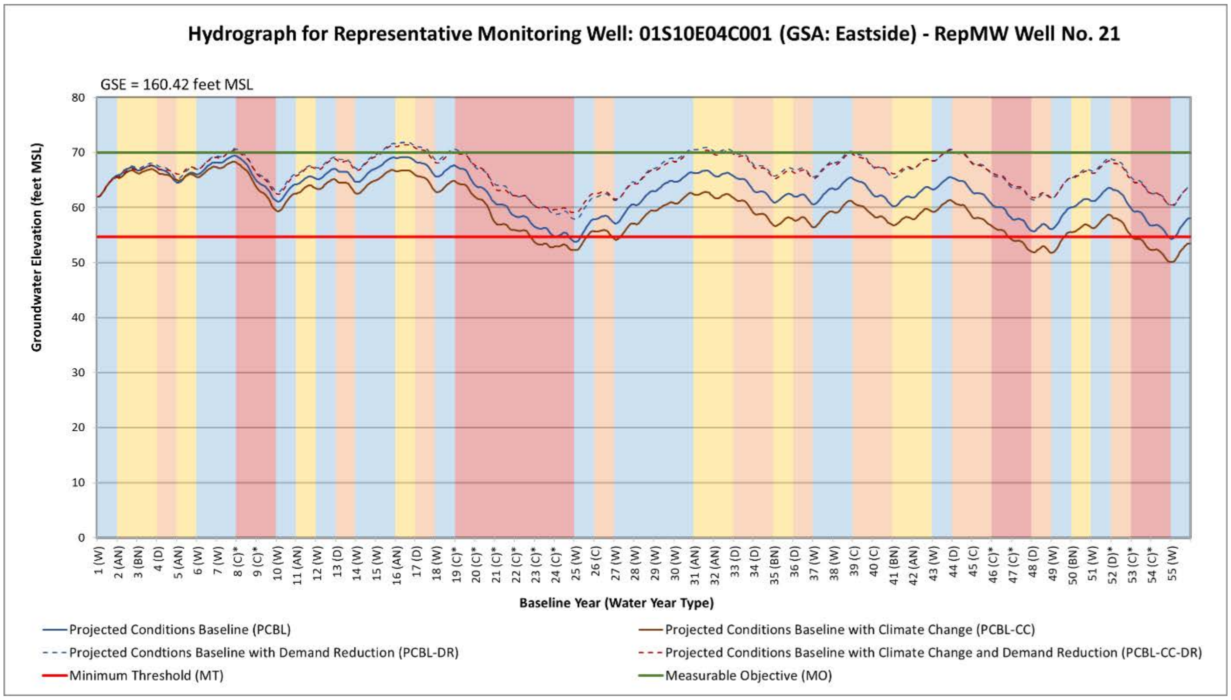


Figure 65: Groundwater Level Hydrograph for Well 01S10E04C001



Under the PCBL Version 3.0 (without climate change or demand reduction), the representative monitoring network well with its hydrograph shown above in Figure 65 (Well 01S10E04C001) exceeded its MT. The text below discusses when and how often MT exceedances occur for the well:

- Well 01S10E04C001:
  - Exceeds its MT in 12 months out of a total of 660 months (2% of all months) and 4 water years out of a total of 55 water years (7% of all water years).
  - The exceedances occur in July of Year 24 in a drought year with exceedances continuing for 7 consecutive months in total, and in August of Year 54 in a drought year with exceedances continuing for 5 consecutive months.

Under the PCBL with demand reductions (PCBL-DR Version 3.0), no representative monitoring network wells exceeded their MTs.

When the demand reduction is included in the ESJWRM, groundwater levels rise across the Subbasin due to the reduction in groundwater pumping from the reduced agricultural areas. Though groundwater levels rise overall, the impact to levels varies from area to area based on the agricultural pumping density. In the PCBL water budget scenario with the demand reduction (PCBL-DR Version 3.0), projections do not show the one well falling below its MT for groundwater levels as compared to the same well in the PCBL Version 3.0 without the demand reduction.

6.3.2 Projected Conditions Baseline with Climate Change and without and with Demand Reduction

Figure 66 shows the location of the two representative monitoring network wells (Well Swenson-3 and Well 01S10E04C001) with projected groundwater levels falling below their MTs for groundwater levels at any point in the 55-year projection of the PCBL with climate change and without demand reductions (PCBL-CC Version

3.0). Figure 67 shows the location of the representative monitoring network well with groundwater levels falling below its MT in the PCBL with climate change and with demand reductions (PCBL-CC-DR Version 3.0).

Figure 68 shows the hydrograph of Well Swenson-3. The hydrographs for the other well exceeding its MTs in the PCBL-CC (Well 01S10E04C001) was shown above in Figure 65. The hydrographs have horizontal lines representing the representative monitoring network well's minimum threshold (red) and measurable objective (green). The ESJWRM model results are shown for the PCBL Version 3.0 (solid blue line), PCBL-DR Version 3.0 (dashed blue line), PCBL-CC Version 3.0 (solid brown line), PCBL-CC-DR Version 3.0 (dashed brown line). Any point these lines cross the red minimum threshold line represents an exceedance in at least one month of the simulation. The hydrographs are discussed in further detail after the figures.

Figure 66: Groundwater Level Representative Monitoring Network Wells with MT Exceedances in the PCBL-CC Version 3.0

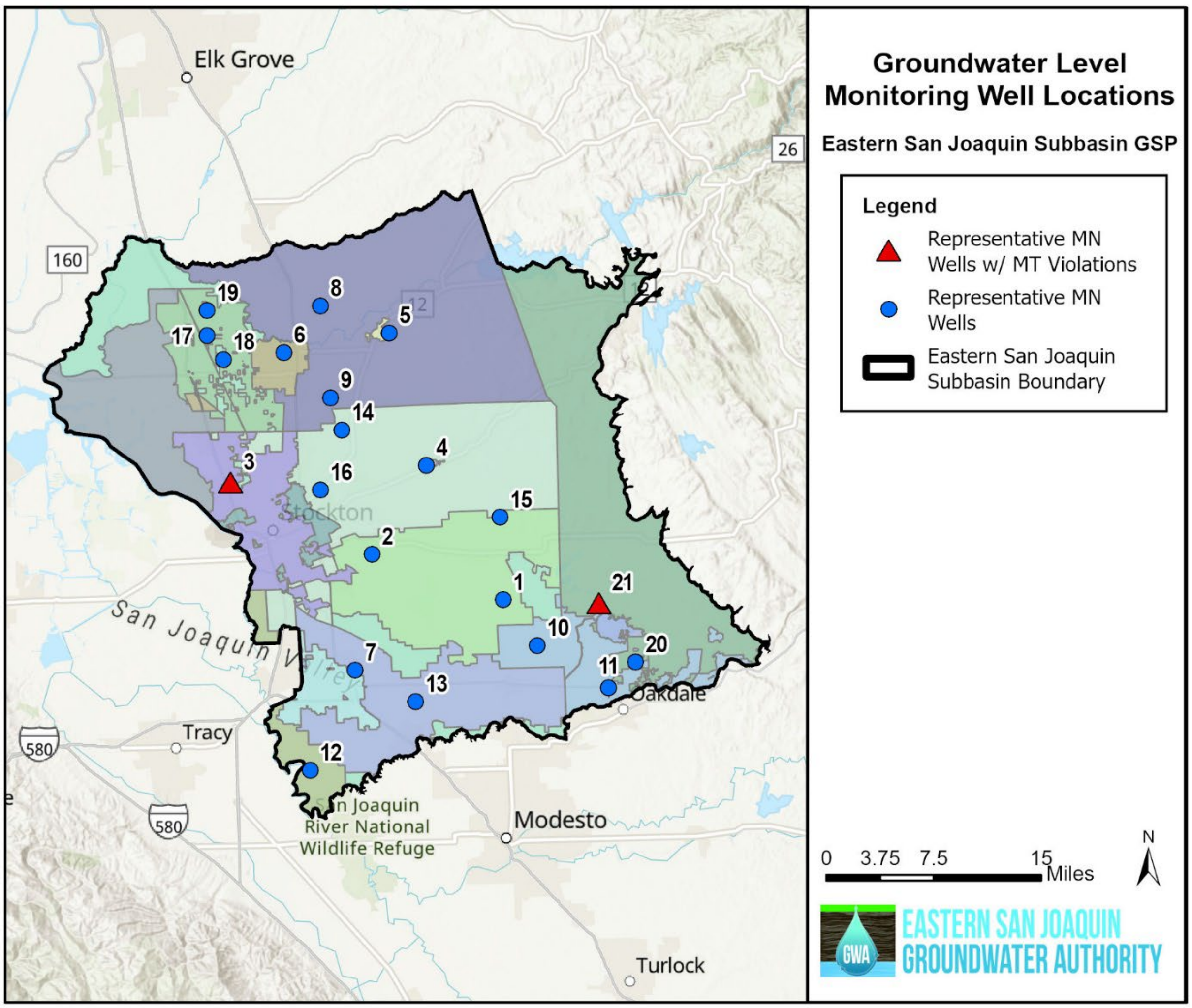


Figure 67: Groundwater Level Representative Monitoring Network Wells with MT Exceedances in the PCBL-CC-DR Version 3.0

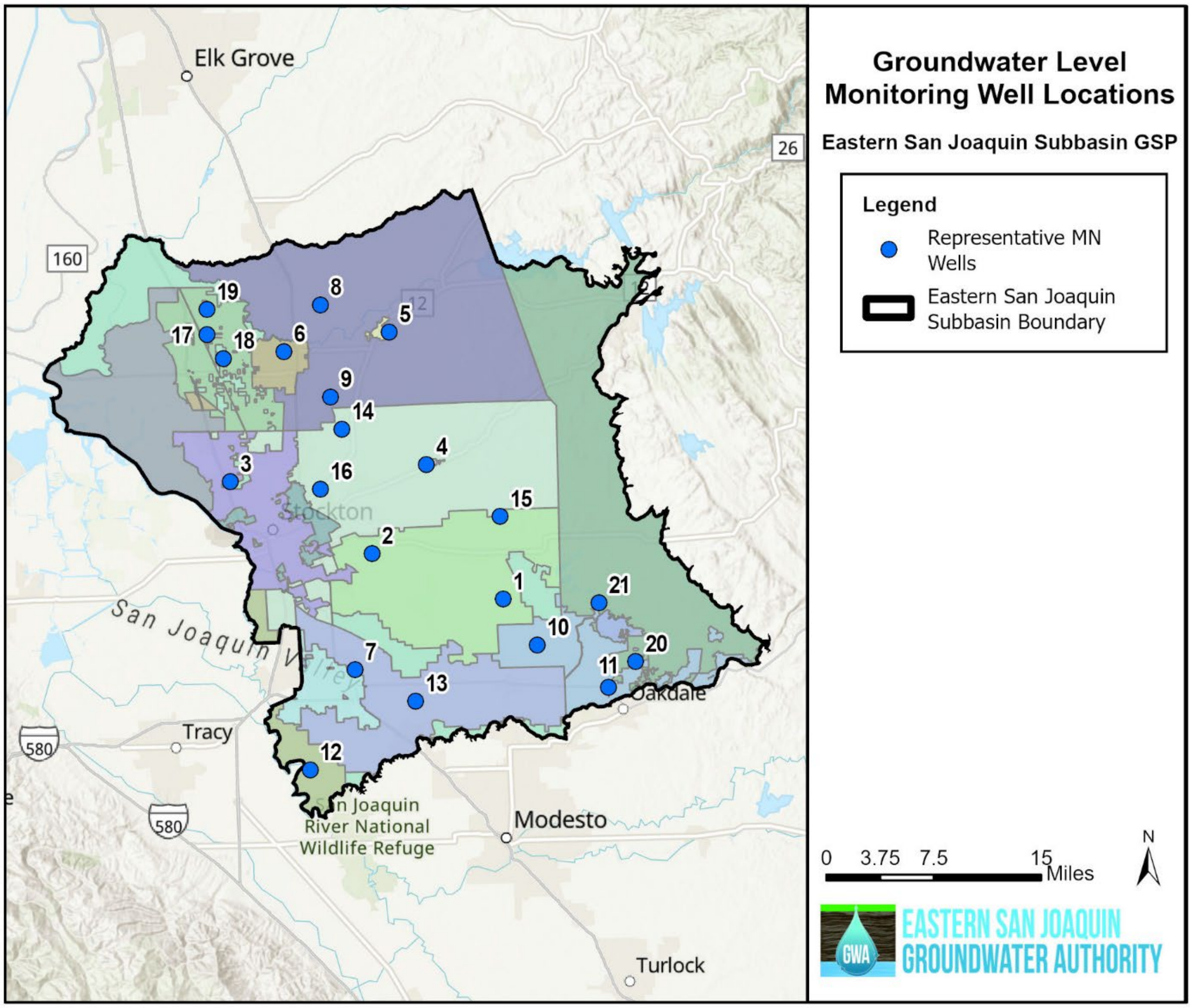
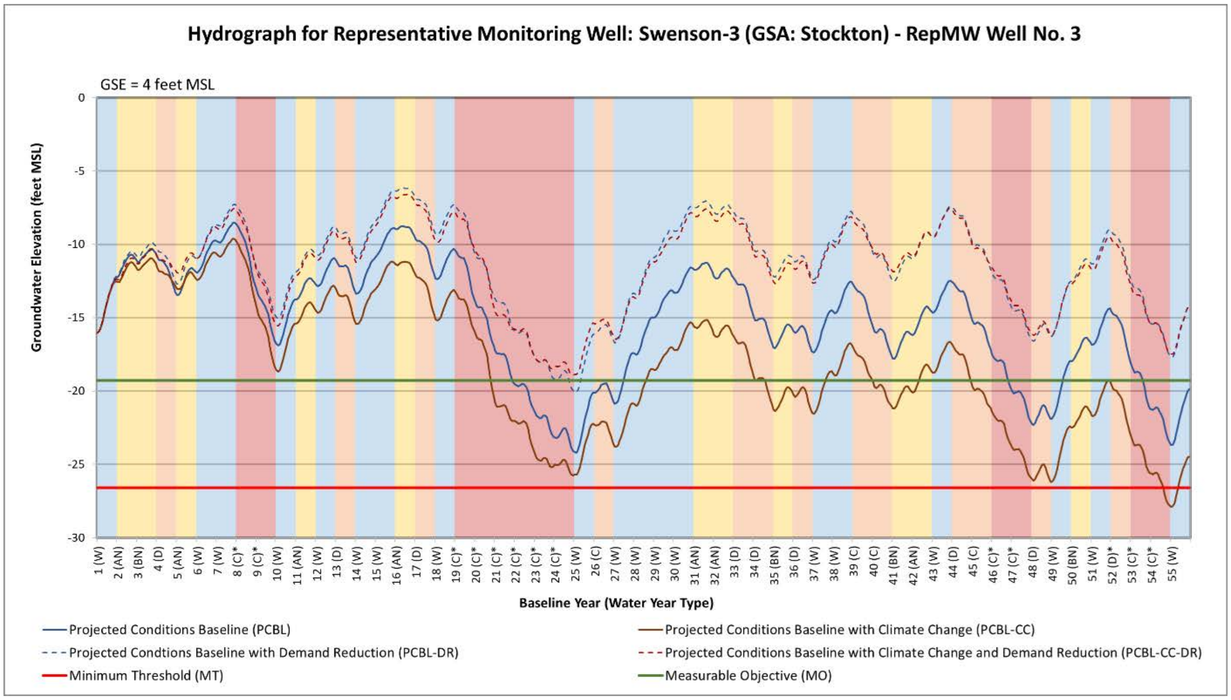


Figure 68: Groundwater Level Hydrograph for Well Swenson-3



Under the PCBL with climate change but without demand reductions (PCBL-CC Version 3.0), two representative monitoring network wells (Well Swenson-3 and Well 01S10E04C001) exceed their MTs.

- Well Swenson-3:
  - Exceeds its MT in 9 months out of a total of 660 months (1% of all months) and 2 water years out of a total of 55 water years (4% of all water years).
  - The exceedances occur in June of Year 54 in a drought year with exceedances continuing for 9 consecutive months in total.
- Well 01S10E04C001:
  - Exceeds its MT in 108 months out of a total of 660 months (16% of all months) and 13 water years out of a total of 55 water years (24% of all water years).
  - The exceedances occur in August of Year 22 in a drought year with exceedances continuing for 3 consecutive water years, in September of Year 26 in a drought year with exceedances continuing for 5 consecutive months, in August of Year 47 in a drought year with exceedances continuing for 3 consecutive water years, and again in November of Year 52 in a drought year with exceedances continuing the remainder of the simulation, or 3 consecutive water years.

Under the PCBL with climate change and with demand reductions (PCBL-CC-DR Version 3.0), no representative monitoring network wells exceeded their MTs.

The demand reduction raises groundwater levels in varying amounts across the Subbasin. As seen with the two wells with MT exceedances in the PCBL-CC Version 3.0, the effects of climate change may continue to significantly impact Subbasin groundwater overdraft and groundwater levels in the future. In the PCBL water budget scenario with the demand reduction and climate change factored in (PCBL-CC-DR Version 3.0), modeling results show no well still falling below their MT for groundwater levels in the 55-year projection.

6.3.3 Groundwater Levels Undesirable Result

An undesirable result for groundwater levels is considered to occur during GSP implementation when at least 25 percent of representative monitoring network wells (5 of 21 wells in the Subbasin) fall below their MTs for two consecutive years. Figure 69 shows the number of wells with 2 consecutive water years of exceedances in the PCBL Version 3.0, PCBL-DR Version 3.0, PCBL-CC Version 3.0, and PCBL-CC-DR Version 3.0 scenarios over 54 years of the simulation (since Year 1 cannot have 2 consecutive years of exceedances). Table 26 shows the number of water years out of the total possible 54 years with 2 consecutive years of exceedances in the same four simulations. Only the PCBL and PCBL-CC simulations have consecutive water years with MT exceedances occurring in at least one well. These exceedances are all during or immediately following extreme drought conditions. No undesirable results were triggered in any of the four simulations.

Figure 69: Number of Wells with 2 Consecutive Water Years of Exceedances

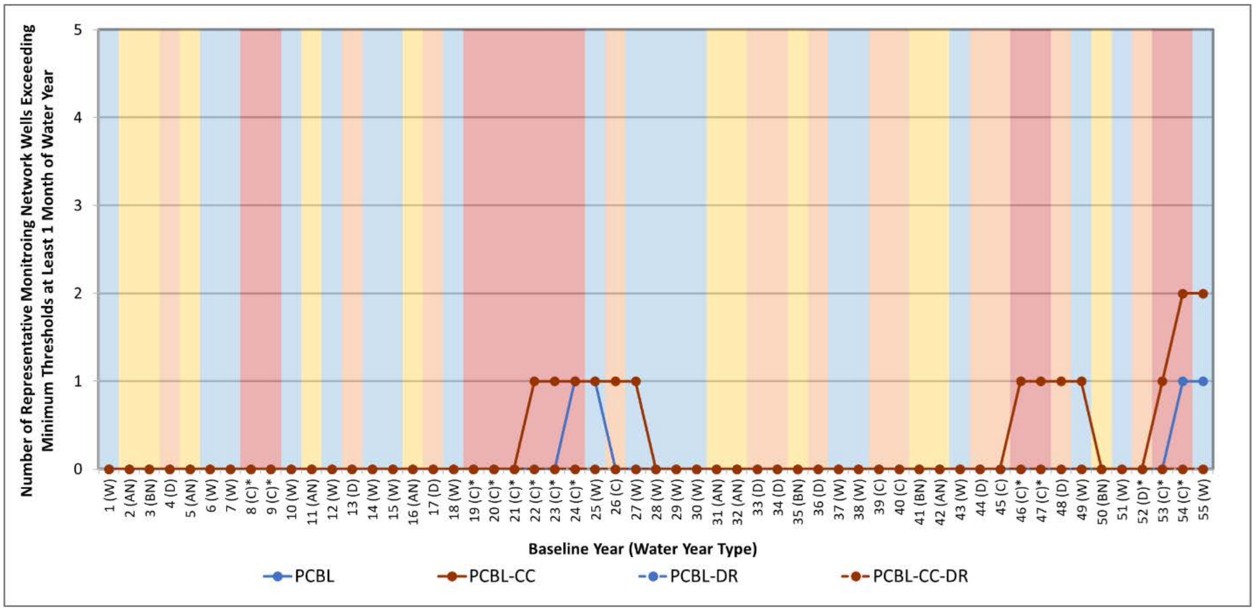


Table 26: Number of Water Years Out of Total with 2 Consecutive Years of Exceedances

Number of Water Years where Wells Have 2 Consecutive Years of Exceedances	PCBL Version 3.0	PCBL-DR Version 3.0	PCBL-CC Version 3.0	PCBL-CC-DR Version 3.0
1 Well	4	0	11	0
2 Wells	0	0	2	0
3 Wells	0	0	0	0
4 Wells	0	0	0	0
5 Wells	0	0	0	0

7 Projected Conditions Baseline Scenarios with Projects & Management Actions

The goal of this section is to document the Projects & Management Actions (PMAs) selected for simulation in the ESJWRM, the assumptions made about potential project volumes and timing, and results of the model runs. This section is adapted from what was originally developed as a technical memorandum attached to the 2022 Revised GSP (Woodard & Curran, 2022b).

Initially, all the projects from the ESJ Subbasin 2019 GSP and 2022 Sustainable Groundwater Management (SGM) Grant Program's SGMA Implementation Round 1 application were considered in updates to the 2022 Revised GSP. Based on updates in the Annual Reports and information from representatives of the GSAs in the ESJGBA, these projects were categorized as Category A or B based on how likely they were to be online by 2040 (and likely to advance in the first five years) and if they already had the necessary water rights and/or agreements to proceed with the project. Eight projects were initially sorted into Category A in 2022. Individual meetings with the project proponents in 2022 identified several additional projects that were already moving forward or were already operational; these additional projects were also added to Category A, for a total of 11 projects. GSAs were asked to review and update projects in 2024 and five GSAs reviewed Category A PMAs and provided updates to the project descriptions and volumes to varying degrees. Two projects were added to the Category A projects in 2024, for a total of 13 projects.

7.1 Category A Projects

The Category A projects are added to the information in two existing model runs: PCBL Version 3.0 and PCBL-CC Version 3.0. The version of the models including Category A projects are the Projected Condition BaseLine with Category A Projects and Management Actions (PCBL-PMA) and Projected Condition BaseLine with Climate Change and Category A Projects and Management Actions (PCBL-CC-PMA). For these model runs, all projects are assumed to be online and fully operational. Figure 1 shows the general locations of where the delivery of water is expected to occur.

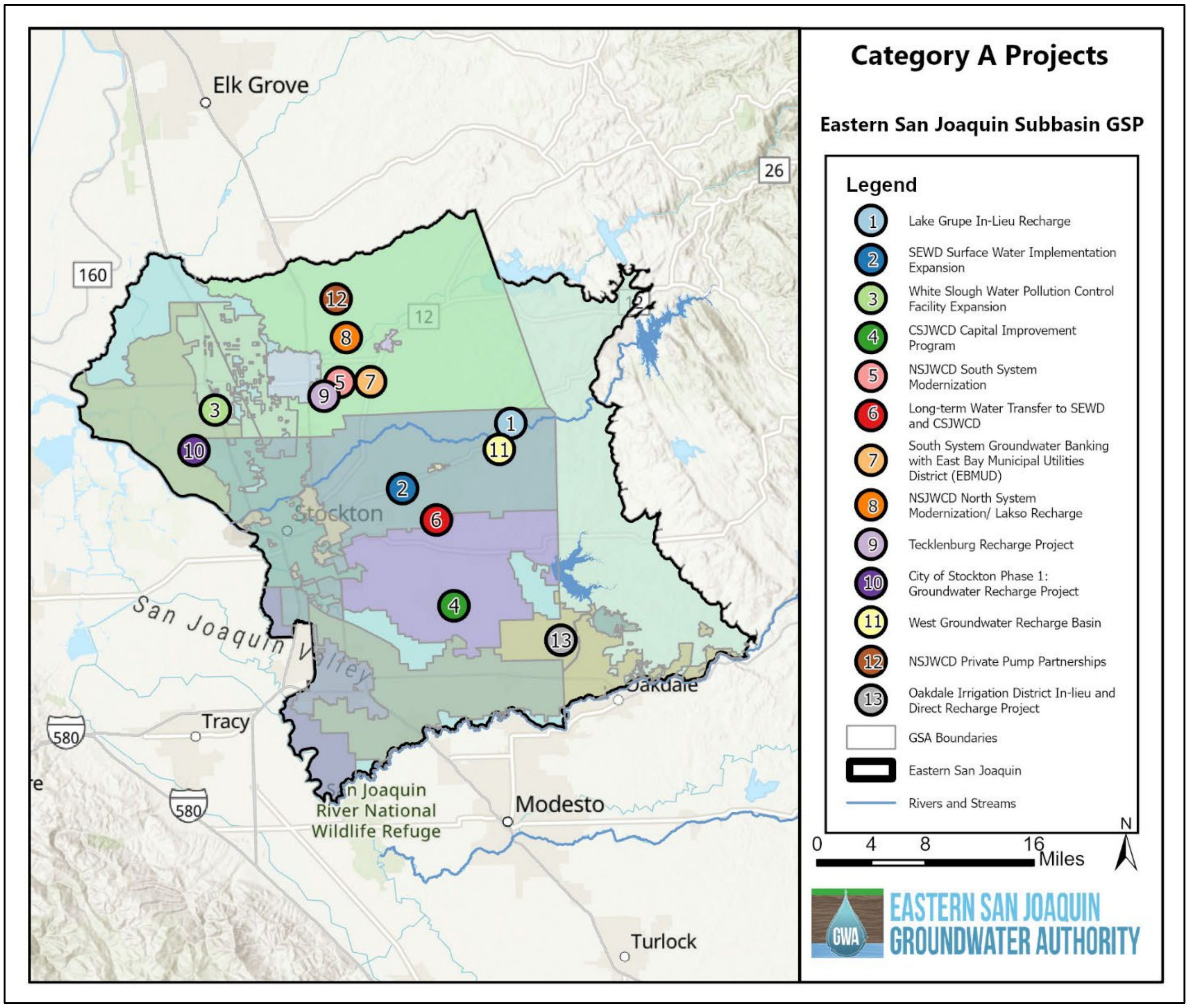
All of the projects discussed below are either in-lieu recharge projects, direct recharge projects, or a combination of the two types, most of which utilize additional surface water coming from the major streams that cross ESJ Subbasin. All of these projects are simulated in ESJWRM as additional surface water diversions in the model. Each project contains a brief description of the proposed version of the project and any assumptions made in simulating the projects in ESJWRM. Since all volumes given below are annual, monthly estimates were assumed by using similar surface water diversions already included in ESJWRM to develop monthly distributions for the annual amounts.

The projects below are listed in no particular order. All information included in this document was the best available estimate at the time and is not necessarily representative of the final design or construction of the projects. Additionally, the Subbasin may choose to pursue projects not included in this technical memorandum in order to meet the needs of SGMA.

In total, 13 Category A projects have been simulated in ESJWRM in the PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0. Seven are in-lieu recharge projects, three are direct recharge projects, and three are a combination of in-lieu recharge and direct recharge. Overall, the projects below include in-lieu recharge for agricultural use (9 projects) with deliveries excluding assumed losses with an average of 46,400 acre-feet per year (AFY) (ranging from 9,700-71,100 AFY depending on baseline year type), in-lieu recharge for urban use (1 project) of 5,000 AFY or 20,000 AFY only in Dry and Drought baseline water years, and direct recharge (5 projects) with an average of 24,500 AFY (ranging from 6,500-24,500 AFY depending on baseline year type).

Note that these project counts include those projects that include components of both in-lieu recharge and direct recharge.

Figure 70: General Location of Category A Projects



7.1.1 SEWD Lake Grupe In-Lieu Recharge

<u>Submitting GSA</u>: Stockton East Water District (SEWD)

<u>Project Source</u>: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.1.

<u>Project Assumptions Confirmed By</u>: Justin Hopkins (SEWD) on May 9, 2022 and Jeanne Zolezzi (Herum\Crabtree\Suntag) on May 12, 2022. No updated confirmation was received during 2024 model data request.

<u>Project Type</u>: In-Lieu Recharge

Water Source: The surface water source of this project is from SEWD's existing contract with the U.S. Bureau of Reclamation (USBR) for the New Hogan Reservoir. Surface water is diverted from the Calaveras River. This is an existing surface water right.

Delivery Area: Approximately 2,500 acres of orchards surrounding Lake Grupe in SEWD

Project Overview: The Lake Grupe In-Lieu Recharge Project, proposed by SEWD, is to construct a surface water diversion turn-out on the Calaveras River, upstream of Bellota, and to supply surface water to farms/growers currently using groundwater. The project is to allow about 2,500 acres of orchard crops to irrigate with surface water from Lake Grupe instead of using groundwater. The project would pump water from the Calaveras River and transport to Lake Grupe via a pipeline and ravine, allowing for both the in-lieu banking of groundwater from irrigation conversion and percolation from the ravine used to transport the water. The project was constructed in 2023.

Project Volume: Since the water is transported by a pipeline to Lake Grupe, no evaporation or seepage losses are assumed to occur between Calaveras River and Lake Grupe. The volume of water delivered was assumed by multiplying 1,750 acres (the estimate of acreage for the project from 2022) by an assumed 2.8 acre-feet per acre per year (AF/AY). In situations where there are multiple dry years, the range of water expected is from 0 to 2,000 AFY. Because the baseline water year type Drought represents strings of dry years (water years that were actually part of drought periods), multiple dry years are captured in the Drought deliveries and were assumed to be 2,000 AFY.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	2,000	Range of 0-2,000 AFY in multiple drought years
Dry	4,900	
Normal	4,900	
Wet	4,900	

7.1.2 SEWD Surface Water Implementation Expansion

Submitting GSA: Stockton East Water District (SEWD)

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.2.

Project Assumptions Confirmed By: Justin Hopkins (SEWD) on May 9, 2022 and Jeanne Zolezzi (Herum\Crabtree\Suntag) on May 12, 2022. No updated confirmation was received during 2024 model data request.

Project Type: In-Lieu Recharge

Water Source: This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir.

Delivery Area: Approximately 6,750 acres adjacent to surface water conveyance systems in SEWD

Project Overview: As part of the SEWD Surface Water Implementation Expansion Project, SEWD would require landowners adjacent to surface water conveyance systems (rivers or pipelines) to utilize surface water as part of the SGMA implementation. This would increase surface water usage by about 18,000 to 20,000 AF/year with in-lieu groundwater recharge benefits. Currently, there are about 6,000 acres irrigated with groundwater that could be converted to surface water. There are also an additional 1,500 acres with inactive surface water accounts. SEWD would be the lead agency in environmental/CEQA review and would assist landowners/growers in establishing a turnout for agricultural irrigation and acquiring necessary permits through federal and state regulatory agencies. SEWD has completed the conversion of 2,505 acres to surface water, is in the construction phase to convert an additional 2,592 acres, and in the planning phase to convert an additional 1,135 acres.

Project Volume: Estimated evaporation and seepage losses occurring between Calaveras River or Stanislaus River and SEWD land are incorporated in a separate diversion in ESJWRM. As a conservative estimate, no additional seepage is assumed to occur due to the transport and delivery of this water. The volume of water delivered was estimated by multiplying an estimated 6,750 acres (average of 6,000 and 7,500 acres) by an assumed 2.8 AF/AY and rounding to the nearest thousand. In situations where there are multiple dry years, the range of water expected is from 0 to 4,000 acre-feet per year (AFY). Because the baseline water year type Drought represents strings of dry years (water years that were actually part of drought periods), multiple dry years are captured in the Drought deliveries and were assumed to be 4,000 AFY.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	4,000	Range of 0-4,000 AFY in multiple drought years
Dry	8,000	
Normal	19,000	
Wet	19,000	

7.1.3 City of Lodi White Slough Water Pollution Control Facility Expansion

Note: Information was received from the agency after PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0 were finalized that altered the project description and expected yield for this project. The section below includes the project understanding as it was included in the model simulation. The project updates presented in Chapter 6.2.4.3 are the most current understanding and information will be updated in the modeling for Version 4.0.

Submitting GSA: City of Lodi

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.3.

Project Assumptions Confirmed By: Travis Kahrs (City of Lodi) on May 11, 2022. No updated confirmation was received during 2024 model data request.

Project Type: Recycled Water/In-Lieu Recharge

Water Source: Treated wastewater effluent from White Slough Water Pollution Control Facility

Delivery Area: 70-acre pond with capacity of 388 AF and 890 acres of agricultural land surrounding White Slough Pollution Control Facility

Project Overview: This project includes the construction of a 70-acre pond expansion with a storage capacity of 388 AF. The purpose of this project is to provide tertiary-treated Title 22 effluent for use as irrigation water on approximately 890 acres of agricultural land used to grow crops for dairy cattle, such as corn, wheat, and alfalfa surrounding the White Slough Water Pollution Control Facility (WPCF) to offset groundwater pumping. Flow will be diverted from Dredger Cut (a dead-end slough of the Sacramento-San Joaquin River Delta) at a rate up to 1,700 gallons per minute over an approximate 75- to 90-day period between October 1 and May 31 of each year. Project studies have demonstrated that the storage provided by this project will significantly offset groundwater pumping through in-lieu use. This project is completed and fully online.

Project Volume: The project is able to store and recharge project year-round due to constant operations of the WPCF. The irrigation season is generally mid-April through September, during which water is provided to 790 acres of agricultural land. In 2020, per the City of Lodi's 2020 Urban Water Management Plan[1], the city used a total of 3,729 AF for agricultural irrigation, with projected volumes to remain the same through at least 2045. Based on a preliminary Surface Pond Percolation Study[2][2] (completed by Petralogix in 2016), the unlined ponds were anticipated to have an annual percolation to groundwater rate of up to 29 to 51 million gallons per year or approximately 100 to 200 AFY. With 3,729 AFY expected to be used for agricultural irrigation in the future, the amount of percolation is estimated to be 4% of this amount or about 150 AFY.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	3,729	
Dry	3,729	
Normal	3,729	
Wet	3,729	

7.1.4 CSJWCD Capital improvement Program

Submitting GSA: Central San Joaquin Water Conservation District (CSJWCD)

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.4.

Project Assumptions Confirmed By: Reid Roberts (CSJWCD) on May 6, 2022. No updated confirmation was received during 2024 model data request.

Project Type: In-Lieu Recharge

Water Source: This project relies on water from New Melones Reservoir. This is an existing surface water right. CSJWCD has long-term water supply contracts with USBR for the New Melones Unit Central Valley Project.

Delivery Area: CSJWCD

Project Overview: CSJWCD assists users to convert groundwater-irrigated fields to surface water use. The user applies for water credits based upon new surface water acres. The user is responsible for constructing a diversion facility. As water is diverted, the district reduces the water charge until credit is used or seven years

[1] City of Lodi, 2021. 2020 Urban Water Management Plan. August 2021

[2] Petralogix, 2016. City of Lodi Surface Pond Percolation Report. September 23, 2016.

since implementation have elapsed. A poll conducted prior to any surface water delivery within the district estimated between 25,000 to 30,000 acres could be brought onto surface water supply. The Capital Improvement Program has been on-going since 1996 and new individual projects are anticipated to begin each year with CSJWCD Board approval and possible streambed alteration permits. Currently, the District takes between 35,000 to 40,000 AFY of its surface water contract to irrigate approximately 15,000 acres. The district has identified an additional 10,000 to 15,000 acres for ongoing expansion of the Capital Improvement Program.

Project Volume: CSJWCD has a contract with USBR for up to 80,000 AFY of Stanislaus River water with a firm yield of 49,000 AFY. In exceptionally dry years (DWR critical years), the district's allotment is zero. An agreement with City of Stockton gives SEWD the first 15,000 AFY for M&I, so the least CSJWCD is expected to receive in Dry years is 34,000 AFY (49,000 AF – 15,000 AF).

Conservatively, a total of 2 AF/acre was assumed to account for variable water use amounts among different crop types. For Normal and Wet years, an estimated 12,000 acres (assuming a rounded average of the estimated 10,000 to 15,000 acres identified for surface water) were used with the assumed 2 AF/acre water use to determine the annual volume of 24,000 AFY. Considering the District's firm yield, Dry years are assumed to yield 12,000 AFY as the difference between the existing amount CSJWCD is estimated to receive already in ESJWRM and the 34,000 AFY total the district can expect to receive at minimum.

CSJWCD's surface water diversions lose an estimated 25-30% on the way to being delivered. This amount will be applied to the diversion in ESJWRM for the calculation of losses due to evaporation and seepage.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	0	
Dry	12,000	
Normal	24,000	
Wet	24,000	

7.1.5 NSJWCD South System Modernization

Submitting GSA: North San Joaquin Water Conservation District (NSJWCD)

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.5.

Project Assumptions Confirmed By: Jennifer Spaletta (Spaletta Law PC) on May 4, 2022. Updated by communication with Jennifer Spaletta (Stoel Rives LLP) and Steve Schwabauer (NSJWCD) on May 13, 2024. Jennifer Spaletta provided updated text.

Project Type: In-Lieu Recharge/Direct Recharge

Water Source: This project relies on water from the Mokelumne River. This is an existing water right held by NSJWCD (Permit 10477).

Delivery Area: NSJWCD South System

Project Overview: This project will modernize the South System Pump and Distribution System to facilitate delivery of additional surface water to farmers in-lieu of groundwater pumping. Pre-2020 deliveries on the South System were 3,000 AFY in wet years (since 1987). NSJWCD has been working on modernizing the South

System Pump Station and Distribution System in phases since 2017 to facilitate delivery of 9,000 AFY of additional surface water to farmers in-lieu of groundwater pumping, or for direct recharge. Water would come from NSJWCD Permit 10477 supplies, which are available in about 55 percent of years for irrigation delivery, and in about 80 percent of years for direct recharge. Utilizing just Permit 10477, it is NSJWCD's goal to deliver maximum wet year quantities of 12,000 AFA through the South System. (Additional deliveries through the South System related to banking with East Bay Municipal Utilities District or EBMUD are discussed in a separate Category A project, "NSJWCD South System Groundwater Banking with EBMUD").

Project Volume: The volumes for the project tabulated below were provided by Jennifer Spaletta on May 13, 2024 and cover both the NSJWCD South System Modernization as well as the NSJWCD Tecklenburg Recharge Project. In wet and normal years, about 50% of the water will be used for agricultural purposes and 50% for recharge (likely via the Tecklenburg Recharge Project). In critical years, no water is available and in dry years, all of the water is expected to be used for recharge projects. Based on these assumptions, the water was split into the two projects in the table below. The project is expected to be 50% built out by 2028 and fully built out through Phase 4B by 2030.

NSJWCD completed Phases 1 and 2 of this project as well as the Tecklenburg Recharge Basin Project from 2017-2024. Phases 1-2 included a new pump station with two pumps with a total capacity of 30 cfs and replacing key segments of the main distribution pipeline. The Tecklenburg Basin involved purchasing a 10 acre parcel, constructing a basin, and constructing piping to get water in the basin. Phase 3 will be complete by 2025 and includes replacing another segment of the main pipeline and adding a 24 inch lateral to the Tecklenburg basin, which will increase its recharge ability.

Phase 4A and Phase 4B are planned but not yet implemented. Phase 4A involves constructing the Handel Lateral to add delivery capacity to another 1,000 acres in the South System area. The Handel Lateral should be complete by 2027. Phase 4B involves replacing another major section of the main South System Distribution pipeline to remove a delivery bottle-neck in the system and increase capacity for both in-lieu and direct recharge deliveries. Phase 4B should be complete by 2030, if the District secures sufficient funding. The volumes displayed in the table below assume Phase 4B of the project is completed.

Future phases (5, 6, etc) involve additional laterals and improvements along Bear Creek and Pixley Slough to increase surface water diversions for direct recharge and irrigation use (in-lieu recharge). These phases require funding. Other improvements to the South System will include additional recharge basins, on-farm flooding agreements and in-lieu connections for irrigation, which will be installed over time in the next 5-10 years.

The table below shows planned build-out using just the Districts' Permit 10477 water right. EBMUD Banking water (discussed in "NSJWCD South System Groundwater Banking with EBMUD") and/or MICUP water under the County's new water right (Category B project) would be additional supplies beyond what is reflected in the table.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)			Notes
	Total South System Modernization and Tecklenburg Recharge Project	South System Modernization	Tecklenburg Recharge Project	
Drought	0	0	0	
Dry	1,500	1,200	300	
Normal	9,000	8,000	1,000	
Wet	12,000	10,000	2,000	

7.1.6 Long-term Water Transfer to SEWD and CSJWCD

Submitting GSA: South San Joaquin GSA and Oakdale Irrigation District GSA

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.6.

Project Assumptions Confirmed By: Justin Hopkins (SEWD) on May 9, 2022 and Emily Sheldon (Oakdale Irrigation District or OID) on May 9, 2022. In May 2024, updated by Emily Sheldon from OID and Brandon Nakagawa with SSJID.

Project Type: Transfers/In-Lieu Recharge

Water Source: This project relies on water from New Melones Reservoir (Stanislaus River water). This is an existing surface water right (pre-1914) held by Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID).

Delivery Area: SEWD and CSJWCD

Project Overview: OID and SSJID have historically participated in long-term water transfers of surplus and pre-1914 surface water rights to other entities in the Eastern San Joaquin Subbasin. These transfers have included one-year transfers to CSJWCD as well as a nearly 10-year transfer to SEWD for both agricultural and urban purposes. CSJWCD and SEWD both have surface water available from the USBR's Central Valley Project on the Stanislaus River; however, project water allocations have become significantly reduced in DWR water year types of below normal and dry years, resulting in increased groundwater reliance to meet annual and permanent crop water demands. Providing long-term water transfers from OID/SSJID to other agencies within ESJ Subbasin would allow for increased average annual surface water deliveries to the Subbasin, reducing groundwater reliance and overdraft within the Subbasin. SEWD and CSJWCD overlie a significant portion of the Subbasin dependent on groundwater and subject to historical overdraft conditions.

No new facilities need to be constructed for this project. Historical transfers have been accomplished through existing facilities, including a tunnel just upstream of the OID/SSJID-owned Goodwin Dam on the Stanislaus River. Transfers from OID/SSJID to SEWD/CSJWCD have historically been agreed to, with historical transfer amounts varying from 0 to 40,000 AF/year. Additional infrastructure may be necessary to increase distribution of surface water supplies to irrigated agriculture and to achieve adequate improvement toward sustainability goals.

Project funding could be provided directly from the districts participating in water transfers. Additional infrastructure to promote surface water use and capital payments for surface water transfers could be provided indirectly by groundwater reliant entities, thereby providing a means of continuing to utilize groundwater while investing in a Subbasin-wide project that assures continued sustainability within the Subbasin.

Project Volume: The amount and use of the transferred water may vary widely, as SEWD may utilize the supply for either municipal and industrial (M&I) deliveries to Stockton area urban contractors or agricultural customers in SEWD's district boundaries, while CSJWCD may use the supply for agricultural customers in CSJWCD's district boundaries. Due to CSJWCD's firm supply of 49,000 AFY from its New Melones water right and the expansion of surface water use within the District through the Category A project "CSJWCD Capital Improvement Program", the district is not expected to require additional surface water via water transfer for agricultural customers within the district boundaries. SEWD also has no plans to take transferred water for agricultural purposes due to its Category A "SEWD Surface Water Implementation Expansion."

SEWD expects to receive water from its own water sources during wet and normal years, so transfers of water from SSJID and OID are only expected to occur in critical and dry water years. SEWD has an agreement with the Stockton area urban contractors that a minimum of 20,000 AFY must be supplied for M&I purposes. The first 15,000 AFY of CSJWCD's 49,000 AFY allocation is provided to SEWD via an agreement between the districts. In critical years, when CSJWCD's supply is also zero, SEWD plans to take 20,000 AFY via transferred water to fulfill its urban agreement and 5,000 AFY of transferred water in dry years when 15,000 AFY is available from CSJWCD's supply. This supply is not guaranteed and SEWD is under no obligation to purchase the water even if SSJID and OID are able to provide water. It is assumed that when the Bureau of Reclamation provides full water allocation to East Side Contractors, no water is anticipated to be transferred.

This project currently only covers the transfer of water from OID and SSJID to SEWD urban customers. Both OID and SSJID may transfer water for agricultural purposes to SEWD and CSJWCD or to other out-of-district users in the future as opportunities arise.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)		Notes
	M&I to SEWD to Urban Contractors	Agricultural	
Drought	20,000	0 (both SEWD and CSJWCD)	
Dry	5,000	0 (both SEWD and CSJWCD)	
Normal	0	0 (both SEWD and CSJWCD)	
Wet	0	0 (both SEWD and CSJWCD)	

7.1.7 NSJWCD South System Groundwater Banking with EBMUD

Submitting GSA: North San Joaquin Water Conservation District (NSJWCD)

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.7.

Project Assumptions Confirmed By: Jennifer Spaletta (Spaletta Law PC) on May 4, 2022. Updated by communication with Jennifer Spaletta (Stoel Rives LLP) and Steve Schwabauer (NSJWCD) on May 13, 2024. Jennifer Spaletta provided updated text.

Project Type: In-Lieu Recharge

Water Source: This project relies on water from the Mokelumne River. This is an existing water right held by East Bay Municipal Utility District (EBMUD) (Permit 10478) as per Protest Dismissal Agreement from 11/25/2014.

Delivery Area: NSJWCD South System

Project Overview: NSJWCD, EBMUD and other entities in San Joaquin County entered into a Protest Dismissal Agreement in 2014 (the "PDA") to resolve various water right protests. The PDA Agreement includes a commitment to undertake a pilot level groundwater banking project and a longer-term groundwater banking project. The pilot level banking project is called the "DREAM" project and was just completed in 2024. The DREAM project involved the delivery of 1,000 AF of EBMUD water into the NSJWCD service area along the South System to use for irrigation, effectuating 1,000 AF of in-lieu groundwater recharge. EBMUD received a banked water credit of 50% of the amount of water recharge, not to exceed 500 AF. EBMUD then withdrew its banked water for delivery to the East Bay. The extraction and return of the banked water is subject to a San Joaquin County groundwater export permit.

EBMUD and NSJWCD have started the preliminary planning for the longer-term banking project. The longer-term banking project will use the same concept as the pilot project but will involve larger quantities of water and potential additional facilities to deliver and use the water for direct or in-lieu recharge within NSJWCD, and to extract and return banked water credits to EBMUD. The longer-term project contemplates EBMUD providing surface water supplies between 3,000 AFY to 6,000 AFY in dry years and 8,000 AFY in wet years to NSJWCD. These surface water supplies would come from EBMUD's water rights on the Mokelumne River and would be in addition to surface water available under NSJWCD's water right. EBMUD would receive a banked water credit for 50% of the additional supplies provided, leaving a net surface/groundwater increase to the NSJWCD area of 50% of all additional supplies provided. The net water gain to NSJWCD may increase if EBMUD does not extract its banked supplies regularly because of the 5% annual loss factor in the San Joaquin County export ordinance.

As part of both the pilot and longer-term projects, EBMUD is funding facilities in NSJWCD that will be necessary for the banking projects, but can also be used by NSJWCD to deliver NSJWCD's own surface water supplies. The PDA also provides that the wet year water supplies could be used by SEWD for groundwater banking if they cannot be used in NSJWCD.

Project Volume: The volumes for the project tabulated below were provided by Jennifer Spaletta on May 13, 2024. EBMUD and NSJWCD have started the preliminary planning for the longer-term banking project. The longer-term project contemplates EBMUD providing surface water supplies between 3,000 AFY to 6,000 AFY in dry years and 8,000 AFY in wet years to NSJWCD. EBMUD would receive a banked water credit for 50% of the additional supplies provided, leaving a net surface/groundwater increase to the NSJWCD area of 50% of all additional supplies provided. The table below only includes the portion that remains in the Subbasin, as the remaining water taken by EBMUD is exported out of the Subbasin.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	0	
Dry	750	
Normal	3,200	80% of Wet year supply
Wet	4,000	

7.1.8 NSJWCD North System Modernization/Lakso Recharge

Submitting GSA: North San Joaquin Water Conservation District (NSJWCD)

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.8.

Project Assumptions Confirmed By: Jennifer Spaletta (Spaletta Law PC) on May 4, 2022. Updated by communication with Jennifer Spaletta (SToel Rives LLP) and Steve Schwabauer (NSJWCD) on May 13, 2024. Jennifer Spaletta provided updated text.

Project Type: In-Lieu Recharge/Direct Recharge

Water Source: This project relies on water from the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).

Delivery Area: NSJWCD North System

Project Overview: This project will repair, upgrade and modernize the North System Pump and Distribution System to facilitate delivery of 4,000 to 6,000 AFY of surface water to farmers in-lieu of groundwater pumping and for groundwater recharge. Water would come from NSJWCD Permit 10477 supplies. The Lakso vineyard is located along the existing North System pipeline and includes very sandy soils that are excellent for recharge. The Lakso recharge project involves using a portion of this vineyard for direct recharge and/or Flood MAR. Flood MAR operations could be expanded to additional vineyards and orchards along the North System pipeline.

This project received a 2022 SGMA Implementation Round 1 grant for $3.9 million. Project construction is anticipated to be complete by March 2025. Phase 1A and 1B of this project were completed in 2023-24 to add a new temporary North Pump Station, new pipeline for part of system, and two on-farm recharge projects. NSJWCD expects to connect 200 acres for irrigation in 2024. NSJWCD secured grants for completing a new permanent North Pump Station (Phase 2) which will occur in 2025-2030.

Future phases (3, 4, etc.) will focus on replacing and modernizing the balance of the pipeline distribution system, adding laterals, adding irrigation turnouts/customers, and additional direct recharge locations.

Project Volume: The volumes for the project tabulated below were provided by Jennifer Spaletta on May 13, 2024. The volumes below assume completion of the project through Phase 2, which is estimated to be completed by 2030. Additional phases beyond Phase 2 would require additional funding and would add between 500-1,000 additional AFY to the volumes in the table below.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	0	
Dry	1,000	
Normal	3,000	
Wet	4,000	

7.1.9 NSJWCD Tecklenburg Recharge Project

Submitting GSA: North San Joaquin Water Conservation District (NSJWCD)

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.9.

Project Assumptions Confirmed By: Jennifer Spaletta (Spaletta Law PC) on May 4, 2022. Updated by communication with Jennifer Spaletta (Stoel Rives LLP) and Steve Schwabauer (NSJWCD) on May 13, 2024. Jennifer Spaletta provided updated text.

Project Type: Direct Recharge

Water Source: This project relies on water from the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).

Delivery Area: NSJWCD South System

Project Overview: NSJWCD constructed and operates a 10-acre recharge pond on the south side of the Mokelumne River on property owned by the Tecklenburg family through a purchase. NSJWCD uses Permit 10477 water available from December 1 through June 30, and not needed for irrigation, for recharge. Because this project can use water available during the direct diversion flood season, water is expected to be available more frequently under the NSJWCD water right for this project, or 80 percent of years. This project was completed by NSJWCD in 2023-24. The Tecklenburg Basin involved purchasing a 10 acre parcel, constructing a basin, and constructing piping to get water in the basin. A future phase of the larger south system project will add a 24 inch lateral to the Tecklenberg basin, which will increase its recharge ability.

Project Volume: The volumes for the project tabulated below were provided by Jennifer Spaletta on May 13, 2024 and cover both the NSJWCD South System Modernization as well as the NSJWCD Tecklenburg Recharge Project. In wet and normal years, about 50% of the water will be used for agricultural purposes and 50% for recharge (likely via the Tecklenburg Recharge Project). In critical years, no water is available and in dry years, all of the water is expected to be used for recharge projects. Based on these assumptions, the water was split into the two projects in the table below. The project is expected to be 50% built out by 2028 and fully built out through Phase 4B by 2030. The volumes for the Tecklenberg basin are the current (2024) recharge volumes for the basin.

Baseline Water	Annual Volume (acre-feet per year or AFY)	

Year Type	Total South System Modernization and Tecklenburg Recharge Project	South System Modernization	Tecklenburg Recharge Project	Notes
Drought	0	0	0	
Dry	1,500	1,200	300	
Normal	9,000	8,000	1,000	
Wet	12,000	10,000	2,000	

7.1.10 City of Stockton Delta Water Treatment Plant Groundwater Recharge Improvements Project

Submitting GSA: City of Stockton

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.10.

Project Assumptions Confirmed By: Received no response to draft assumptions sent out on May 3, 2022 and May 24, 2022. Slight communication from Mitchell Maidrand (City of Stockton) was received during 2024 data request.

Project Type: Direct Recharge

Water Source: Delta Water Treatment Plant

Delivery Area: Recharge basin adjacent to Delta Water Treatment Plant (approximately 70 acres of ponds at buildout in 2040)

Project Overview: The City of Stockton – Municipal Utilities Department (MUD) commissioned the Delta Water Supply Project (DWSP) in 2012 to provide a supplemental surface water supply to its customers. The project included a river diversion pumping station, 12 miles of 54-inch raw water pipeline, a 30 million gallon per day water treatment plant, and six miles of finished water pipelines. This project, located on approximately 60 acres of a larger 130-acre parcel on Lower Sacramento Road, was designed, in part, to protect the groundwater basin through conjunctive management to improve the City's water supply reliability portfolio.

The original Draft Environmental Impact Report (2005) programmatically evaluated the concept of an Aquifer Storage and Recovery (ASR) project as part of a long-term water resource planning effort for the City. During the design phase, MUD commissioned the Design-Build team to conduct a preliminary groundwater recharge feasibility study of the approximate 70-acre site adjacent to the Delta Water Treatment Plant (DWTP). This study concluded that with available water from the City's Delta diversion and from Woodbridge Irrigation District, a direct groundwater recharge and recovery project was feasible and recommended additional engineering feasibility and design studies to confirm water availability, recharge infiltration rates, and storage capabilities. The draft study, completed in 2009, is now focused on further evaluation beginning with geotechnical and hydrogeologic effort and groundwater feasibility report to inform a future project phase of implementing a groundwater recharge and recovery project.

The City is considering the completion of an Underground Storage Supplement through the State Water Resources Control Board for Water Right Permit 21176. Pipeline infrastructure and turnouts will be needed to convey Delta water, diverted under Permit 21176, from the incoming Intake Pump Station 54-inch raw water line to the proposed recharge basin location at the Delta Water Treatment Plant.

This project received a 2022 SGMA Implementation Round 1 grant for $250,000 to conduct a geotechnical investigation of the recharge site to determine the suitability of the site for groundwater recharge and recovery. A feasibility study was completed in December 2023 and determined a recharge potential of approximately 22,000 AFY.

Project Volume: A feasibility memorandum completed in 2009[1] estimated that Mokelumne River water purchased from WID as well as City of Lodi stormwater available from the Wilkerson Lateral could be utilized for recharge purposes. An estimated amount of up to 6,500 AFY between March 1 and October 15 would be available from WID, with water assumed to be available only during water year types that are "Wet" or "Above Normal." Additionally, Lodi stormwater is a potential source for groundwater recharge and an estimated 1,545 AFY is available mostly during winter months when precipitation occurs. The estimated recharge rate at the site was 0.8 AF/day.

In order to expand the use of Permit 21176 water, City of Stockton's water supply from the San Joaquin River could also be utilized. With an assumed infiltration pond size of 70 acres and a wetted period of 228 days, an estimated 12,768 AFY could potentially be stored to the groundwater basin. Though if water was available during only a 90-day application period, the potential recharge volume would be 5,040 AFY. In the City of Stockton's water rights petition[2], an annual total of 5,102 AFY was estimated to be available for groundwater banking with zero in April through June. Though this project has been called groundwater banking in the past, there are no firm plans to extract water and no more water would be extracted than was recharged. A more detailed technical analysis of the timing and quantity of water supply will be conducted in the future.

In order to be conservative in the estimation of the project's recharge potential, the lower estimate of 5,040 AFY was assumed. Due to the varying sources of water supply that may be available for recharge (WID water, Lodi stormwater, and Stockton water), water is expected to be able to be recharged year-round.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	5,040	
Dry	5,040	
Normal	5,040	
Wet	5,040	

7.1.11 SEWD West Groundwater Recharge Basin

Submitting GSA: Stockton East Water District (SEWD)

[1] Swann, B. and Heywood, B., 2009. Draft Memorandum Groundwater Recharge Program Evaluation. March 24, 2009.
[2] City of Stockton Water Right Permit 21176 Petition for Extension of Time

Project Source: First included as Category A project in 2022 GSP Amendment. Included in 2024 GSP Amendment as Chapter 6.2.4.11.

Project Assumptions Confirmed By: Justin Hopkins (SEWD) on May 9, 2022. No updated confirmation was received during 2024 model data request.

Project Type: Direct Recharge

Water Source: This project relies on water from New Hogan Reservoir (Calaveras River water) and New Melones Reservoir (Stanislaus River water). This is an existing surface water right. SEWD has long-term water supply contracts with USBR for both New Hogan Reservoir and New Melones Reservoir. In addition to Calaveras River and Stanislaus River water, stormwater runoff will also contribute to the volume of water available for recharge.

Delivery Area: Recharge basin near SEWD water treatment plant

Project Overview: The United States Army Corps of Engineers (ACOE) plans to excavate dirt to use for levees near the Dr. Joe Waidhofer Water Treatment Plant operated by SEWD. SEWD will use this estimated 100-acre pit once it is created for a new groundwater recharge basin. The recharge at the site was estimated to be about 0.5 feet per day. Construction on the project started in 2024.

Project Volume: Due to the varying sources of water (surface water and stormwater runoff), the project is expected to be able to recharge project year-round.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	1,500	
Dry	4,000	
Normal	16,000	
Wet	16,000	

7.1.12 NSJWCD Private Pump Partnerships

Submitting GSA: North San Joaquin Water Conservation District (NSJWCD)

Project Source: New project added in 2024 and included in 2024 GSP Amendment as Chapter 6.2.4.12.

Project Assumptions Confirmed By: Communication with Jennifer Spaletta (SToel Rives LLP) and Steve Schwabauer (NSJWCD) on May 13, 2024. Jennifer Spaletta provided text.

Project Type: In-Lieu Recharge/Direct Recharge

Water Source: This project relies on water from the Mokelumne River. This is an existing surface water right held by NSJWCD (Permit 10477).

Delivery Area: NSJWCD on both sides of the Mokelumne River

Project Overview: This project involves agreements between NSJWCD and existing riparian pumpers along the Mokelumne River to use their existing pumps to pump NSJWCD's Permit 10477 water for delivery to adjacent non-riparian lands or recharge basins/on-farm recharge. This project leverages existing infrastructure to achieve increased surface water use and reduced groundwater pumping in the district. NSJWCD is implementing this project for 1 landowner in 2024 for 200 acre and plans to add an additional 200 acre each year for 5 years.

Project Volume: The volumes for the project tabulated below were provided in a document sent by Jennifer Spaletta on May 13, 2024. As a new project, the current delivery volumes are 0 AFY, but by the end of 2024, 1 landowner with 200 acres will be getting 300 AFY in normal years and 600 AFY in dry years. Since the project plans to add an additional 200 acres every year, by 2030 there will be an estimated 1,000 acres of land receiving surface water from private pumps. The estimated volume of water for 1,000 acres is 1,500 AFY in normal years and 3,000 AFY in wet years. The project is not expected to run in drought or dry years.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	0	
Dry	0	
Normal	1,500	
Wet	3,000	

7.1.13 OID In-Lieu and Direct Recharge Project

Submitting GSA: Oakdale Irrigation District (OID)

Project Source: New project added in 2024 and included in 2024 GSP Amendment as Chapter 6.2.4.13.

Project Assumptions Confirmed By: Communication with Emily Sheldon (OID) on May 15, 2024.

Project Type: In-Lieu Recharge/Direct Recharge

Water Source: This project relies on water from New Melones Reservoir (Stanislaus River water). This is an existing surface water right (pre-1914) held by Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID).

Delivery Area: Landowners outside of OID’s boundaries to the east

Project Overview: The Oakdale Irrigation District In-lieu and Direct Recharge Project is intended to be a cooperative long-term project between OID and landowners to the east of OID’s boundaries within the East Side San Joaquin GSA. The purpose of this project is to allow OID to facilitate surface water deliveries for in-lieu use or direct recharge for East Side San Joaquin GSA landowners during times and conditions that will not impact OID’s existing agricultural customers.

Project Volume: The project envisions the development of up to approximately 25,000 AF of surface water from the Stanislaus River being made available to landowners east of OID’s service area boundaries in both the Eastern San Joaquin and Modesto Subbasins in all, except Critically Dry, water years. Since this project was already included in the PCBL and was calculated using a recent historical average, this PMA doesn’t contribute any additional water in the PCBL-PMA Version 3.0 or PCBL-CC-PMA Version 3.0. Projected PMA volumes may be revisited in future versions of the model.

Baseline Water Year Type	Annual Volume (acre-feet per year or AFY)	Notes
Drought	0	
Dry	0	
Normal	3,000	
Wet	3,000	

7.2 Assumptions Used to Develop Projected Conditions Baseline Scenarios with Projects & Management Actions

Both models (PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0) share the same input files, excepting those files related to climate change (stream inflows, evapotranspiration, and precipitation). The files relating to the Category A projects simulated as new surface water diversions are identical between the two models. Any differences in the amount of water delivered in the two models are due to differences in agricultural demand and the amount of water available in streams. A summary of the 13 Category A PMAs simulated as additional diversions in both PCBL-PMA Version 3.0 and PCBL-CC- PMA Version 3.0 models is provided in Table 27, along with fractions for recoverable loss (i.e., percolation or canal seepage), non-recoverable loss (i.e., evaporation), and delivery (i.e., amount delivered is equal to the total amount minus the recoverable and non-recoverable losses). One PMA was already included in the PCBL as Diversion 55 and is also included in Table 27. The remaining 65 PCBL Version 3.0 and PCBL-CC Version 3.0 diversions are summarized in Section 3.2.9.

Table 27: Summary of ESJWRM Category A Projects Surface Water Deliveries

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Average Annual Diversion*** (acre- feet)
					RL*	NL**	Delivery	
55	OID In-lieu and Direct Recharge Project	Import (outside of ESJWRM)	Landowners outside of OID's eastern boundary	Ag	0%	0%	100%	3,000
67	Stockton East WD Lake Grupe In-Lieu Recharge	Calaveras River	Approximately 1,750 acres of orchards surrounding Lake Grupe in SEWD	Ag	0%	0%	100%	4,300
68	Stockton East WD Surface Water Implementation Expansion	Import (outside of ESJWRM)	Approximately 6,750 acres adjacent to surface water conveyance systems in SEWD	Ag	0%	0%	100%	13,300
69	Stockton East WD West Groundwater Recharge Basin	Import (outside of ESJWRM)	Recharge basin near SEWD water treatment plant	Recharge	100%	0%	0%	10,200
70	Central San Joaquin WCD Capital improvement Program	Import (outside of ESJWRM)	CSJWCD	Ag	15%	2%	83%	20,500
71	Long-term Water Transfer to Stockton East WD for M&I	Import (outside of ESJWRM)	City of Stockton area urban users	Urban	0%	0%	100%	12,200
72	City of Lodi White Slough Water Pollution Control Facility Expansion	Import (outside of ESJWRM)	890 acres of agricultural land surrounding White Slough Pollution Control Facility	Ag	4%	2%	94%	3,700
73	North San Joaquin WCD South System Modernization	Mokelumne River	NSJWCD South System	Ag	0%	0%	100%	6,900

ID	Description	Diversion Location	Delivery Area	Primary Use	Fraction			Average Annual Diversion*** (acre- feet)
					RL*	NL**	Delivery	
74	North San Joaquin WCD Tecklenburg Recharge Project	Mokelumne River	Recharge basin located in NSJWCD South System	Recharge	100%	0%	0%	1,300
75	North San Joaquin WCD South System Groundwater Banking with EBMUD	Mokelumne River	NSJWCD South System	Ag	0%	0%	100%	2,800
76	North San Joaquin WCD North System Modernization/Lasko Recharge	Mokelumne River	NSJWCD North System	Ag	50%	0%	50%	4,000
77	City of Stockton Delta Water Treatment Plant Groundwater Recharge Improvements Project Geotechnical Investigation	Import (outside of ESJWRM)	Recharge basin adjacent to Delta Water Treatment Plant	Recharge	100%	0%	0%	5,000
82	North San Joaquin WCD Private Pump Partnerships	Mokelumne River	Riparian areas along Mokelumne River within NSJWCD	Recharge	50%	0%	50%	3,000

*RL = Recoverable Loss (canal seepage or recharge)

**NL = Non-Recoverable Loss (evaporation)

*** Averages calculated only for years with diversions occurring (i.e., non-zero average)

7.3 Projected Conditions Baseline Scenarios with Category A Projects & Management Actions Results

This section provides a summary of the PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0 model results.

7.3.1 Projected Conditions Baseline with Category A Projects & Management Actions

The section below summarizes the results for the PCBL-PMA Version 3.0 as compared to the PCBL Version 3.0. Neither of these runs include climate change.

7.3.1.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
  - Groundwater pumping
  - Surface water deliveries
  - Shortage (if applicable)
- Outflows:
  - Demand (either agricultural or urban)
  - Surplus (if applicable)

The average annual PCBL-PMA Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,315 TAFY, consisting of approximately 1,153 TAFY of agricultural demand and 162 TAFY of urban demand. This demand is met by an annual average of 572 TAFY of surface water deliveries (493 TAFY of agricultural and 79 TAFY of urban deliveries) and is supplemented by 755 TAFY of groundwater production (687 TAFY of agricultural and 68 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is 28 TAFY of surplus in the Subbasin-scale agricultural water supply, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 28. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 71 and Figure 72 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 28 also includes the PCBL Version 3.0 results and a Category A projects benefit calculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. The PCBL-PMA Version 3.0 has an average of 41 TAFY more surface water for agricultural purposes and 6 TAFY more surface water for urban areas compared to the PCBL Version 3.0. For urban areas, this represents a reduction in groundwater pumping of 600 AFY. For agricultural areas, the increased surface water results in 34 TAFY less groundwater pumping, a number smaller than the amount of surface water provided due to a mismatch between the Category A water supplied and model-calculated agricultural demand on a monthly basis.

Table 28: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-PMA Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-PMA Version 3.0	PMA Benefit (PCBL-PMA Version 3.0 minus PCBL Version 3.0)
Agricultural Area (thousand acres)	365	365	0
Agricultural Demand (TAF)	1,153	1,153	0
Agricultural Groundwater Pumping (TAF)	721	687	-34
Agricultural Surface Water Deliveries (TAF)	452	493	41
Agricultural Surplus (TAF)[1]	19	28	8
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	162	6
Urban Groundwater Pumping (TAF)	67	68	1
Urban Surface Water Deliveries (TAF)	73	79	6
Urban Shortage (TAF)[1]	16	16	0

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 71: ESJ Subbasin Projected Agricultural Demand in PCBL-PMA Version 3.0

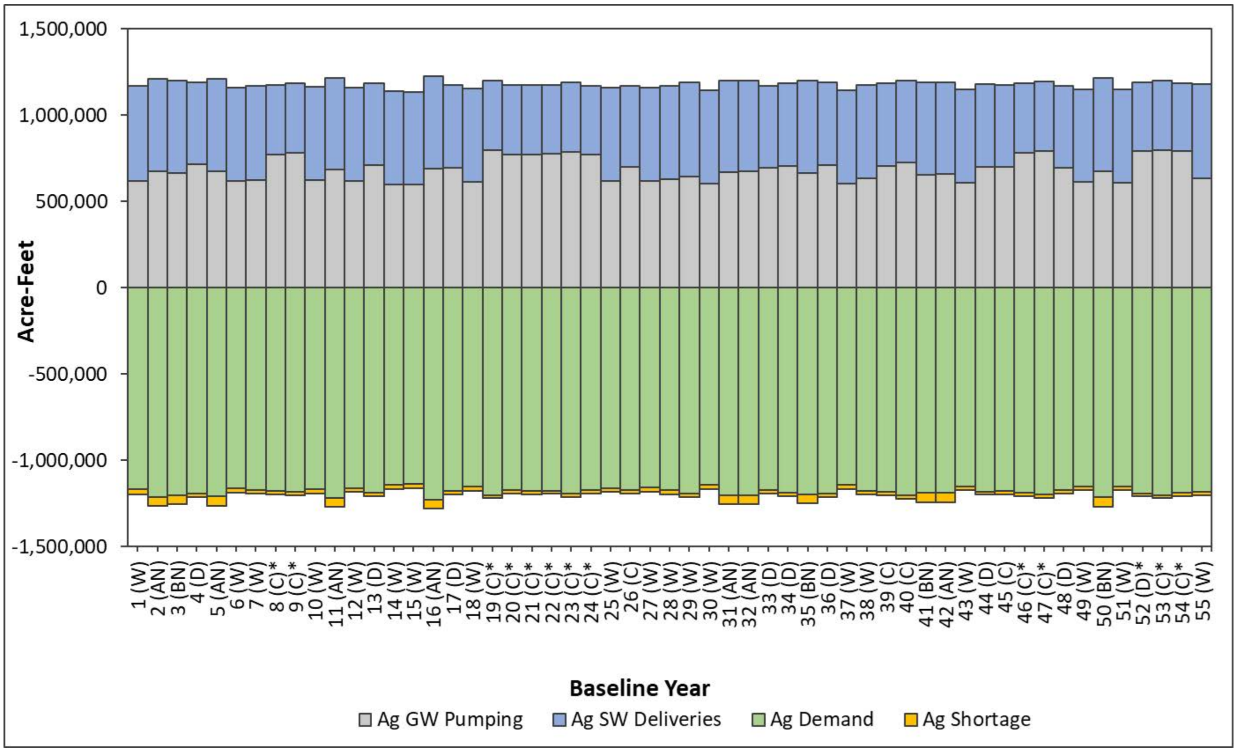
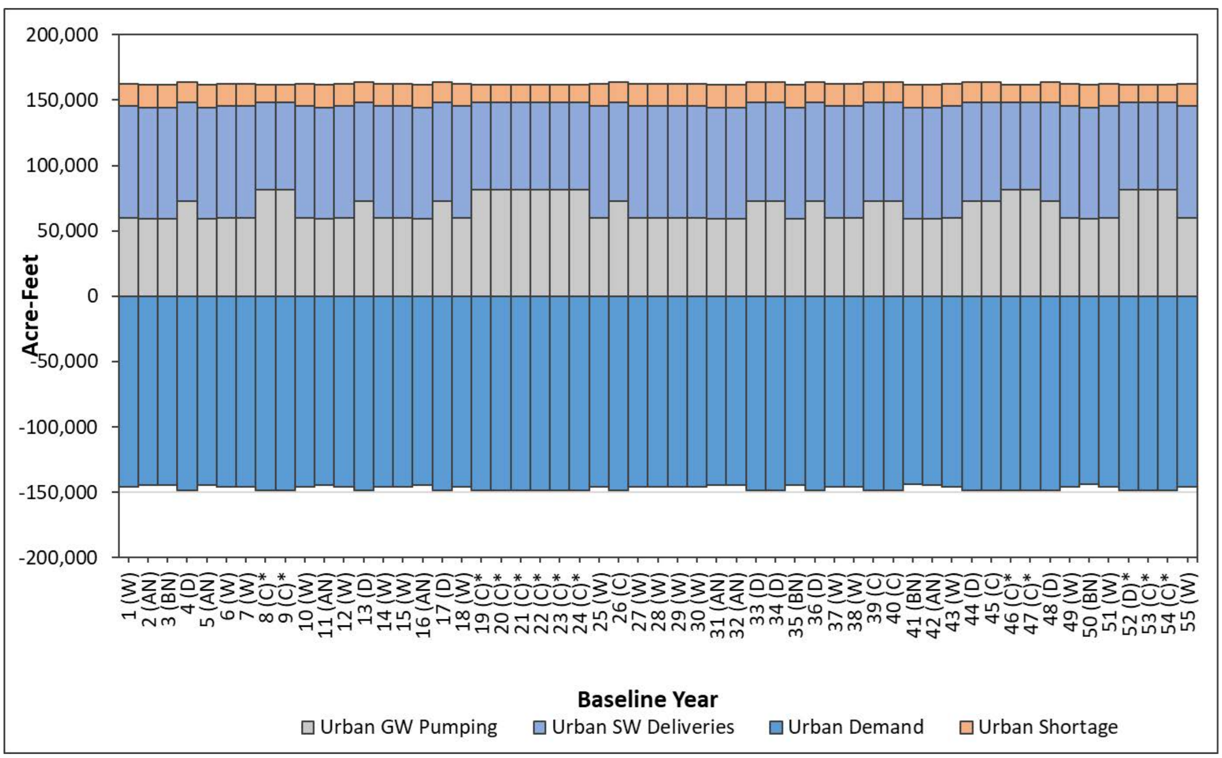


Figure 72: ESJ Subbasin Projected Urban Demand in PCBL-PMA Version 3.0



7.3.1.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
    - Deep percolation (from rainfall and irrigation applied water)
    - Gain from stream (or recharge due to stream seepage)
    - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
    - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
    - Groundwater pumping
    - Loss to stream (or outflow to streams and rivers)
    - Boundary outflow (to surrounding groundwater subbasins)
    - Change in groundwater storage (can be either an inflow or outflow)

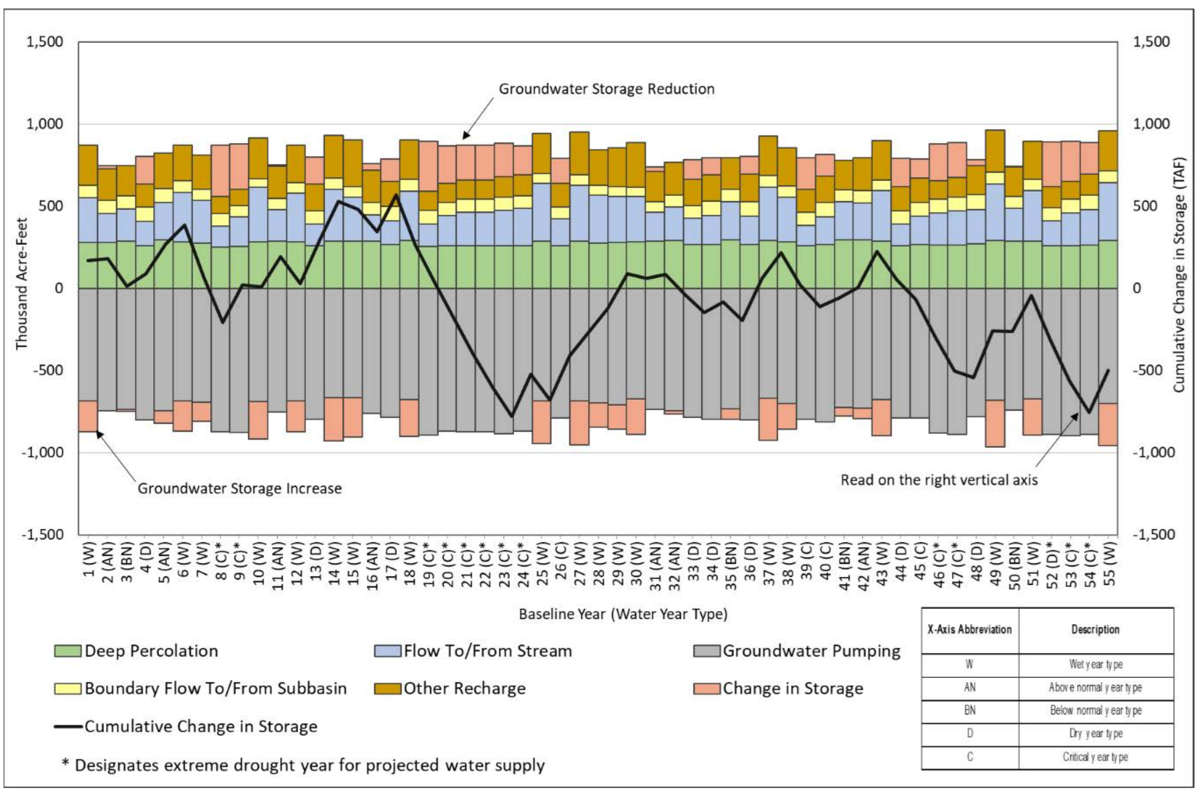
Pumping in the PCBL-PMA Version 3.0 remains the largest component in the groundwater budget with an annual average 766 TAFY. The PCBL-PMA Version 3.0 offsets this pumping with 275 TAFY of deep percolation, a net gain from stream of 223 TAFY, 184 TAFY of other recharge (includes recharge from unlined canals, reservoir seepage, managed aquifer recharge, and Sierra Nevada Mountain recharge), and a total subsurface inflow of 75 TAFY. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual groundwater storage deficit in ESJ Subbasin in the PCBL-PMA Version 3.0 is 9 TAFY, indicating that some groundwater overdraft is still occurring even with the Category A projects. These annual averages are shown in Table 29. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 73.

Table 29 also includes the PCBL Version 3.0 results and a Category A projects benefit calculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. The results indicate that the Category A projects will resolve the PCBL Version 3.0 Subbasin overdraft condition when impacts due to climate change are not included. Without projects, the modeling shows an average overdraft of 30 TAFY over the 55 years of the PCBL Version 3.0 simulation. With Category A projects in place, the modelling shows a projected overdraft of -9 TAFY on average in the PCBL-PMA Version 3.0. The PCBL-PMA Version 3.0 shows an average increase of 21 TAFY of groundwater in storage when compared to the PCBL Version 3.0. Compared to the PCBL Version 3.0, with Category A projects modeled, the PCBL-PMA Version 3.0 has 33 TAFY less groundwater pumping due to the new in-lieu recharge projects, 19 TAFY more recharge (both direct recharge projects and canal seepage losses for the in-lieu recharge projects), and 17 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL Version 3.0 and PCBL-PMA Version 3.0 simulations.

Table 29: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between PCBL Version 3.0 and PCBL-PMA Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL Version 3.0	PCBL-PMA Version 3.0	PMA Benefit (PCBL-PMA Version 3.0 minus PCBL Version 3.0)
Deep Percolation (TAF)	270	275	5
Deep Percolation of Precipitation (TAF)	*55*	*55*	*0*
Deep Percolation of Applied Water (TAF)	*215*	*220*	*5*
Other Recharge (TAF)	165	184	19
Net Stream Seepage (TAF)	240	223	-17
Net Boundary Inflow (TAF)	94	75	-19
Groundwater Pumping (TAF)	799	766	-33
Change in Groundwater Storage (TAF)	-30	-9	21

Figure 73: ESJ Subbasin Projected Hydrologic Groundwater Budget in PCBL-PMA Version 3.0



7.3.2 Projected Conditions Baseline with Climate Change and Category A Projects and Management Actions

The section below summarizes the results for the PCBL-CC-PMA Version 3.0 as compared to the PCBL-CC Version 3.0.

7.3.2.1 Land and Water Use Water Budget

The land and water use budget includes two different versions, agricultural and urban, and represents the balance of the model-calculated water demands with the water supplied. Both the agricultural and urban versions include the same components that make up the water balance:

- Inflows:
  - Groundwater pumping
  - Surface water deliveries
  - Shortage (if applicable)
- Outflows:
  - Demand (either agricultural or urban)
  - Surplus (if applicable)

The average annual PCBL-CC-PMA Version 3.0 water demand for the Subbasin within the 55-year simulation period is 1,401 TAFY, consisting of approximately 1,238 TAFY of agricultural demand and 162 TAFY of urban demand. This demand is met by an annual average of 572 TAFY of surface water deliveries (493 TAFY of agricultural and 79 TAFY of urban deliveries) and is supplemented by 835 TAFY of groundwater production (767 TAFY of agricultural and 68 TAFY of urban pumping). Due to uncertainties in the estimation of projected agricultural demand and historical supply records, there is about 22 TAFY of surplus in the Subbasin scale agricultural water use budget, which is insignificant relative to the total volume of water use. Shortage and surplus represent a misalignment between the reported, estimated, or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus. These annual averages are shown in Table 30. The annual land and water use budgets across the ESJ Subbasin are shown in Figure 74 and Figure 75 for the Subbasin as a whole, showing the agricultural and urban, respectively, demands plotted with water supplies.

Table 30 also includes the PCBL-CC Version 3.0 results and a Category A projects benefit calculated as the PCBL-CC-PMA Version 3.0 results minus the PCBL-CC Version 3.0 results. The PCBL-CC-PMA Version 3.0 has an average of 41 TAFY more surface water for agricultural purposes and 6 TAFY more surface water for urban areas compared to the PCBL-CC Version 3.0. For urban areas, this represents a reduction in groundwater pumping of 600 AFY. For agricultural areas, the increased surface water results in 34 TAFY less groundwater pumping, a number smaller than the amount of surface water provided due to a mismatch between the Category A water supplied and model-calculated agricultural demand on a monthly basis.

Differences between the amount of surface water supplied for PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0 are due to differences in the amount of surface water available in streams impacted by climate change. These differences are small (less than 200 AFY) between results in Table 28 and Table 30.

Table 30: ESJ Subbasin Land and Water Use Budget Annual Average Comparison Between PCBL-CC Version 3.0 and PCBL-CC-PMA Version 3.0

Land and Water Use Budget Component	Annual Average		
	PCBL-CC Version 3.0	PCBL-CC-PMA Version 3.0	PMA Benefit (PCBL-CC-PMA Version 3.0 minus PCBL-CC Version 3.0)
Agricultural Area (thousand acres)	365	365	0
Agricultural Demand (TAF)	1,240	1,238	-1
Agricultural Groundwater Pumping (TAF)	801	767	-34
Agricultural Surface Water Deliveries (TAF)	452	493	41
Agricultural Surplus (TAF)[1]	14	22	8
Urban Area (thousand acres)	129	129	0
Urban Demand (TAF)	156	162	6
Urban Groundwater Pumping (TAF)	67	68	1
Urban Surface Water Deliveries (TAF)	73	79	6
Urban Shortage (TAF)[1]	16	16	0

[1] Shortage and surplus represent a misalignment between the reported, estimated or assumed water supply (groundwater pumping and surface water deliveries) and the calculated demands. In the historical model, this can occur when there are inaccuracies in the reported water supplies or uncertainties in the methodology and/or parameters used to calculate the demand. In the projected conditions, there are uncertainties in the assumptions and parameters used for both monthly supply and demand estimates and/or calculations, resulting in misalignments, which is reported as shortage or surplus.

Figure 74: ESJ Subbasin Projected Agricultural Demand in the PCBL-CC-PMA Version 3.0

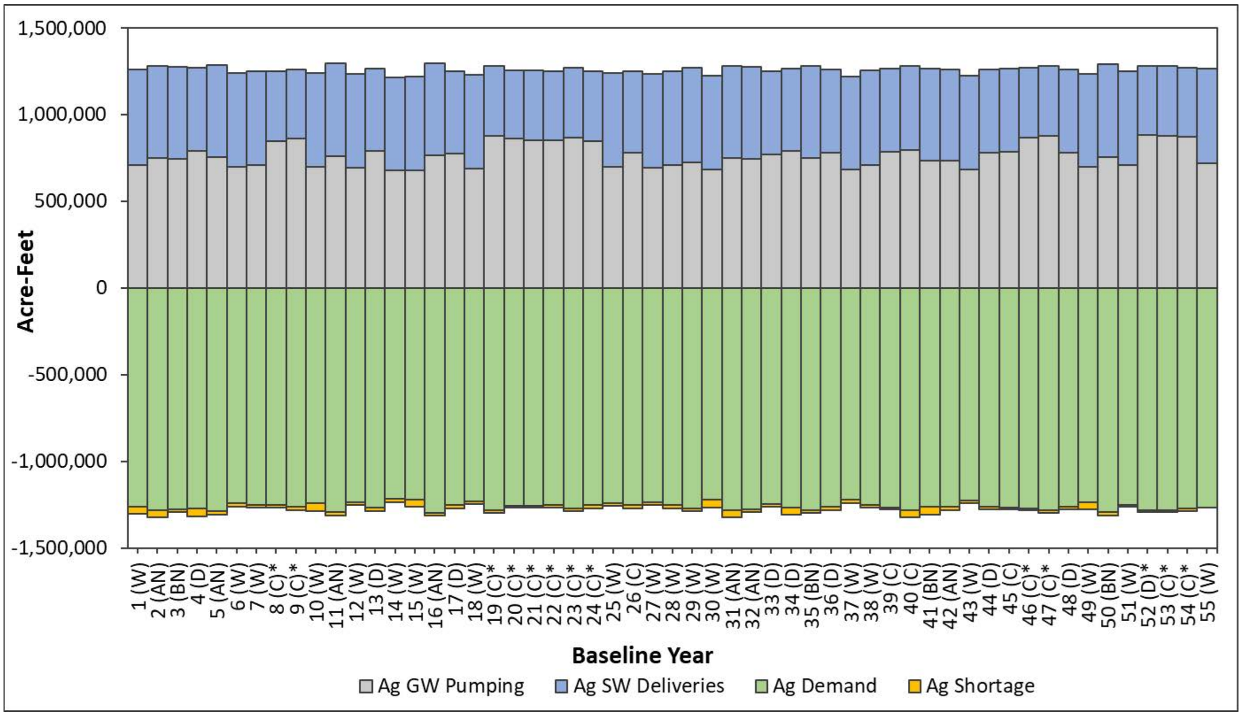
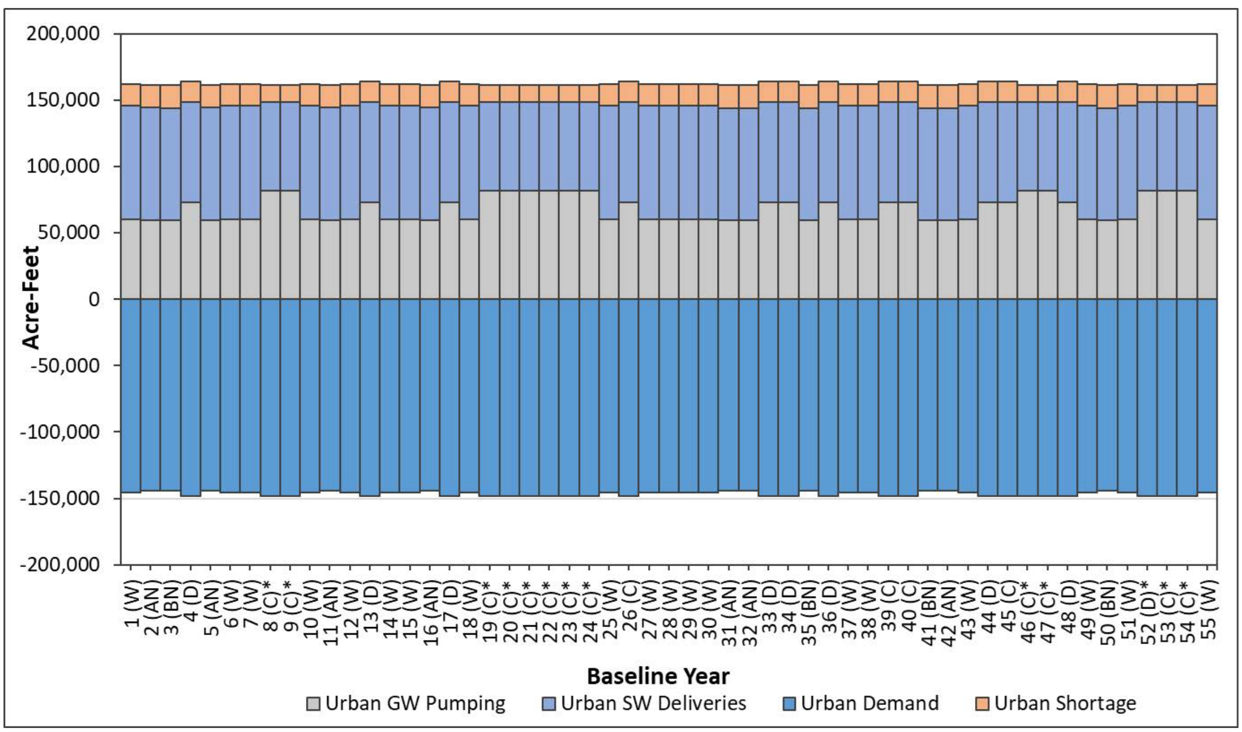


Figure 75: ESJ Subbasin Projected Urban Demand in the PCBL-CC-PMA Version 3.0



7.3.2.2 Hydrologic Groundwater Budget

The primary components of the groundwater budget are the same as represented in the historical model. Corresponding to the major hydrologic processes affecting groundwater flow in the Subbasin, these are:

- Inflows:
    - Deep percolation (from rainfall and irrigation applied water)
    - Gain from stream (or recharge due to stream seepage)
    - Boundary inflow (from surrounding groundwater subbasins and the Sierra Nevada Mountains)
    - Other Recharge (from other sources such as irrigation canal seepage, managed aquifer recharge projects, and reservoir seepage)
- Outflows:
    - Groundwater pumping
    - Loss to stream (or outflow to streams and rivers)
    - Boundary outflow (to surrounding groundwater subbasins)
    - Change in groundwater storage (can be either an inflow or outflow)

Pumping in the PCBL-CC-PMA Version 3.0 remains the largest component in the groundwater budget with an annual average 846 TAFY. The PCBL-CC-PMA Version 3.0 offsets this pumping with 274 TAFY of deep percolation, a net gain from stream of 260 TAFY, 187 TAFY of other recharge (includes recharge from unlined canals, reservoir seepage, managed aquifer recharge, and Sierra Nevada Mountain recharge), and a total subsurface inflow of 91 TAFY annually. The cumulative change in groundwater storage can be calculated from the annual change in groundwater storage. Due to inherent uncertainties in model input data, calculations, and calibration, all budget components have a degree of uncertainty. Given this uncertainty, the projected long-term average annual the groundwater storage deficit in ESJ Subbasin in the PCBL-CC-PMA Version 3.0 is 34 TAFY, indicating that groundwater overdraft is still occurring even with the Category A projects due to the impacts climate change on the Subbasin. These annual averages are shown in Table 31. The groundwater budgets, with average cumulative change in storage, are shown for the ESJ Subbasin in Figure 76.

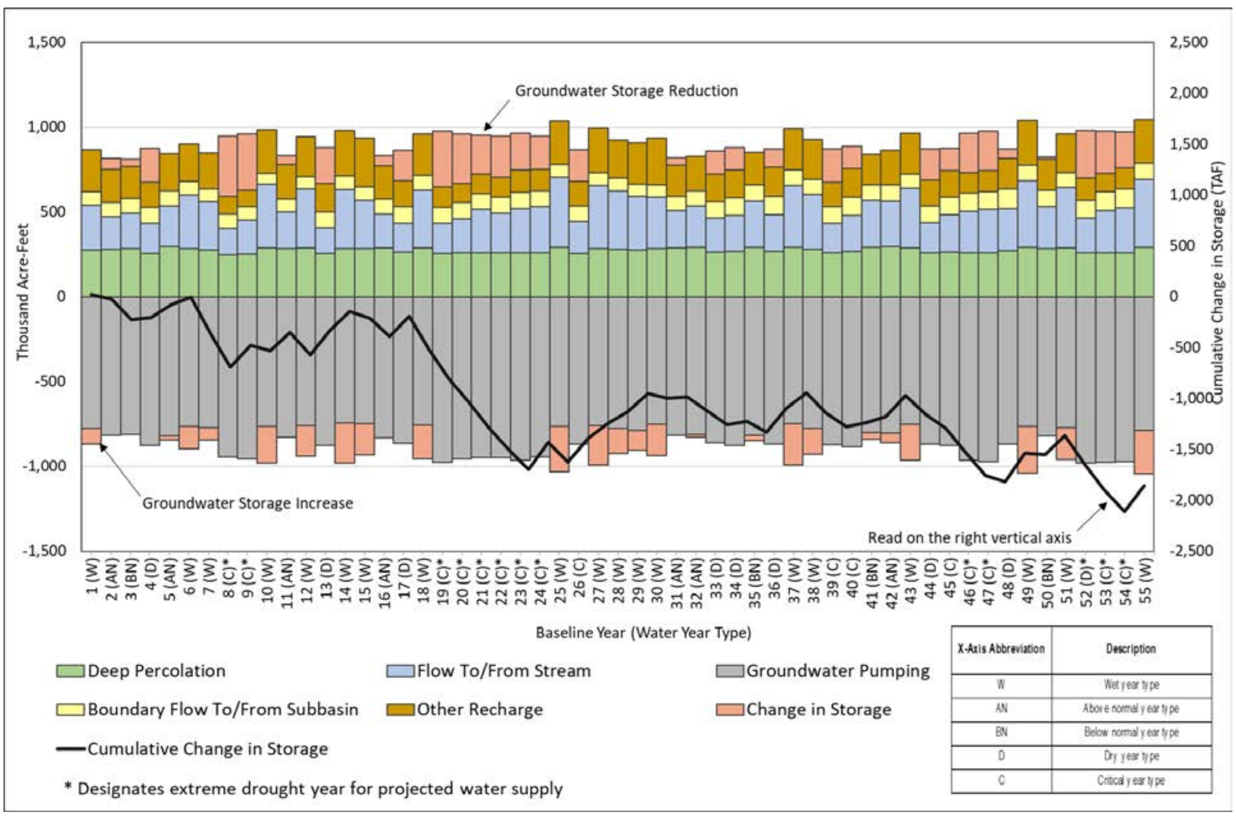
Table 31 also includes the PCBL Version 3.0 results and a Category A projects benefit calculated as the PCBL-PMA Version 3.0 results minus the PCBL Version 3.0 results. While the groundwater storage deficit in the PCBL Version 3.0 is projected to be corrected through the implementation of Category A projects as seen in PCBL-PMA Version 3.0, the modeling shows that when climate change is factored in for the PCBL-CC-PMA Version 3.0, there is still additional work (e.g., projects and/or management actions) that may need to be done to maintain subbasin sustainability. The PCBL-CC Version 3.0 has a projected overdraft of 56 TAFY. When projects are added in, as simulated in PCBL-CC-PMA Version 3.0, this overdraft amount is reduced to 34 TAFY, but still represents continuing groundwater overdraft in the Subbasin that is not sustainable.

Compared to the PCBL-CC Version 3.0, with Category A projects modeled, the PCBL-CC-PMA Version 3.0 has 34 TAFY less groundwater pumping due to the new in-lieu recharge projects, 19 TAFY more recharge (both direct recharge projects and canal seepage losses for the in-lieu recharge projects), and 17 TAFY less stream seepage into the groundwater system due to higher groundwater levels. Other hydrologic groundwater budget component differences are small between the PCBL-CC Version 3.0 and PCBL-CC-PMA Version 3.0 simulations.

Table 31: ESJ Subbasin Hydrologic Groundwater Budget Annual Average Comparison Between the PCBL-CC and the PCBL-CC-PMA Version 3.0

Hydrologic Groundwater Budget Component	Annual Average		
	PCBL-CC	PCBL-CC-PMA Version 3.0	PMA Benefit (PCBL-CC-PMA Version 3.0 minus PCBL-CC)
Deep Percolation (TAF)	268	274	6
Deep Percolation of Precipitation (TAF)	*52*	*52*	*0*
Deep Percolation of Applied Water (TAF)	*216*	*222*	*6*
Other Recharge (TAF)	168	187	19
Net Stream Seepage (TAF)	276	260	-17
Net Boundary Inflow (TAF)	111	91	-20
Groundwater Pumping (TAF)	879	846	-34
Change in Groundwater Storage (TAF)	-56	-34	22

Figure 76: ESJ Subbasin Projected Hydrologic Groundwater Budget in the PCBL-CC-PMA Version 3.0



7.4 Projected Conditions Baseline Scenarios with Category A Projects & Management Actions Groundwater Level Hydrographs

In order to evaluate how the chronic lowering of groundwater levels sustainability indicator might be impacted by Subbasin projected conditions, including climate change and Category A projects, groundwater hydrographs were analyzed for the 21 representative monitoring network wells selected in the GSP to monitor Subbasin groundwater levels. The goal of this analysis was to see where, when, and how often these groundwater hydrographs exceeded the minimum thresholds (MTs) established in the GSP. An undesirable result for groundwater levels as established in the GSP and refined in 2022 edits is when at least 25 percent of representative monitoring network wells (5 out of 21 wells) for the Subbasin are projected to exceed established minimum thresholds for two consecutive years. Figure 62 shows the location of these 21 representative monitoring network wells identified in the GSP as the monitoring network for the chronic lowering of groundwater levels.

Groundwater level hydrographs at the 21 representative monitoring network wells were used to evaluate the impacts of the Category A Projects under the PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0 as compared to the PCBL Version 3.0 and PCBL-CC Version 3.0, respectively. Two representative monitoring network wells (Well Swenson-3, and Well 01S10E04C001) reported groundwater levels below their minimum thresholds for at least one month in any of the models evaluated (PCBL Version 3.0, PCBL- PMA Version 3.0, PCBL-CC Version 3.0, and PCBL-CC-PMA Version 3.0). The hydrographs of these two representative monitoring network wells are shown and discussed in Sections 3.3.1 and 3.3.2. Subbasin undesirable results for groundwater levels are discussed in Section 3.3.3.

7.4.1 Projected Conditions Baseline without and with Category A Projects and Management Actions

Figure 63 shows the location of the representative monitoring network well (Well 01S10E04C001) with groundwater levels below its minimum threshold at any point in the 55-year projection of the PCBL Version 3.0 (without climate change or Category A projects). Figure 77 shows the location of the representative monitoring network wells with groundwater levels below their MT in the PCBL-PMA Version 3.0. Figure 78 shows the hydrograph of Well 01S10E04C001. The hydrographs have horizontal lines representing the representative monitoring network well's minimum threshold (red) and measurable objective (green). The ESJWRM model results are shown for the PCBL Version 3.0 (solid blue line), PCBL-PMA Version 3.0 (dotted blue line), PCBL-CC Version 3.0 (solid brown line), PCBL-CC-PMA Version 3.0 (dotted brown line). Any point these lines cross the red minimum threshold line represents an exceedance in at least one month of the simulation. The hydrographs are discussed in further detail after the figures.

Figure 77: Groundwater Level Representative Monitoring Network Wells with MT Exceedances in PCBL-PMA Version 3.0

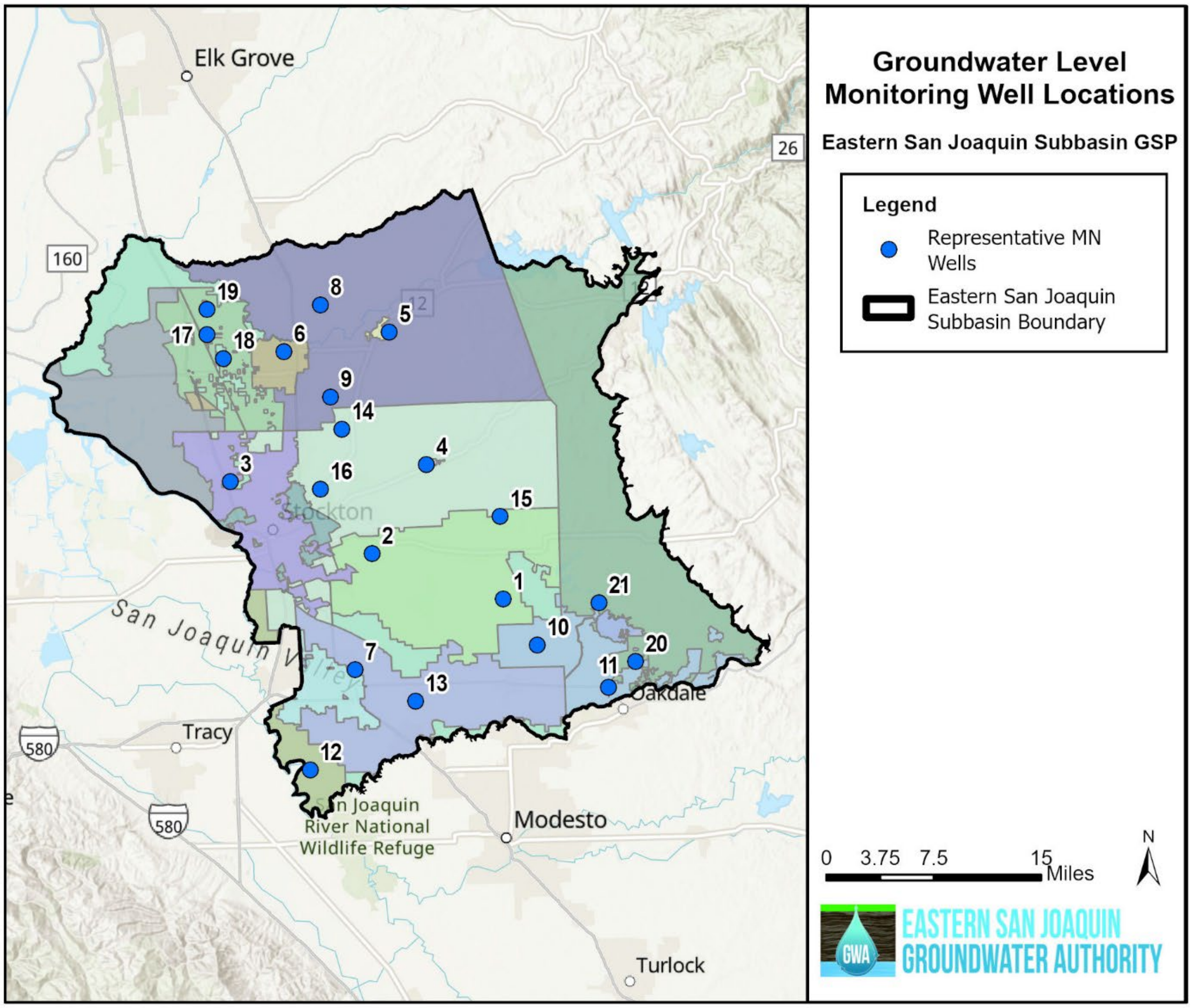
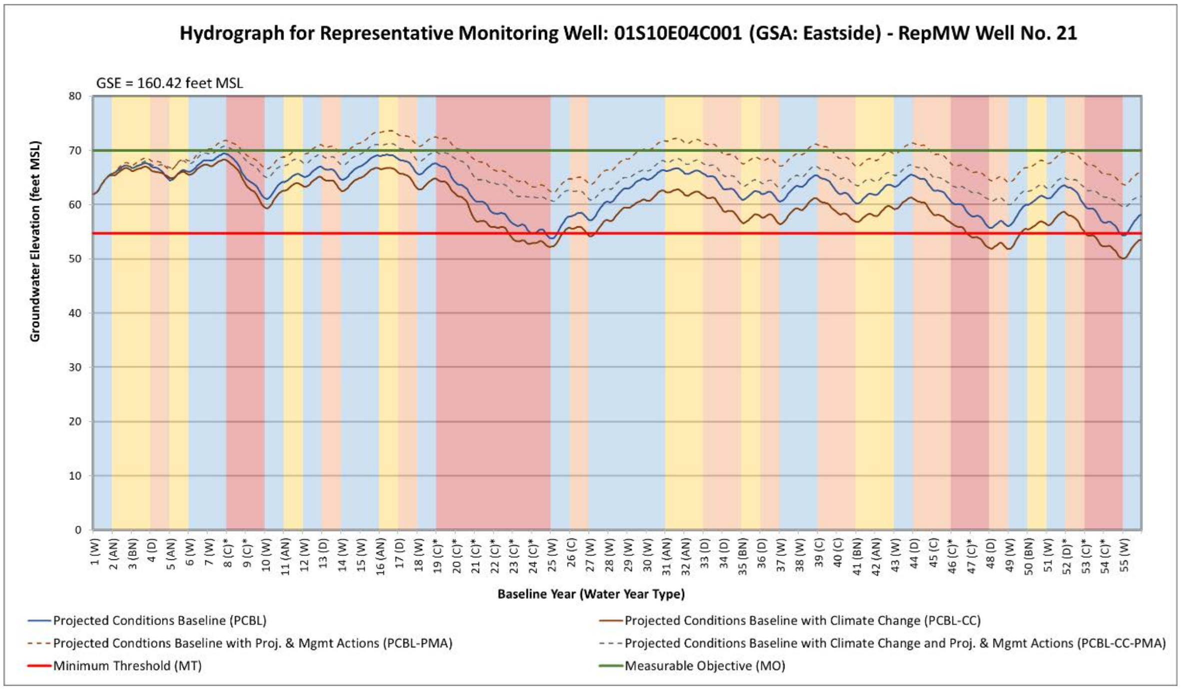


Figure 78: Groundwater Level Hydrograph for Well 01S10E04C001



Under the PCBL Version 3.0 (without climate change or Category A projects), the representative monitoring network well with its hydrograph shown above in Figure 78 (Well 01S10E04C00) exceed its minimum threshold. The text below discusses when and how often MT exceedances occur for the well:

- Well 01S10E04C001:
  - Exceeds its MT in 12 months out of a total of 660 months (2% of all months) and 4 water years out of a total of 55 water years (7% of all water years).
  - The exceedances occur in July of Year 24 in a drought year with exceedances continuing for 7 consecutive months in total, and in August of Year 54 in a drought year with exceedances continuing for 5 consecutive months.

Under the PCBL with Category A projects (PCBL-PMA Version 3.0), no representative monitoring network wells exceeded their MTs.

When Category A projects are included in the ESJWRM, groundwater levels rise across the Subbasin due to the additional groundwater recharge projects and reduction in groundwater pumping from additional surface water diversions. Though groundwater levels rise overall, the impact to levels varies from area to area based on proximity to the Category A projects. In the PCBL Version 3.0 water budget scenario with projects included (PCBL-PMA Version 3.0), projections show no wells falling below their minimum thresholds for groundwater levels as compared to the one well in the PCBL Version 3.0 without Category A projects. In other words, the Category A projects caused one well that was exceeding its MT in the PCBL Version 3.0 to no longer exceed its MT the PCBL-PMA Version 3.0. This well, located in the southeast portion of the subbasin, has groundwater levels increasing due to the Category A projects occurring across the subbasin.

7.4.2 Projected Conditions Baseline with Climate Change and without and with Category A Projects and Management Actions

Figure 66 shows the location of the two representative monitoring network wells (Well Swenson-3 and Well 01S10E04C001) with projected groundwater levels falling below their MTs for groundwater levels at any point in the 55-year projection of the PCBL with climate change and without Category A projects (PCBL-CC Version 3.0). Figure 79 shows the location of the representative monitoring network wells with groundwater levels falling below their MTs in the PCBL with climate change and with Category A projects (PCBL-CC-PMA Version 3.0).

Figure 80 shows the hydrograph of Well Swenson-3. The hydrograph for the other well exceeding its MTs in the PCBL-CC Version 3.0 was shown above in Figure 78. The hydrographs have horizontal lines representing the representative monitoring network well's minimum threshold (red) and measurable objective (green). The ESJWRM model results are shown for the PCBL Version 3.0 (solid blue line), PCBL-PMA Version 3.0 (dotted blue line), PCBL-CC Version 3.0 (solid brown line), PCBL-CC-PMA Version 3.0 (dotted brown line). Any point these lines cross the red minimum threshold line represents an exceedance in at least one month of the simulation. The hydrographs are discussed in further detail after the figures.

Figure 79: Groundwater Level Representative Monitoring Network Wells with MT Exceedances in the PCBL-CC-PMA Version 3.0

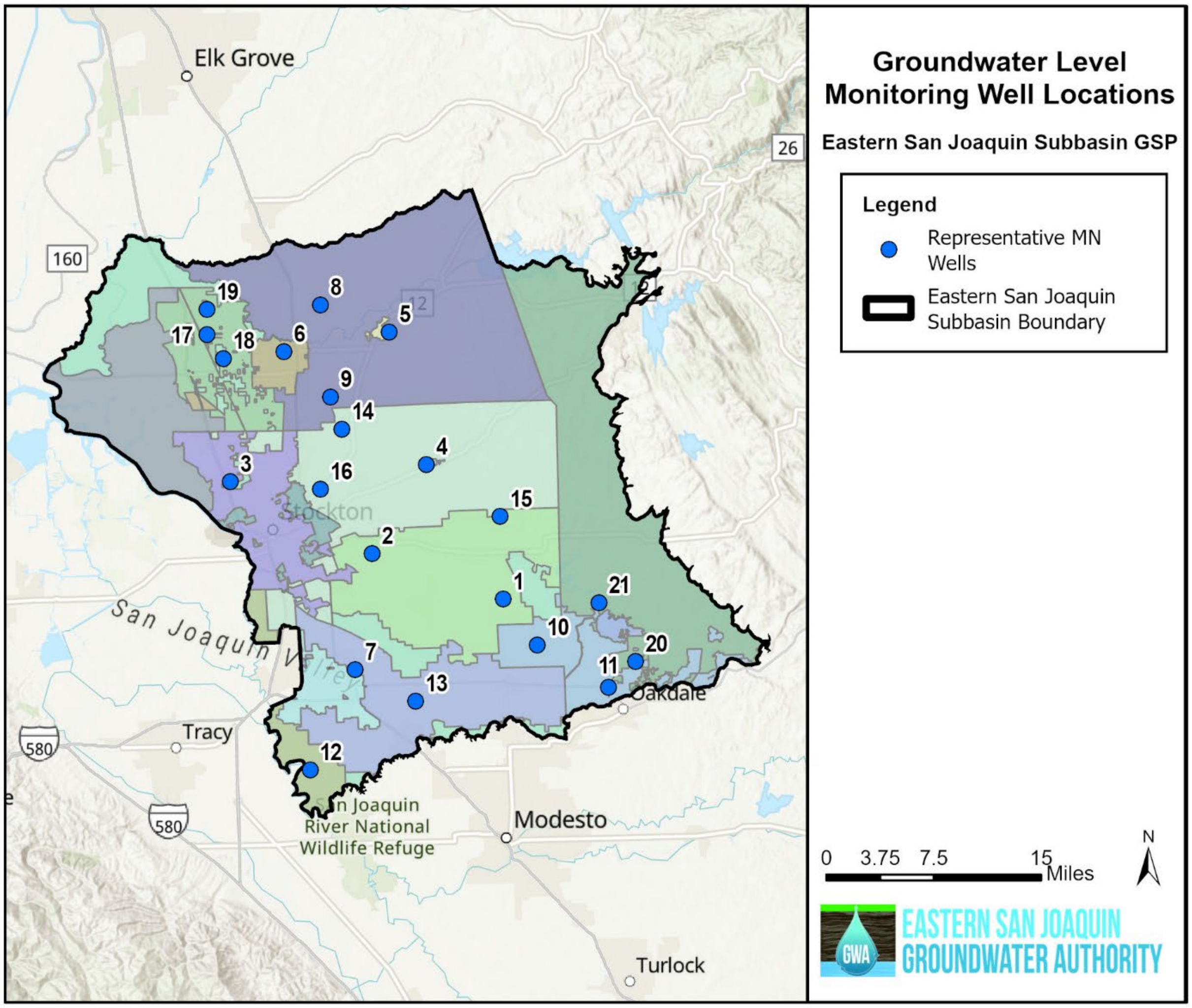
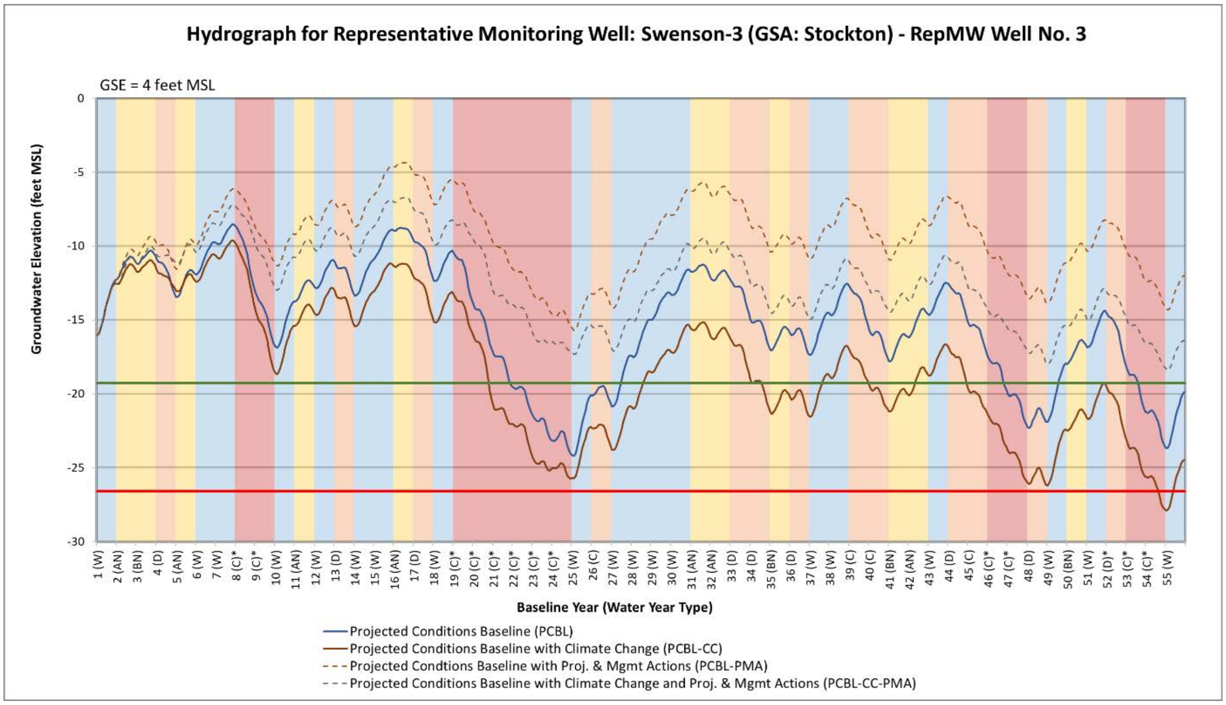


Figure 80: Groundwater Level Hydrograph for Well Swenson-3



Under the PCBL with climate change but without Category A projects (PCBL-CC Version 3.0), both representative monitoring network wells (Well Swenson-3 and Well 01S10E04C001) exceed their MTs.

- Well Swenson-3:
  - Exceeds its MT in 9 months out of a total of 660 months (1% of all months) and 2 water years out of a total of 55 water years (4% of all water years).
  - The exceedances occur in June of Year 54 in a drought year with exceedances continuing for 9 consecutive months in total.
- Well 01S10E04C001:
  - Exceeds its MT in 108 months out of a total of 660 months (16% of all months) and 13 water years out of a total of 55 water years (24% of all water years).
  - The exceedances occur in August of Year 22 in a drought year with exceedances continuing for 3 consecutive water years, in September of Year 26 in a drought year with exceedances continuing for 5 consecutive months, in August of Year 47 in a drought year with exceedances continuing for 3 consecutive water years, and again in November of Year 52 in a drought year with exceedances continuing the remainder of the simulation, or 3 consecutive water years.

Under the PCBL with climate change and with Category A projects (PCBL-CC-PMA Version 3.0), no representative monitoring network wells exceeded their MTs.

Category A projects raise groundwater levels in varying amounts across the Subbasin. As seen with the two wells with MT exceedances in the PCBL-CC Version 3.0, the effects of climate change may continue to significantly impact Subbasin groundwater overdraft and groundwater levels in the future. In the PCBL water budget scenario with projects and climate change factored in (PCBL-CC-PMA Version 3.0), modeling results showed an improvement in groundwater levels in the 55-year projection, with no representative monitoring network wells falling below their MTs.

7.4.3 Groundwater Levels Undesirable Result

An undesirable result for groundwater levels is considered to occur during GSP implementation when at least 25 percent of representative monitoring network wells (5 of 21 wells in the Subbasin) fall below their MTs for two consecutive years. Figure 81 shows the number of wells with 2 consecutive water years of exceedances in the PCBL Version 3.0, PCBL-CC Version 3.0, PCBL-PMA Version 3.0, and PCBL-CC-PMA Version 3.0 models over 54 years of the simulation (since Year 1 cannot have 2 consecutive years of exceedances). Table 32 shows the number of water years out of the total possible 54 years with 2 consecutive years of exceedances in the same four simulations. Only the PCBL Version 3.0 and PCBL-CC Version 3.0 simulations have consecutive water years with MT exceedances occurring in at least one well. These exceedances are all during or immediately following extreme drought conditions. No undesirable results were triggered in any of the four simulations.

Figure 81: Number of Wells with 2 Consecutive Water Years of Exceedances

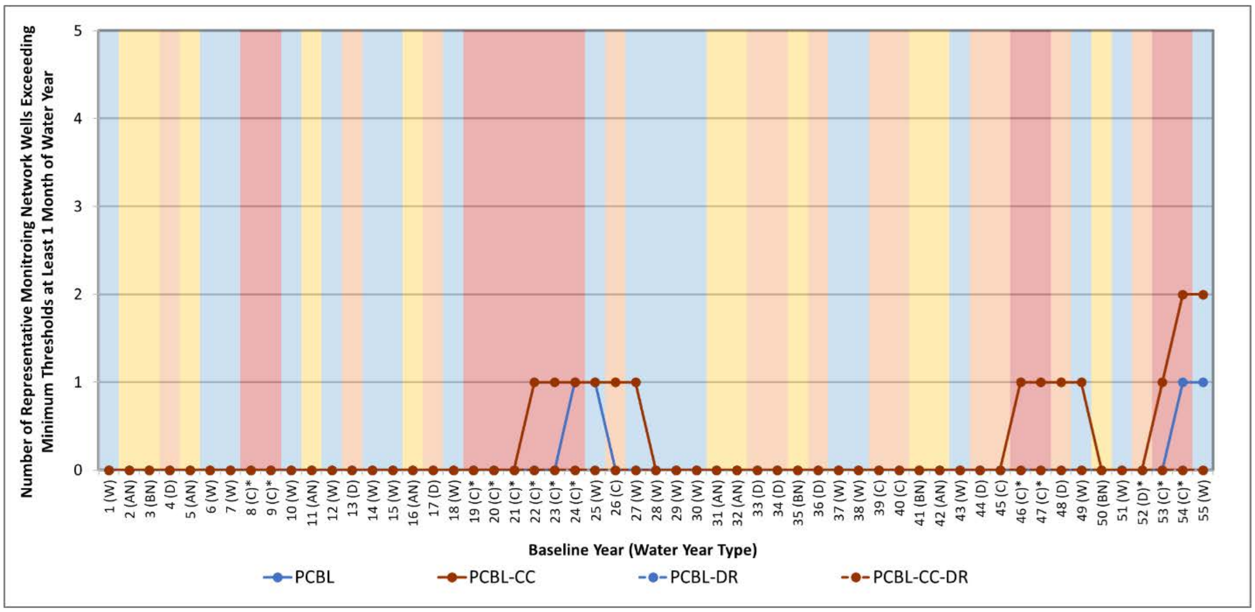


Table 32: Number of Water Years Out of Total with 2 Consecutive Years of Exceedances

Number of Water Years where Wells Have 2 Consecutive Years of Exceedances	PCBL Version 3.0	PCBL-PMA Version 3.0	PCBL-CC Version 3.0	PCBL-CC-PMA Version 3.0
1 Well	4	0	11	0
2 Wells	0	0	2	0
3 Wells	0	0	0	0
4 Wells	0	0	0	0
5 Wells	0	0	0	0

8 Conclusions and Recommendations

The updated Historical ESJWRM Version 3.0 is a robust, comprehensive, defensible, and well-established integrated water resources model for assessing the water resources in the ESJ Subbasin under historical and projected conditions using PCBL Version 3.0. The following recommendations are to be considered for further refinements and enhancements of the model:

- **Continue engagement with local groundwater users and managers**. Continue working with local agencies and groundwater users in ESJ Subbasin to further understand the local operations of the groundwater system and improve representation of groundwater users in the ESJWRM.
- **Enhance variability of potential evapotranspiration**. The current version of the IDC used for estimation of the consumptive use of crops in the ESJWRM uses monthly potential ET values that are the same for all years during the model period. Given that there may be annual variability in the potential ET data with possible effects on the annual estimation of crop water demand, it is recommended to use more detailed data with temporal variability to develop a full time series of ET values for use in the model. With the widespread availability of evapotranspiration data sources (e.g., ITRC, Formations Environmental, Cal-SIMETAW, OpenET), the ESJGWA plans to review available sources and determine a dataset to use for inclusion in ESJWRM.
- **Update information from C2VSimFG**. Many datasets in ESJWRM relied on DWR's C2VSimFG (unreleased version from approximately 2017) for information on the unsaturated zone, small watersheds, rainfall-runoff patterns, and more. C2VSimFG has since been updated and continues to undergo revisions to better represent the California Central Valey. ESJWRM may benefit from further examination of and potentially updates to the datasets from C2VSimFG.
- **Refine information for Cosumnes and Modesto Subbasins.** Now that the neighboring subbasins to ESJ Subbasin all have established GSPs and local models, coordination with the neighboring GSAs could improve ESJWRM by updating Cosumnes and Modesto Subbasins water supply and demand or pulling boundary conditions along the borders with ESJ Subbasin using the neighboring local models.
- **Climate change refinement.** The climate change approach is based on the methodology in DWR's guidance document (DWR, 2018a) and uses "best available information" related to climate change in the Subbasin. There are limitations and uncertainties associated with the analysis. One important limitation is that CalSim II does not fully simulate local surface water operations. Thus, the analysis conducted for this GSP may not fully reflect how surface and groundwater basin operations would respond to the changes in water demand and availability caused by climate change. Mokelumne River flows are simulated in PCBL-CC as unimpaired despite the potential of changes to operations for Pardee and Camanche Reservoirs under climate change conditions. This presents an opportunity in future efforts to improve the analysis to better project streamflow. Use of a local model and the perturbation factor approach were deemed appropriate given the uncertainties in the climate change analysis. DWR may refine climate change information in the further and necessitate an update to the approach used in ESJWRM.
- **Calaveras River seepage**. The current version (Version 3.0) of the Historical ESJWRM model incorporated and was calibrated using the best data and information available at the time it was updated. A GSA has since brought forward new information on Calaveras River seepage that may complement information in the ESJWRM. Based on this information received, the ESJGWA will perform further analysis to have a better estimate of the historical river seepage, which should help

improve the model calibration. Once the model is recalibrated, the projected condition modeling work will be re-evaluated. These potential changes to Calaveras River seepage may also potentially have impacts on the estimates of sustainable yield. ESJWRM has been and continues to be a useful analysis tool that has supported the ESJGWA in development and maintenance of the GSP and other policy measures. As with all analysis tools, ESJWRM is a living model that undergoes further refinements as data gaps are filled and new and updated information becomes available to support further understanding of the subbasin's hydrogeology and operational conditions, which in turn helps develop more robust information in support of the Subbasin's GSP and path to sustainability.

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APPENDIX 3-A.
CONSULTATION INITIATION LETTER FROM THE CALIFORNIA DEPARTMENT OF WATER RESOURCES TO THE EASTERN SAN JOAQUIN PLAN ADMINISTRATOR ENTITLED "EASTERN SAN JOAQUIN SUBBASIN - 2020 GROUNDWATER SUSTAINABILITY PLAN," DATED NOVEMBER 18, 2021

ATTACHMENT 2

CALIFORNIA DEPARTMENT OF WATER RESOURCES
SUSTAINABLE GROUNDWATER MANAGEMENT OFFICE
901 P Street, Room 313-B | Sacramento, CA 95814 | P.O. Box 942836 | Sacramento, CA 94236-0001

November 18, 2021

Kris Balaji, PMP, P.E.
Eastern San Joaquin Subbasin Plan Administrator
1810 E. Hazelton Avenue, Stockton, CA 95201
kbalaji@sjgov.org

RE: Eastern San Joaquin Subbasin - 2020 Groundwater Sustainability Plan

Dear Kris Balaji,

The Eastern San Joaquin Groundwater Authority submitted the Eastern San Joaquin Groundwater Subbasin (Subbasin) Groundwater Sustainability Plan (GSP) to the Department of Water Resources (Department) for evaluation and assessment as required by the Sustainable Groundwater Management Act (SGMA).[1]

Department staff have substantially completed an initial review of the GSP and have identified potential deficiencies (see the enclosed document) which may preclude the Department's approval.[2] Department staff have also developed potential corrective actions[3] for each potential deficiency. The potential deficiencies do not necessarily represent all deficiencies or discrepancies that the Department may identify in the GSP but focus on those deficiencies that staff believe, if not addressed, could lead to a determination that the GSP is incomplete or inadequate.[4] This letter initiates consultation between the Department, the Plan Manager, and the Subbasin's 15 groundwater sustainability agencies (GSAs) regarding the amount of time needed to address the potential deficiencies and corrective actions. The Department will issue a final determination as described under the GSP Regulations[5] no later than January 29, 2022.

If the Department determines the GSP to be incomplete, the deficiencies precluding approval would need to be addressed within a period not to exceed 180 days from the

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[1] Water Code § 10720 et seq.
[2] 23 CCR § 355.2(e)(2).
[3] 23 CCR § 355.2(e)(2)(B).
[4] The Department recognizes that litigation regarding the GSP has been filed. The filing of litigation does not alter or affect the Department's mandate to issue its final assessment of the Agency's groundwater sustainability plan (GSP or Plan) for the basin within two years of its submission. (Water Code §10733.4(d).) Furthermore, the Department's assessment will consist of a technical review of the submitted Plan, as required by SGMA and the GSP Regulations, and the filing of the litigation did not in any way influence or affect the Department's evaluation of the Plan. The Department expresses no opinion on the claims of the parties in the pending litigation involving the GSP.
[5] 23 CCR Division 2, Chapter 1.5, Subchapter 2.

determination. A determination of incomplete would allow the GSAs to formally address identified deficiencies and submit a revised GSP to the Department for further review and evaluation. Department staff will contact you before making the final determination to discuss the potential deficiencies and the amount of time needed by the GSAs to address the potential corrective actions detailed in the enclosed document.

Materials submitted to the Department to address deficiencies must be part of the GSP. The GSAs must justify that any materials submitted are part of the revised GSP; this justification is also part of the submittal. To facilitate the Department's review of the revised GSP, the GSAs should also provide a companion document with tracked changes of modifications made to address deficiencies. The GSAs must submit the revised GSP through the DWR SGMA Portal where, as is currently available, interested parties may provide comments on submitted materials to the Department.

Department staff will work expeditiously to review materials submitted to address deficiencies and to evaluate compliance of the revised GSP. The Department will keep a GSP status designated as incomplete during its review of the submitted materials. The Department could subsequently approve an incomplete GSP if the GSAs have taken corrective actions to address deficiencies identified by the Department within a period not to exceed 180 days from the determination. The Department could also issue a determination of inadequate for an incomplete GSP if the Department, after consultation with the State Water Resources Control Board, determines the GSAs have not taken sufficient actions to correct the deficiencies identified by the Department.

If you have any questions, please do not hesitate to contact the Sustainable Groundwater Management Office staff by emailing sgmps@water.ca.gov.

Thank you,

Paul Gosselin

Paul Gosselin
Deputy Director for Sustainable Groundwater Management

Enclosure:

1. Potential Deficiencies and Corrective Actions

ATTACHMENT 2

Potential Deficiencies and Corrective Actions

Department of Water Resources (Department) staff have identified deficiencies regarding the Eastern San Joaquin Subbasin (Subbasin) Groundwater Sustainability Plan (GSP) that may preclude the Department's approval. Therefore, consistent with the GSP Regulations, Department staff are considering corrective actions the Subbasin's groundwater sustainability agencies (GSAs) should review to determine whether and how the deficiencies can be addressed. The deficiencies and potential corrective actions are explained below, including the general regulatory background, the specific deficiencies identified in the GSP, and specific actions to address the deficiencies. The specific actions identified are potential corrective actions until the Department makes a final determination.

General Background

Potential deficiencies identified in the Eastern San Joaquin Subbasin GSP relate to the development and documentation of sustainable management criteria, including undesirable results and minimum thresholds that define when undesirable results may occur.

The Department's GSP Regulations describe several required elements of a GSP under the heading of "Sustainable Management Criteria"[6], including undesirable results, minimum thresholds, and measurable objectives. These components of sustainable management criteria must be quantified so that GSAs, the Department, and other interested parties can monitor progress towards sustainability in a basin consistently and objectively.

A GSA relies on local experience, public outreach and involvement, and information about the basin it has described in the GSP basin setting (i.e., the hydrogeologic conceptual model, the description of current and historical groundwater conditions, and the water budget), among other factors, to develop criteria for defining undesirable results and setting minimum thresholds and measurable objectives.[7]

The Sustainable Groundwater Management Act (SGMA) defines sustainable groundwater management as the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.[8] Avoidance of undesirable results is thus explicitly part of sustainable groundwater management as established by SGMA and critical to the success of a GSP.

The definition of undesirable results is critical to establishing an objective method to define and measure sustainability for a basin. As an initial matter, SGMA provides a

[6] 23 CCR § Article 5, Subarticle 3.
[7] 23 CCR §§ 354.8, 354.10, 354.12 *et seq*.
[8] Water Code § 10721(v).

qualitative definition of undesirable results as "one or more" of six specific "effects caused by groundwater conditions occurring throughout the basin."[9]

GSAs define, in their GSPs, the specific significant and unreasonable effects that would constitute undesirable results and the groundwater conditions that would produce those results in their basins.[10] The GSAs' definition must include a description of the processes and criteria relied upon to define undesirable results and describe the effect of undesirable results on the beneficial uses and users of groundwater, surface land uses (for subsidence), and surface water (for interconnected surface water).[11]

SGMA leaves the task of establishing undesirable results and setting thresholds largely to the discretion of the GSAs, subject to review by the Department. In its review, the Department requires a thorough and reasonable analysis of the groundwater conditions and the associated effects the GSAs must manage the groundwater basin to avoid, and the GSAs' stated rationale for setting objective and quantitative sustainable management criteria to prevent those undesirable conditions from occurring.[12] If a GSP does not meet this requirement, the Department cannot evaluate the GSAs' likelihood of achieving their sustainability goal. That does not necessarily mean that the GSP or its objectives are inherently unreasonable; rather, the Department cannot evaluate whether the GSP's implementation would successfully achieve sustainable management if it is unclear what undesirable conditions the GSAs seek to avoid.

Potential Deficiency 1. The GSP lacks sufficient justification for identifying that undesirable results for chronic lowering of groundwater levels, subsidence, and depletion of interconnected surface waters can only occur in consecutive non-dry water year types. The GSP also lacks sufficient explanation for its chronic lowering of groundwater levels minimum thresholds and undesirable results.

The first potential deficiency relates to the GSP's requirement of two consecutive non-dry (i.e., below normal, above normal, or wet) water-year types and the exclusion of dry and critically dry water-year types in the identification of undesirable results for chronic lowering of groundwater levels, and, by proxy, land subsidence and depletions of interconnected surface water.

Background

Related to this potential deficiency, SGMA defines the term "Undesirable Result," in part, as one or more of the following effects caused by groundwater conditions occurring throughout the basin:[13]

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[9] Water Code § 10721(x).
[10] California Department of Water Resources, Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria (Draft), November 2017.
[11] 23 CCR §§ 354.26(b), 354.28(c)(5), 354.28(c)(6).
[12] 23 CCR § 355.4(b)(1).
[13] Water Code § 10721(x).

- Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.
- Significant and unreasonable land subsidence that substantially interferes with surface land uses.
- Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.

Potential Deficiency Details

Department staff identified two areas of concern, described below, which, if not addressed, may preclude approval of the GSP. Regarding the first area of concern, the GSP identifies that an undesirable result occurs "when at least 25 percent of representative monitoring wells used to monitor groundwater levels (5 of 20 wells in the Subbasin) fall below their minimum level thresholds for two consecutive years that are categorized as non-dry years (below-normal, above-normal, or wet), according to the San Joaquin Valley Water Year Hydrologic Classification." The GSP further states that "the lowering of groundwater levels during consecutive dry or critically-dry years is not considered to be unreasonable, and would therefore not be considered an undesirable result, unless the levels do not rebound to above the thresholds following those consecutive non-dry years."[14]

Department staff find that the water-year type requirement in the definition of the undesirable result for chronic lowering of groundwater levels (i.e., two consecutive non-dry years) is not consistent with the intent of SGMA. The water-year type requirement could potentially allow for unmanaged and continued lowering of groundwater levels under certain hydrologic or climatic conditions that have occurred historically. A review of historical San Joaquin Valley water-year type classifications[15] indicates the potential for dry periods without the occurrence of a second consecutive non-dry year to persist for greater than ten years (see, e.g., the 11 years from water years 1985 through 1995). Department staff also note that concurrent below normal, above normal, or wet years occurred in only five of the last twenty water years from 2001 through 2020. Because of this definition, GSAs in the Subbasin could disregard potential impacts of groundwater level declines below the minimum thresholds during extended periods of dry years, even if interrupted by normal or wet years.

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[14] ESJ GSP, p. 253.
[15] Chronological Reconstructed Sacramento and San Joaquin Valley Water Year Hydrologic Classification Indices, Water Year 1901 through 2020. California Department of Water Resources, https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST.

Department staff also find this methodology inconsistent with other portions of the GSP. For example, while describing measurable objectives for groundwater levels, the GSP states, "the margin of operational flexibility is intended to accommodate droughts, climate change, conjunctive use operations, or other groundwater management activities. The margin of operational flexibility is defined as the difference between the minimum threshold and the measurable objective."[16] Based on these statements, it appears the minimum thresholds already accommodate drought conditions, so it is unclear why the GSP's definition of undesirable results further excludes minimum threshold exceedances during dry water years. (See Potential Corrective Action 1a.)

SGMA states that "overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods."[17] If the GSAs intended to incorporate this concept into their definition of the undesirable result for chronic lowering of groundwater levels, the GSP fails to identify specific extraction and groundwater recharge management actions the GSAs would implement[18] or otherwise describe how the Subbasin would be managed to offset, by increases in groundwater levels or storage during other periods, dry year reductions of groundwater storage. The GSP identifies many projects that, once implemented, may lead to the elimination of long-term overdraft conditions in the Subbasin. However, the GSP does not sufficiently detail how projects and management actions, in conjunction with the proposed chronic lowering of groundwater levels sustainable management criteria, will offset drought-related groundwater reductions and avoid significant and unreasonable impacts when groundwater level minimum thresholds are potentially exceeded for an extended period in the absence of two consecutive non-dry years. (See Potential Corrective Action 1b.)

As noted above, the GSP states that minimum thresholds developed for chronic lowering of groundwater levels serve as proxies for subsidence[19] and depletion of interconnected surface waters.[20] Therefore, Department staff assume the GSAs intend to apply the same water-year type criteria to undesirable results for those sustainability indicators (i.e., land subsidence or depletion of interconnected surface water undesirable results do not occur until groundwater levels exceed the thresholds for two consecutive non-dry water years). However, where SGMA acknowledges that groundwater level declines during drought periods are not sufficient to cause an undesirable result for chronic lowering of groundwater levels, the statute does not similarly provide an exception for subsidence or stream depletion during periods of drought. (See Potential Corrective Action 1c.)

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[16] ESJ GSP, p. 259.
[17] Water Code § 10721(x)(1).
[18] 23 CCR § 354.44(b)(9).
[19] ESJ GSP, p. 270.
[20] ESJ GSP, p. 271.

Department staff's second area of concern is the GSP's evaluation of the effects of the proposed minimum thresholds and undesirable results on beneficial uses and users of groundwater. The GSP identifies that the chronic lowering of groundwater levels could cause undesirable results from wells going dry, reductions in pumping capacities, increased pumping costs, the need for deeper well installations or lowering of pumps, and adverse impacts to environmental uses and users.[21] The GSP builds an analysis of domestic wells going dry into its minimum thresholds, thereby considering the factors of wells going dry and the need for deeper well installations. However, it does not address how the management criteria address the other factors identified by the GSAs as potential undesirable results, including reductions in pumping capacity or increased pumping costs for shallow groundwater users, or adverse impacts to environmental uses and users.

The GSAs set minimum thresholds in the Subbasin at the shallower of the 10th percentile domestic [or municipal] well depth or the historical low groundwater levels with a subtracted buffer value, which the GSP states allows for operational flexibility.[22] These minimum threshold values generally allow groundwater levels to decline below historic lows; minimum thresholds defined using the buffer value approach allow twice the historical drawdown from the shallowest recorded groundwater levels.[23] Aside from the GSP's domestic well analysis, the only description of how minimum thresholds were evaluated to avoid undesirable results appears to be the statements that “for the majority of the Subbasin, GSA representatives identified no undesirable results, even if groundwater were to reach historical low groundwater levels” and that no GSA indicated undesirable results would occur “if the minimum threshold was set deeper than the [historic low] based on their understanding.”[24] The GSP provides no further explanation or description of how the individual GSAs concluded that there would be no undesirable results based on the minimum thresholds.

The GSP only considers an undesirable result to occur for groundwater levels in the Subbasin when at least 25 percent of representative monitoring wells (5 of 20 wells) fall below their minimum threshold value for two consecutive non-dry water years.[25] The GSP does not justify or discuss how the GSAs developed the 25 percent threshold, nor does it explain or disclose the potential impacts anticipated during extended drier climate conditions using this threshold. In other words, the proposed management program may lead to potential effects on domestic wells or other beneficial uses and users during prolonged dry- or below-normal periods, and that information should, at a minimum, be disclosed and considered in the GSP. (See Potential Corrective Action 1d.)

If, after considering this potential deficiency, the GSAs retain minimum thresholds that allow for continued lowering of groundwater levels, it is reasonable to assume that some

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[21] ESJ GSP, p. 253.
[22] ESJ GSP, p. 254.
[23] ESJ GSP, p. 258.
[24] ESJ GSP, p. 255.
[25] ESJ GSP, p. 253.

groundwater well impacts (e.g., loss of production capacity) will occur during the implementation of the GSP. SGMA requires GSAs to consider the interests of all groundwater uses and users and to implement their GSPs to mitigate overdraft conditions.[26] Implementing specific projects and management actions prevents undesirable results and achieves the sustainable yield of the basin. The GSAs should describe how projects and management actions would address drinking water impacts due to continued overdraft between the start of GSP implementation and the achievement of the sustainability goal. If the GSP does not include projects or management actions to address drinking water impacts, the GSP should contain a thorough discussion, with supporting facts and rationale, explaining how and why GSAs determined not to include actions to address those impacts from continued groundwater lowering below pre-SGMA levels. (See Potential Corrective Action 1e.)

Additionally, related to the groundwater level declines allowed for by the GSA's minimum thresholds, the GSAs have not explained how those groundwater level declines relate to the degradation of groundwater quality sustainability indicator. GSAs must describe, among other items, the relationship between minimum thresholds for a given sustainability indicator (in this case, chronic lowering of groundwater levels) and the other sustainability indicators.[27] The GSAs generally commit to monitoring a wide range of water quality constituents but they have only developed sustainable management criteria for total dissolved solids because they state they have not observed a causal nexus between groundwater management and degradation associated with the other constituents. While Department staff are not aware of evidence sufficient to conclude that the GSAs acted unreasonably by focusing on total dissolved solids, it is clear that the GSAs did not consider, or at least did not document, the potential for degradation to occur due to further lowering of groundwater levels beyond the historic lows. (See Potential Corrective Action 1f.)

Potential Corrective Action 1

a) Department staff believe the management approach described in the GSP, which couples minimum thresholds and measurable objectives that account for operational flexibility during dry periods with a definition of undesirable results that disregards minimum threshold exceedances in all years except consecutive below normal, above normal, or wet years, to be inconsistent with the objectives of SGMA. Therefore, the GSAs should remove the water-year type requirement from the GSP's undesirable result definition.
b) The GSP should be revised to include specific projects and management actions the GSAs would implement to offset drought-year groundwater level declines.
c) The GSAs should thoroughly explain how their approach avoids undesirable results for subsidence and depletion of interconnected surface waters, as SGMA does not

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[26] 23 CCR § 355.4(b)(4), 355.4(b)(6).
[27] 23 CCR § 354.28(b)(2).

include an allowance or exemption for those conditions to continue in periods of drought.

d) Removing the water-year type requirement from the definition of an undesirable result (item a, above) would result in a GSP with groundwater level minimum thresholds designed to be generally protective of 90 percent of domestic wells regardless of regional hydrologic conditions. In that scenario, the GSAs should explain the rationale for determining that groundwater levels can exceed those thresholds at 25 percent of monitoring sites for two consecutive years before the effects would be considered significant and unreasonable. The GSAs should also explain how other factors they identified as "potential undesirable results" (e.g., adverse impacts to environmental uses and users) factored into selecting minimum thresholds and describe anticipated effects of the thresholds on beneficial uses and users of groundwater. Furthermore, the GSAs should explain whether other drinking water users that may rely on shallow wells, such as public water systems and state small water systems, were considered in the GSAs' site-specific thresholds. If not, the GSAs should conduct outreach with those users and incorporate their shallow wells, as applicable, into the site-specific minimum thresholds and measurable objectives.

e) The GSAs should revise the GSP to describe how they would address drinking water impacts caused by continued overdraft during the period between the start of GSP implementation and achieving the sustainability goal. If the GSP does not include projects or management actions to address those impacts, the GSP should contain a thorough discussion, with supporting facts and rationale, explaining how and why the GSAs determined not to include specific actions to address drinking water impacts from continued groundwater lowering below pre-SGMA levels.

f) The GSP should be revised to explain how the GSAs will assess groundwater quality degradation in areas where further groundwater level decline, below historic lows, is allowed via the minimum thresholds. The GSAs should further describe how they will coordinate with the appropriate groundwater users, including drinking water, environmental, and irrigation users as identified in the GSP. The GSAs should also discuss efforts to coordinate with water quality regulatory agencies and programs in the Subbasin to understand and develop a process for determining if continued lowering of groundwater levels is resulting in degraded water quality in the Subbasin during GSP implementation.

<u>Potential Deficiency 2. The GSP does not provide enough information to support the use of the chronic lowering of groundwater level sustainable management criteria and representative monitoring network as a proxy for land subsidence.</u>

Background

The GSP Regulations state that minimum thresholds for land subsidence should identify the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results. These quantitative values should be supported by: [28]

- The identification of land uses or property interests potentially affected by land subsidence;
- An explanation of how impacts to those land uses or property interests were considered when establishing minimum thresholds;
- Maps or graphs showing the rates and extents of land subsidence defined by the minimum thresholds.

The GSP Regulations allow the use of groundwater elevations as a proxy for land subsidence. However, GSAs must demonstrate a significant correlation between groundwater levels and land subsidence and must demonstrate that groundwater level minimum thresholds represent a reasonable proxy for avoiding land subsidence undesirable results. Additionally, the GSAs must demonstrate how the monitoring network is adequate to identify undesirable results for both metrics.

Potential Deficiency Details

Department staff find that the GSP does not adequately identify or define minimum thresholds and undesirable results for land subsidence. The GSP also does not provide adequate justification and explanation for using the groundwater level minimum thresholds and representative monitoring network as a proxy for land subsidence.

Generally, the GSP identifies that irrecoverable loss of groundwater storage and damage to infrastructure, including water conveyance facilities and flood control facilities, are potential impacts of land subsidence.[29] However, the GSP does not identify specific infrastructure locations, particularly those associated with public safety, in the Subbasin and the rate and extent of subsidence that would substantially interfere with those land surface uses and may lead to undesirable results. Additionally, without identifying infrastructure considered at risk for interference from land subsidence, Department staff cannot evaluate whether the groundwater level representative monitoring network is adequate to detect potential subsidence-related impacts.

Department staff find the GSP does not provide adequate evidence to demonstrate a significant correlation between groundwater levels and land subsidence in the Subbasin.

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[28] 23 CCR § 354.28(c)(5).
[29] ESJ GSP, p. 269.

Without explaining this correlation, the Department cannot evaluate whether the groundwater level minimum thresholds and associated conditions required for identifying an undesirable result would protect against significant and unreasonable impacts related to land subsidence. The GSP states a significant correlation exists between groundwater levels and land subsidence, with lowering groundwater levels driving further land subsidence.[30] Department staff agree with this general statement. However, the GSP fails to provide adequate evidence to evaluate further this correlation, specifically concerning potential subsidence caused by groundwater levels falling below historic lows, as would be allowed by the groundwater level minimum thresholds set in the GSP.

The GSP's justification for using the proposed groundwater level minimum thresholds as a proxy for land subsidence appears to rely mainly on an incomplete analysis and a data set with significant data gaps. The GSP states there are no historical records of significant and unreasonable land subsidence in the Subbasin.[31] The GSP also states that there is a lack of direct land subsidence monitoring in the Subbasin.[32] The GSP uses this absence of historical records to assert that historically dewatered geologic units are not compressible and, therefore, not at risk for land subsidence. Although groundwater level minimum thresholds are below historic lows, the GSP states that the GSAs do not expect further declines in groundwater levels to dewater materials deeper than 205 feet below ground surface (the deepest groundwater level minimum threshold value in the Subbasin).[33] The GSP states that subsurface materials encountered up to this depth are the same [non-compressible] geologic units that have been historically dewatered.

Department staff find multiple aspects of this justification speculative and not supported by the best available science. First, the GSP presents no analysis of historic groundwater levels or historically dewatered subsurface materials to support the conclusion that the geologic units are not compressible. Second, the GSP does not provide an evaluation showing how additional declines in groundwater levels would only affect subsurface materials similar to those which have been historically dewatered. Third, the GSP is unclear on whether the conditions required to identify an undesirable result for chronic lowering of groundwater levels in the Subbasin are also required to identify an undesirable result for land subsidence. Management proposed in the GSP could allow groundwater level minimum thresholds to be exceeded in periods where two consecutive non-dry years do not occur, which does not support the claim that only materials up to the deepest groundwater level minimum threshold (205 feet below ground surface) will be dewatered.

Department staff note that the legislature intended that implementation of SGMA would avoid or minimize subsidence[34] once GSAs achieve the sustainability goal for a basin. Without analysis examining how allowable groundwater levels below those historically

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[30] ESJ GSP, p. 270.
[31] ESJ GSP, p. 269.
[32] ESJ GSP, p. 270.
[33] ESJ GSP, p. 270.
[34] Water Code § 10720.1(e).

experienced in the Subbasin may affect land subsidence, Department staff cannot determine if the GSP adequately avoids or minimizes land subsidence. While SGMA does not require prevention of all land subsidence, the GSP does not provide sufficient evidence to conclude that the proposed chronic lowering of groundwater level minimum thresholds are adequate to detect and avoid land subsidence undesirable results.

Potential Corrective Action 2

The GSAs must provide detailed information to demonstrate how the use of the chronic lowering of groundwater level minimum thresholds are sufficient as a proxy to detect and avoid significant and unreasonable land subsidence that substantially interferes with surface land uses. Alternatively, the GSAs could commit to utilizing direct monitoring for subsidence, e.g., with remotely sensed subsidence data provided by the Department. In that case, the GSAs should develop sustainable management criteria based on rates and extents of subsidence. Department staff suggest the GSAs consider and address the following issues:

1. The GSAs should revise the GSP to identify the total subsidence that critical infrastructure in the Subbasin can tolerate during GSP implementation. Support this identification with information on the effects of subsidence on land surface beneficial uses and users and the amount of subsidence that would substantially interfere with those uses and users.
2. The GSAs should revise the GSP to document a significant correlation between groundwater levels and specific amounts or rates of land subsidence. The analysis should account for potential subsidence related to groundwater level declines below historical lows and further declines that are allowed to exceed minimum thresholds (i.e., during non-consecutive non-dry years, if applicable based on the resolution to Potential Deficiency 1, above). This analysis should demonstrate that groundwater level declines allowed during GSP implementation are preventative of the rates and magnitudes of land subsidence considered significant and unreasonable based on the identified infrastructure of concern. If there is not sufficient data to establish a correlation, the GSAs should consider other options such as direct monitoring of land subsidence (e.g., remotely sensed data provided by the Department, extensometers, or GPS stations) until such time that the GSAs can establish a correlation.
3. The GSAs should explain how the groundwater level representative monitoring network is sufficient to detect significant and unreasonable subsidence that may substantially interfere with land uses, specifically any identified infrastructure of concern. If the groundwater level monitoring network alone is not adequate, based on specific infrastructure locations, Department staff suggest incorporating continued analysis of available InSAR data to cover areas with data gaps.

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APPENDIX 3-B. DETERMINATION LETTER FROM DWR TO ESJ ENTITLED **"APPROVED DETERMINATION OF THE REVISED** GROUNDWATER SUSTAINABILITY PLAN SUBMITTED FOR THE SAN JOAQUIN VALLEY – EASTERN SAN JOAQUIN **SUBBASIN" DATED JULY 6, 2023**

ATTACHMENT 2

CALIFORNIA DEPARTMENT OF WATER RESOURCES

SUSTAINABLE GROUNDWATER MANAGEMENT OFFICE

715 P Street, 8th Floor | Sacramento, CA 95814 | P.O. Box 942836 | Sacramento, CA 94236-0001

July 6, 2023

Fritz Buchman
San Joaquin County Public Works
P.O. Box 1810
Stockton, CA 95201
info@esjgroundwater.org

RE: Approved Determination of the Revised Groundwater Sustainability Plan Submitted for the San Joaquin Valley – Eastern San Joaquin Subbasin

Dear Fritz Buchman,

The Department of Water Resources (Department) has evaluated the resubmitted groundwater sustainability plan (GSP) for the San Joaquin Valley – Eastern San Joaquin Subbasin in response to the Department's incomplete determination on January 28, 2022 and has determined the GSP is approved. The approval is based on recommendations from the Staff Report, included as an exhibit to the attached Statement of Findings, which describes that the groundwater sustainability agencies (GSAs) have taken sufficient action to correct deficiencies identified by the Department and the Eastern San Joaquin GSP satisfies the objectives of the Sustainable Groundwater Management Act (SGMA) and substantially complies with the GSP Regulations. The Staff Report also proposes recommended corrective actions that the Department believes will enhance the GSP and facilitate future evaluation by the Department. The Department strongly encourages the recommended corrective actions be given due consideration and suggests incorporating all resulting changes to the GSP in the future.

Recognizing SGMA sets a long-term horizon for GSAs to achieve their basin sustainability goals, monitoring progress is fundamental for successful implementation. GSAs are required to evaluate their GSPs at least every five years and whenever the Plan is amended, and to provide a written assessment to the Department. Accordingly, the Department will evaluate approved GSPs and issue an assessment at least every five years. The Department will initiate the first periodic review of the Eastern San Joaquin GSP no later than January 29, 2025.

Please contact Sustainable Groundwater Management staff by emailing sgmps@water.ca.gov if you have any questions related to the Department's assessment or implementation of your GSP.

Thank You,

Paul Gosselin

Paul Gosselin
Deputy Director
Sustainable Groundwater Management

Attachment:

1. Statement of Findings Regarding the Approval of the San Joaquin Valley – Eastern San Joaquin Groundwater Sustainability Plan (July 6, 2023)

ATTACHMENT 2

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES

STATEMENT OF FINDINGS REGARDING THE APPROVAL OF THE SAN JOAQUIN VALLEY – EASTERN SAN JOAQUIN SUBBASIN GROUNDWATER SUSTAINABILITY PLAN

The Department of Water Resources (Department) is required to evaluate whether a submitted groundwater sustainability plan (GSP or Plan) conforms to specific requirements of the Sustainable Groundwater Management Act (SGMA or Act), is likely to achieve the sustainability goal for the basin covered by the Plan, and whether the Plan adversely affects the ability of an adjacent basin to implement its GSP or impedes achievement of sustainability goals in an adjacent basin. (Water Code § 10733.) The Department is directed to issue an assessment of the Plan within two years of its submission. (Water Code § 10733.4.) If a Plan is determined to be Incomplete, the Department identifies deficiencies that preclude approval of the Plan and identifies corrective actions required to make the Plan compliant with SGMA and the GSP Regulations. The GSA has up to 180 days from the date the Department issues its assessment to make the necessary corrections and submit a revised Plan. (23 CCR § 355.2(e)(2)). This Statement of Findings explains the Department's decision regarding the revised Plan submitted by the Central Delta Water Agency GSA, Central San Joaquin Water Conservation District GSA, City of Lodi GSA, City of Manteca GSA, City of Stockton GSA, County of San Joaquin GSA - Eastern San Joaquin 1, County of San Joaquin GSA - Eastern San Joaquin 2, Eastside San Joaquin GSA, Linden County Water District GSA, Lockeford Community Service District GSA, North San Joaquin Water Conservation District GSA, Oakdale Irrigation District GSA, South Delta Water Agency GSA, South San Joaquin GSA, Stockton East Water District GSA, and Woodbridge Irrigation District GSA (GSAs or Agencies) for the San Joaquin Valley – Eastern San Joaquin Subbasin (Subbasin) (Basin No. 5-022.01).

Department management has discussed the Plan with staff and has reviewed the Department Staff Report, entitled Sustainable Groundwater Management Program Groundwater Sustainability Plan Assessment Staff Report, attached as Exhibit A, recommending approval of the GSP. Department management is satisfied that staff have conducted a thorough evaluation and assessment of the Plan and concurs with staff's recommendation and all the recommended corrective actions. The Department therefore **APPROVES** the Plan and makes the following findings:

A. The initial Plan for the basin submitted by the GSA for the Department's evaluation satisfied the required conditions as outlined in § 355.4(a) of the GSP Regulations (23 CCR § 350 et seq.), and Department Staff therefore evaluated the initial Plan.

B. On January 28, 2022, the Department issued a Staff Report and Statement of Findings determining the initial GSP submitted by the Agencies for the Subbasin to be incomplete, because the GSP did not satisfy the requirements of SGMA, nor did it substantially comply with the GSP Regulations. At that time, the Department provided corrective actions in the Staff Report that were intended to address the deficiencies that precluded approval. Consistent with the GSP Regulations, the Department provided the Agencies with up to 180 days to address the deficiencies detailed in the Staff Report. On July 27, 2022, within the 180 days provided to remedy the deficiencies identified in the Staff Report related to the Department's initial incomplete determination, the Agencies resubmitted a revised 2022 GSP to the Department for evaluation. When evaluating a revised GSP that was initially determined to be incomplete, the Department reviews the materials (e.g., revised or amended GSP) that were submitted within the 180-day deadline and does not review or rely on materials that were submitted to the Department by the GSA after the resubmission deadline. Part of the Department's review focuses on how the Agencies have addressed the previously identified deficiencies that precluded approval of the initially submitted Plan. The Department shall find a Plan previously determined to be incomplete to be inadequate if, after consultation with the State Water Resources Control Board, the Department determines that the Agencies have not taken sufficient actions to correct the deficiencies previously identified by the Department. (23 CCR § 355.2(e)(3)(C).) The Department shall approve a Plan previously found to be incomplete if the Department determines the Agencies have sufficiently addressed the deficiencies that precluded approval. The Department may evaluate other components of the Plan, particularly to assess whether revisions to address deficiencies may have affected other components of a Plan or its likelihood of achieving sustainable groundwater management and may offer recommended corrective actions to deal with any issues of concern.

C. The Department's Staff Report, dated January 28, 2022, identified the deficiencies that precluded approval of the initially submitted Plan. After thorough evaluation of the revised Plan, the Department makes the following findings regarding the sufficiency of the actions taken by the Agencies to correct those deficiencies:

1. <u>Deficiency 1</u>: The corrective action advised the Agencies to address several aspects of the Plan's discussion, analyses, and justification of groundwater level, subsidence, and interconnected surface waters sustainable management criteria and potential impacts to beneficial uses and users. The Department found that the initial GSP did not adequately justify why undesirable results would only occur during consecutive non-dry water years for the chronic lowering of groundwater levels, land subsidence, and depletion of interconnected

surface water sustainability indicators. The Department also found that the GSP lacked sufficient explanation for the established minimum thresholds and undesirable results for groundwater levels.

The 2023 Staff Report associated with the revised Plan indicates that the Agencies have taken sufficient actions to correct this deficiency such that, at this time, although the Staff Report includes recommended corrective actions to further align this aspect of the Plan with the GSP Regulations, the Department no longer finds the deficiency to preclude approval, and further finds that the Agencies have the ability to achieve the sustainability goal for the basin on SGMA timelines, and that the Department will be able to periodically monitor and evaluate the likelihood of Plan implementation to achieve sustainability.

2. Deficiency 2: The corrective action advised the Agencies to address the Plan's discussion supporting the use of chronic lowering of groundwater levels sustainable management criteria and monitoring network as a proxy for land subsidence. The initial GSP did not provide enough information supporting the use of groundwater levels as a proxy for subsidence.

   The 2023 Staff Report indicates that the Agencies have taken sufficient actions to correct this deficiency such that, at this time, although the Staff Report includes recommended corrective actions to further align this aspect of the Plan with the GSP Regulations, the Department finds Plan approval is not precluded, that the Agencies have the ability to achieve the sustainability goal for the basin on SGMA timelines, and that the Department will be able to periodically monitor and evaluate the likelihood of Plan implementation to achieve sustainability.

D. The Plan satisfies the required conditions as outlined in § 355.4(a) of the GSP Regulations (23 CCR § 350 et seq.):

   1. The Plan was complete, meaning it generally appeared to include the information required by the Act and the GSP Regulations sufficient to warrant a thorough evaluation and issuance of an assessment by the Department. (23 CCR § 355.4(a)(2).)

   2. The Plan, either on its own or in coordination with other Plans, appears to cover the entire Basin sufficient to warrant a thorough evaluation. (23 CCR § 355.4(a)(3).)

E. The general standards the Department applied in its evaluation and assessment of the Plan are: (1) "conformance" with the specified statutory requirements, (2) "substantial compliance" with the GSP Regulations, (3) whether the Plan is likely to achieve the sustainability goal for the Subbasin within 20 years of the implementation of the Plan, and (4) whether the Plan adversely affects the ability of an adjacent basin to implement its GSP or impedes achievement of sustainability goals in an adjacent basin. (Water Code § 10733.) Application of these standards requires exercise of the Department's expertise, judgment, and discretion when making its determination of whether a Plan should be deemed "approved," "incomplete," or "inadequate."

The statutes and GSP Regulations require Plans to include and address a multitude and wide range of informational and technical components. The Department has observed a diverse array of approaches to addressing these technical and informational components being used by GSAs in different basins throughout the state. The Department does not apply a set formula or criterion that would require a particular outcome based on how a Plan addresses any one of SGMA's numerous informational and technical components. The Department finds that affording flexibility and discretion to local GSAs is consistent with the standards identified above; the state policy that sustainable groundwater management is best achieved locally through the development, implementation, and updating of local plans and programs (Water Code § 113); and the Legislature's express intent under SGMA that groundwater basins be managed through the actions of local governmental agencies to the greatest extent feasible, while minimizing state intervention to only when necessary to ensure that local agencies manage groundwater in a sustainable manner. (Water Code § 10720.1(h)). The Department's final determination of a Plan's status is made based on the entirety of the Plan's contents on a case-by-case basis, considering and weighing factors relevant to the particular Plan and Subbasin under review.

F. In making these findings and Plan determination, the Department also recognized that: (1) it maintains continuing oversight and jurisdiction to ensure the Plan is adequately implemented; (2) the Legislature intended SGMA to be implemented over many years; (3) SGMA provides Plans 20 years of implementation to achieve the sustainability goal in a Subbasin (with the possibility that the Department may grant GSAs an additional five years upon request if the GSA has made satisfactory progress toward sustainability); and, (4) local agencies acting as GSAs are authorized, but not required, to address undesirable results that occurred prior to enactment of SGMA. (Water Code §§ 10721(r); 10727.2(b); 10733(a); 10733.8.)

G. The Plan conforms with Water Code §§ 10727.2 and 10727.4, substantially complies with 23 CCR § 355.4, and appears likely to achieve the sustainability goal for the Subbasin.

1. The sustainable management criteria and the GSP's goal to maintain an economically viable groundwater resource for the beneficial use of the people of the Subbasin by operating within its sustainable yield or by modifying existing management actions to address future conditions are sufficiently justified and explained. The Plan relies on credible information and science to quantify the groundwater conditions that the Plan seeks to avoid and provides an objective way to determine whether the Basin is being managed sustainably in accordance with SGMA. (23 CCR § 355.4(b)(1).)

2. The Plan demonstrates a thorough understanding of where data gaps exist (e.g., hydrogeological conceptual model, groundwater conditions, and water budgets) and demonstrates a commitment to eliminate those data gaps. The GSP intends to address these data gaps by incorporating new information into the numerical model and expanding the existing monitoring network. Filling these known data gaps, and others described in the Plan, should lead to the refinement of the GSAs' monitoring networks, the Subbasin's water model, and sustainable management criteria to better inform and guide future adaptive management strategies. (23 CCR § 355.4(b)(2).)

3. The sustainable management criteria and projects and management actions are commensurate with the level of understanding of the Subbasin setting. The projects and management actions described in the Plan provide a feasible approach to achieving the Subbasin's sustainability goal and should provide the GSAs' with greater versatility to adapt and respond to changing conditions and future challenges during GSP implementation. (23 CCR § 355.4(b)(3).)

4. The Plan provides a detailed explanation of how the various interests of groundwater uses and users in the Subbasin were considered in developing the sustainable management criteria and how those interests would be impacted by the established minimum thresholds. (23 CCR § 355.4(b)(4).)

5. The Plan's proposed projects and management actions appear feasible at this time and, if implemented expeditiously, appear likely to prevent undesirable results and ensure that the Subbasin is operated within its sustainable yield on SGMA timelines. The Department will continue to monitor Plan implementation and reserves the right to change its determination if projects and management actions are not implemented or appear unlikely to prevent undesirable results or unlikely to achieve sustainability within SGMA timeframes. (23 CCR § 355.4(b)(5).)

6. The Plan includes a reasonable assessment of overdraft conditions and includes reasonable means to mitigate overdraft, if present. (23 CCR § 355.4(b)(6).)

7. At this time, it does not appear that the Plan will adversely affect the ability of an adjacent basin to implement its GSP or impede achievement of sustainability goals in an adjacent basin. While no discussion was included on the potential impacts to adjacent basins, the Plan's water budget included subsurface outflows and inflows estimates between the adjacent subbasins. The Plan states that various inter-basin coordination meetings have taken place with the seven adjacent subbasins mainly discussing the elements of the critically over-drafted Subbasin and efforts to coordinate in the future. (23 CCR § 355.4(b)(7).)

8. If required, a satisfactory coordination agreement has been adopted by all relevant parties. (23 CCR § 355.4(b)(8).)

9. The GSAs' member agencies are Central Delta Water Agency, Central San Joaquin Water Conservation District, City of Lodi, City of Manteca, City of Stockton, Calaveras County Water District, Stanislaus County, Rock Creek Water District, Linden County Water District, Lockeford Community Services District, North San Water Conservation District, Oakdale Irrigation District, San Joaquin County, North Delta Water Agency, San Joaquin County No. 2 (Cal Water), South Delta Water Agency, South San Joaquin Irrigation District, City of Ripon, City of Escalon, Stockton East Water District, and Woodbridge Irrigation District. Given the legal authority and financial resources of the GSAs' member agencies and the additional authorities granted the GSAs' under SGMA, the Department concludes the GSAs' likely have the legal authority and financial resources necessary to implement the Plan. (23 CCR § 355.4(b)(9).)

10. Through review of the Plan and consideration of public comments, the Department determines that the GSAs adequately responded to comments that raised credible technical or policy issues with the Plan, sufficient to warrant approval of the Plan at this time. The Department also notes that the recommended corrective actions included in the Staff Report are important to addressing certain technical or policy issues that were raised and, if not addressed before future, subsequent plan evaluations, may preclude approval of the Plan in those future evaluations. (23 CCR § 355.4(b)(10).)

H. In addition to the grounds listed above, DWR also finds that:

1. The Plan provides an assessment conducted by the GSA which evaluated potential impacts to beneficial uses and users based on the established sustainable management criteria. The assessment estimated impacts to domestic and municipal supply wells by evaluating the 10^{th} percentile well depths and comparing those to the initial minimum thresholds values to establish the minimum thresholds at individual representative monitoring points which, if not exceeded, would be protective of approximately 90-percent of domestic or municipal wells in the Subbasin. The Department developed its GSP Regulations consistent with and intending to further the human right to water policy (Water Code § 106.3) through implementation of SGMA and the Regulations, primarily by achieving sustainable groundwater management in a basin. By ensuring substantial compliance with the GSP Regulations, the Department has considered the state policy regarding the human right to water in its evaluation of the Plan. (23 CCR § 350.4(g).)

2. The Plan acknowledges and identifies interconnected surface waters within the Subbasin. The GSAs propose to use chronic groundwater level sustainable management criteria as proxy for the depletions of interconnected surface water sustainability indicator, however, the Department recognizes that many data gaps related to interconnected surface water exist within the Subbasin. The GSAs should fill data gaps, evaluate additional modeling data, and coordinate with agencies and interested parties to understand beneficial uses and users that may be impacted by depletions of interconnected surface water caused by groundwater pumping. Future updates to the Plan should aim to improve the sustainable management criteria as more information and improved methodologies become available.

3. The California Environmental Quality Act (Public Resources Code § 21000 *et seq*.) does not apply to the Department's evaluation and assessment of the Plan.

Accordingly, the revised GSP submitted by the Agencies for the Eastern San Joaquin Subbasin is hereby **APPROVED.** The recommended corrective actions identified in the Staff Report will assist the Department's future review of the Plan's implementation for consistency with SGMA and the Department therefore recommends the Agencies address them by the time of the Department's periodic review, which is set to begin on January 29, 2025, as required by Water Code § 10733.8. Failure to address the Department's Recommended Corrective Actions before future, subsequent plan evaluations, may lead to a Plan being determined incomplete or inadequate.

Signed:

Karla Nemeth

Karla Nemeth, Director
Date: July 6, 2023

Exhibit A: Groundwater Sustainability Plan Assessment Staff Report – San Joaquin Valley – Eastern San Joaquin Subbasin (July 6, 2023)

State of California
Department of Water Resources
Sustainable Groundwater Management Program
Groundwater Sustainability Plan Assessment
Staff Report

Groundwater Basin Name:	San Joaquin Valley – Eastern San Joaquin Subbasin (No. 5-022.01)
Submitting Agencies:	Central Delta Water Agency GSA; Central San Joaquin Water Conservation District GSA; City of Lodi GSA; City of Manteca GSA; City of Stockton GSA; County of San Joaquin GSA - Eastern San Joaquin 1; County of San Joaquin GSA - Eastern San Joaquin 2; Eastside San Joaquin GSA; Linden County Water District GSA; Lockeford Community Service District GSA; North San Joaquin Water Conservation District GSA; Oakdale Irrigation District GSA; South Delta Water Agency GSA; South San Joaquin GSA; Stockton East Water District GSA; Woodbridge Irrigation District GSA
Submittal Type:	Revised Plan in Response to Incomplete Determination of the 2020 Groundwater Sustainability Plan
Submittal Date:	July 27, 2022
Recommendation:	Approve
Date:	July 6, 2023

On July 27, 2022, the Central Delta Water Agency GSA, Central San Joaquin Water Conservation District GSA, City of Lodi GSA, City of Manteca GSA, City of Stockton GSA, County of San Joaquin GSA - Eastern San Joaquin 1, County of San Joaquin GSA - Eastern San Joaquin 2, Eastside San Joaquin GSA, Linden County Water District GSA, Lockeford Community Service District GSA, North San Joaquin Water Conservation District GSA, Oakdale Irrigation District GSA, South Delta Water Agency GSA, South San Joaquin GSA, Stockton East Water District GSA, and Woodbridge Irrigation District GSA (collectively, the GSAs or Agencies) submitted the Eastern San Joaquin Groundwater Subbasin Revised June 2022 Groundwater Sustainability Plan (GSP or Plan) for the San Joaquin Valley – Eastern San Joaquin Subbasin (Subbasin) to the Department of Water Resources (Department) in response to the Department's incomplete determination on

January 28, 2022,[1] for evaluation and assessment as required by the Sustainable Groundwater Management Act (SGMA)[2] and GSP Regulations.[3]

After evaluation and assessment, Department staff conclude the GSAs have taken sufficient actions to correct deficiencies identified by the Department and recommend approval of the 2022 Plan. Department staff have identified recommended corrective actions for the GSA to address by the Plan's first periodic evaluation.

Overall, Department staff believe the Plan contains the required components of a GSP; demonstrates a thorough understanding of the Subbasin based on what appears to be the best available science and information; sets reasonable and supported sustainable management criteria to prevent undesirable results as defined in the Plan; has a reasonable monitoring network; and proposes a set of projects and management actions that, if successfully implemented, are likely to achieve the sustainability goal defined for the Subbasin.[4] Department staff will continue to monitor and evaluate the Subbasin's progress toward achieving the sustainability goal through annual reporting, periodic evaluations of the GSP, and GSP implementation.

This assessment includes six sections:

- **Section 1 – Summary:** Provides an overview of the Department's assessment and recommendations.
- **Section 2 – Evaluation Criteria:** Describes the legislative requirements and the Department's evaluation criteria.
- **Section 3 – Required Conditions:** Describes the submission requirements of a response to an incomplete determination to be evaluated by the Department.
- **Section 4 – Deficiency Evaluation:** Provides an assessment of whether and how the contents included in the GSP resubmittal addressed the deficiencies identified by the Department in the initial incomplete determination.
- **Section 5 – Plan Evaluation:** Provides a detailed assessment of the contents included in the GSP organized by each Subarticle outlined in the GSP Regulations.
- **Section 6 – Staff Recommendation:** Includes the staff recommendation for the Plan and any recommended corrective actions.

[1] Water Code § 10733.4(b); 23 CCR § 355.4(a)(4). https://sgma.water.ca.gov/portal/service/gspdocument/download/7777.
[2] Water Code § 10720 *et seq*.
[3] 23 CCR § 350 *et seq*.
[4] 23 CCR § 354.24.

1 SUMMARY

Department staff conclude that the GSAs took sufficient action to correct the deficiencies previously identified. Accordingly, Department staff recommend **approval** of the Groundwater Sustainability Plan for the Eastern San Joaquin Groundwater Subbasin, along with implementation of corrective actions described in this Staff Report, which should be addressed by the next periodic Plan evaluation to further improve Plan implementation and achievement of basin sustainability in accordance with SGMA timelines.

The GSAs have identified areas for improvement of their Plan (e.g., addressing data gaps related to the hydrogeologic conceptual model and monitoring networks, including the refinement of aquifer characteristics, depth-discrete groundwater level and groundwater quality data, shallow groundwater levels near surface waters and natural communities commonly associated with groundwater (NCCAGs), and groundwater level data in the east and northwest areas of the Subbasin). Department staff concur that those items are important and recommend that the GSAs address them as soon as possible. Department staff have also identified additional recommended corrective actions designed to address shortcomings of the Plan, as described in this Staff Report, that the GSAs should consider for the first periodic evaluation of the Plan (see Section 6). The recommended corrective actions generally focus on the following:

1) groundwater level sustainable management criteria and the evaluation of impacts to beneficial uses and users,
2) land subsidence sustainable management criteria and monitoring network,
3) clarification of water budget and sustainable yield estimates,
4) clarification of sustainable management criteria related to the reduction of groundwater in storage,
5) additional explanation of seawater intrusion sustainable management criteria and the effects on beneficial uses and users, and clarification related to development the seawater intrusion isocontour line,
6) additional explanation of potential impacts related to depletions of interconnected surface waters, and additional details regard the existing and proposed monitoring network for depletions of interconnected surface water,
7) recommendations related to the seawater intrusion and groundwater quality monitoring networks.

Addressing the recommended corrective actions identified in Section 6 of this Staff Report will be important to demonstrate, on an ongoing basis, that implementation of the Plan is likely to achieve the sustainability goal.

2 EVALUATION CRITERIA

The Department evaluates whether a Plan conforms to the statutory requirements of SGMA[5] and is likely to achieve the basin's sustainability goal,[6] whether evaluating a basin's first Plan,[7] a Plan previously determined incomplete,[8] an amended Plan,[9] or a GSA's periodic evaluation to an approved Plan.[10] To achieve the sustainability goal, each version of the Plan must demonstrate that implementation will lead to sustainable groundwater management, which means the management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.[11] The Department is also required to evaluate, on an ongoing basis, whether the Plan will adversely affect the ability of an adjacent basin to implement its groundwater sustainability program or achieve its sustainability goal.[12]

The Plan evaluated in this Staff Report is a revision of the 2020 Plan, which was evaluated by the Department and found to be incomplete. An incomplete Plan is one which Department staff identified one or more deficiencies that preclude its initial approval. Deficiencies may include a lack of supporting information that is sufficiently detailed or analyses that are sufficiently thorough and reasonable, or where Department staff determine it is unlikely the GSA(s) in the basin/subbasin could achieve the sustainability goal under the proposed Plan. After GSAs have been afforded up to 180 days to address the deficiencies and based on the GSAs' efforts, the Department can either approve[13] the Plan or determine the Plan inadequate.[14]

The Department's evaluation and assessment of a revised or amended Plan, subsequent to the initial Plan being found to be incomplete, as presented in this Staff Report, continues to follow Article 6 of the GSP Regulations[15] to determine whether the Plan, with revisions or additions prepared by the GSA, complies with SGMA and substantially complies with the GSP Regulations.[16] As stated in the GSP Regulations, "substantial compliance means that the supporting information is sufficiently detailed and the analyses sufficiently thorough and reasonable, in the judgment of the Department, to evaluate the Plan, and the Department determines that any discrepancy would not materially affect the

[5] Water Code §§ 10727.2, 10727.4, 10727.6.
[6] Water Code § 10733; 23 CCR § 354.24.
[7] Water Code § 10720.7.
[8] 23 CCR § 355.2(e)(2).
[9] 23 CCR § 355.10.
[10] 23 CCR § 355.6.
[11] Water Code § 10721(v).
[12] Water Code § 10733(c).
[13] 23 CCR §§ 355.2(e)(1).
[14] 23 CCR §§ 355.2(e)(3).
[15] 23 CCR § 355 *et seq*.
[16] 23 CCR § 350 *et seq*.

ability of the Agency to achieve the sustainability goal for the basin, or the ability of the Department to evaluate the likelihood of the Plan to attain that goal."[17]

When reviewing a revised or amended Plan that had previously been determined to be incomplete, Department staff primarily assess whether the GSA(s) have taken sufficient actions to correct any deficiencies identified by the Department.[18] A Plan approval does not signify that Department staff, were they to exercise the professional judgment required to develop a Plan for the basin, would make the same assumptions and interpretations as those contained in the revised Plan, but simply that Department staff have determined that the modified assumptions and interpretations relied upon by the submitting GSA(s) are supported by adequate, credible evidence, and are scientifically reasonable. Assessment of a revised or amended Plan previously determined to be incomplete may involve the review of new information presented by the GSA(s), including models and assumptions, and a reevaluation of that information based on scientific reasonableness. In conducting its assessment, Department staff does not recalculate or reevaluate technical information or perform its own geologic or engineering analysis of that information.

The recommendation to approve a Plan previously determined to be incomplete is based on a determination that the GSA(s) have taken sufficient actions (e.g., amended or revised the Plan) to correct the deficiencies previously identified by the Department that precluded earlier approval.

3 REQUIRED CONDITIONS

For a Plan that the Department determines to be incomplete, the Department identifies corrective actions to address those deficiencies that preclude approval of the Plan as initially submitted. The GSAs in a basin, whether developing a single GSP covering the basin or multiple GSPs, must attempt to sufficiently address those corrective actions within the time provided, not to exceed 180 days, for the Plan to be evaluated by the Department.

3.1 INCOMPLETE RESUBMITTAL

The GSP Regulations specify that the Department shall evaluate a revised GSP if the GSA has taken corrective actions to address deficiencies within 180 days from the date the Department issued an incomplete determination.[19]

The Department issued the incomplete determination on January 28, 2022. The GSAs submitted a revised GSP to the Department on July 27, 2022, within the 180-day deadline.

[17] 23 CCR § 355.4(b).
[18] 23 CCR §§ 355.2(e)(3)(C).
[19] 23 CCR § 355.4(a)(4).

4 Deficiency Evaluation

As stated in Section 355.4 of the GSP Regulations, a basin "shall be sustainably managed within 20 years of the applicable statutory deadline consistent with the objectives of the Act." The Department's assessment is based on a number of related factors including whether the elements of a GSP were developed in the manner required by the GSP Regulations, whether the GSP was developed using appropriate data and methodologies and whether its conclusions are scientifically reasonable, and whether the GSP, through the implementation of clearly defined and technically feasible projects and management actions, is likely to achieve a tenable sustainability goal for the basin.

In its initial incomplete determination, the Department identified deficiencies in the 2020 Plan which precluded that Plan's approval.[20] In January 2022 the GSAs were given 180 days to take corrective actions to remedy the identified deficiencies. Consistent with the GSP Regulations, Department staff have evaluated the revised 2022 Plan to determine if the GSAs have taken sufficient actions to correct the deficiencies.

4.1 Deficiency 1. The GSP lacks sufficient justification for determining that undesirable results for chronic lowering of groundwater levels, subsidence, and depletion of interconnected surface waters can only occur in consecutive non-dry water year types. The GSP also lacks sufficient explanation for its minimum thresholds and undesirable results for chronic lowering of groundwater levels.

4.1.1 Corrective Action

The corrective actions issued by the Department in its January 28, 2022, assessment related to this deficiency are as follows:

> The GSAs must provide more detailed explanation and justification regarding the selection of the sustainable management criteria for groundwater levels, particularly the undesirable results and minimum thresholds, and the effects of those criteria on the interests of beneficial uses and users of groundwater. Department staff recommended the GSAs consider and address the following:
>
> 1a. Department staff believe the management approach described in the GSP, which couples minimum thresholds and measurable objectives that account for operational flexibility during dry periods with a definition of undesirable results that disregards minimum threshold exceedances in all years except consecutive below normal, above normal, or wet years, to be inconsistent with sustainable

[20] https://sgma.water.ca.gov/portal/service/gspdocument/download/7777.

groundwater management under SGMA. Therefore, the GSAs should remove the water-year type requirement from the GSP's undesirable result definition.

1b. The GSP should be revised to include specific projects and management actions the GSAs would implement to offset drought-year groundwater level declines.

1c. The GSAs should thoroughly explain how their management approach and minimum thresholds avoid undesirable results for subsidence and depletion of interconnected surface waters, in light of the fact that SGMA does not include an allowance or exemption for conditions that occur during periods of drought for those sustainability indicators.

1d. Removing the water-year type requirement from the definition of an undesirable result (item a, above) would result in a GSP with groundwater level minimum thresholds designed to be generally protective of 90 percent of domestic wells regardless of regional hydrologic conditions. In that scenario, the GSAs should explain the rationale for determining that groundwater levels can exceed those thresholds at 25 percent of monitoring sites for two consecutive years before the effects would be considered significant and unreasonable. The GSAs should also explain how other factors they identified as "potential undesirable results" (e.g., adverse impacts to environmental uses and users) were considered when developing and selecting minimum thresholds and describe anticipated effects of the thresholds on beneficial uses and users of groundwater. Furthermore, the GSAs should explain whether other drinking water users that may rely on shallow wells, such as public water systems and state small water systems, were considered in the GSAs' site-specific thresholds. If not, the GSAs should conduct outreach with those users and incorporate their shallow wells, as applicable, into the consideration of site-specific minimum thresholds and measurable objectives.

1e. The GSAs should revise the GSP to describe how they would address drinking water impacts caused by continued overdraft during the period between the start of GSP implementation and achieving the sustainability goal. If the GSP does not include projects or management actions to address those impacts, the GSP should contain a thorough discussion, with supporting facts and rationale, explaining how and why the GSAs determined not to include specific actions to address drinking water impacts from continued groundwater lowering below pre-SGMA levels.

1f. The GSP should be revised to explain how the GSAs will assess groundwater quality degradation in areas where further groundwater level decline, below historic lows, is allowed via the minimum thresholds. The GSAs should further describe how they will coordinate with the appropriate groundwater users, including drinking water, environmental, and irrigation users as identified in the GSP. The GSAs should also discuss efforts to coordinate with water quality regulatory agencies and programs in the Subbasin to understand and develop a process for determining if continued lowering of groundwater levels is resulting in degraded water quality (e.g., increased concentrations of constituents of concern) in the Subbasin during GSP implementation.

4.1.2 Evaluation

In response to the multi-component corrective action provided for Deficiency 1, the Agencies submitted a revised GSP, including three new technical memoranda (Appendix 2-B, Appendix 3-D, and Appendix 3-E) address the deficiencies.

Deficiency 1a – relating to the exclusion of dry water year types in the identification of undesirable results for the chronic lowering of groundwater levels – was addressed in Appendix 2-B and Section 3.3.1.1.2 of the GSP.[21] To address Deficiency 1a, the revised GSP changes the definition of an undesirable result for the chronic lowering of groundwater levels to remove the non-dry water year type requirement. This change results in an undesirable result for the chronic lowering of groundwater levels to be defined as "when at least 25 percent of representative monitoring wells used to monitor groundwater levels (5 of 20 wells in the Subbasin) fall below their minimum level thresholds for two consecutive years."[22] Department staff conclude this change to be sufficient to address Deficiency 1a.

Deficiency 1b – relating to the identification of projects and management actions that will offset drought-related groundwater level declines – was addressed in Appendix 2-B. Deficiency 1b was initially recommended by Department staff as an alternative pathway to address the exclusion of dry and critical water year types in the identification of undesirable results for the chronic lowering of groundwater levels. With the removal of the water year type requirement, addressed in Deficiency 1a, Department staff believe that Deficiency 1b has already been addressed sufficiently; however, the GSP does provide an updated project list that includes potential surface water supplementation and in-lieu recharge estimates for different water year types and an updated modeling analysis of how projects will affect the groundwater budget and overdraft conditions in the Subbasin. The modeling results presented in the GSP indicate that even with the implementation of Category A Projects – defined as projects that are likely to advance in the next five years and have existing water rights or agreements – the Subbasin is projected to experience overdraft of 15,700 acre-feet per year when considering climate change.[23] The modeling results indicate that if Category A Projects are implemented as described, the Subbasin should not experience any undesirable results related to chronic lowering of groundwater levels (based on the updated definition), even under the climate change scenario; however, undesirable results may still occur (under the climate change scenario) if Category A Projects are not implemented as anticipated.[24] Based on these results, the GSP acknowledges that additional projects and management actions may be needed to address projected overdraft under climate change, and potential undesirable

[21] Eastern San Joaquin 2022 GSP, Appendix 2-B, pp. 1392-1393 and Section 3.3.1.1.2, p. 290.
[22] Eastern San Joaquin 2022 GSP, Section 3.3.1.1.2, p. 290.
[23] Eastern San Joaquin 2022 GSP, Appendix 2-B, p. 1402.
[24] Eastern San Joaquin 2022 GSP, Appendix 2-B, p. 1408.

results due to unforeseen changes in Category A Project implementation. The GSP indicates that an adaptive management approach will be utilized to address these concerns, and potential management actions and additional (Category B) projects were identified.[25] In general, Department staff conclude that the projects, potential management strategies and updated modeling results presented in the GSP provide a sufficient understanding of how the Agencies plan to manage the Subbasin under differing hydrologic conditions, even though the GSP acknowledges that additional, yet-to-be determined projects or management actions may be necessary to achieve sustainability.

Deficiency 1c, which requested additional justification to show how undesirable results for land subsidence and depletions of interconnected surface waters would not occur during dry water years where minimum thresholds are allowed to be exceeded (based on the previous definition of undesirable results and the use of groundwater levels as a proxy), was addressed sufficiently by the GSAs' response to Deficiency 1a. With the removal of the water-year type requirement from the identification of undesirable results for the chronic lowering of groundwater levels, Deficiency 1c is also addressed.

Deficiency 1d was addressed in Appendix 3-D. In explaining the rationale for how undesirable results related to the chronic lowering of groundwater levels would only occur when at least 25 percent of representative monitoring wells exceed their minimum thresholds for two consecutive years, the GSP describes that the 25-percent threshold (of representative monitoring well exceedances) was considered to be sufficient to identify subbasin-wide undesirable results, whereas less than 25 percent would be considered more localized events. Additionally, the GSP explains that two consecutive years of exceedances were selected to identify an undesirable result because two years would establish a pattern rather than an isolated event, but three years of exceedances was felt to be too extreme.[26] While the rationale presented in the GSP is understandable, Department staff cannot determine whether it is reasonable as the GSP provides no additional analysis of these thresholds that would describe the potential allowable impacts. For example, while the GSP indicates that minimum thresholds are generally protective of 90 percent of domestic (or municipal) wells in the Subbasin, if groundwater levels in up to four of 20 representative monitoring wells are allowed to exceed minimum thresholds (without triggering undesirable results), then 90 percent of domestic (or municipal) wells are not truly protected. Updated modeling scenarios included in the GSP indicate that minimum threshold exceedances will still occur in some areas of the Subbasin.[27] While Department staff do not believe this precludes approval at this time, they do believe that these modeling scenarios could be used to estimate potential impacts, particularly related to wells going dry, to support the notion that the proposed groundwater management approach will avoid significant and unreasonable undesirable results and recommend that minimum thresholds be evaluated in relation to the well depths of public water systems and state small water systems reliant on groundwater.

[25] Eastern San Joaquin 2022 GSP, Appendix 2-B, pp. 1410-1412.
[26] Eastern San Joaquin 2022 GSP, Appendix 3-D, p. 1595.
[27] Eastern San Joaquin 2022 GSP, Appendix 2-B, pp. 1402-1409.

While it may be reasonable to assume that wells in these systems are generally deeper than domestic wells, which were part of the minimum threshold analysis, Department staff recommend that an evaluation of these systems be disclosed by the GSP and an explanation for the selection of 25 percent exceedance for two years considered to be an undesirable result (see Recommended Corrective Action 1a).

Deficiency 1d also requested additional explanation for how other potential impacts, such as adverse impacts to environmental uses and users, were considered in the selection of minimum thresholds and the identification of undesirable results. In responding to this request, the Technical Memorandum included in Appendix 3-D essentially reiterated what was already presented in the original GSP. The revised GSP states that "[f]or the majority of the Subbasin, GSA representatives identified no undesirable results, even if groundwater were to reach historical low groundwater levels."[28] Additionally, while the explanation is somewhat unclear, the GSP implies that individual GSAs each "confirmed" that no undesirable results would occur if minimum thresholds were set deeper than historic lows (based on the established minimum thresholds).[29] The GSP does not disclose the potential impacts to environmental uses and users of groundwater related to the groundwater level minimum thresholds. Based on what is presented in the revised GSP, it is difficult for Department staff to evaluate the minimum thresholds and identification of undesirable results related to the chronic lowering of groundwater levels because no additional explanation or analysis was presented to describe how environmental uses and users would avoid experiencing significant and unreasonable impacts, particularly considering that groundwater level minimum thresholds are set below historic lows.

While it is understandable that the effects of changing groundwater levels on environmental uses and users may be difficult to observe and quantify than impacts that potentially affect groundwater wells or considered a data gap, the GSP does not present any analysis evaluating minimum thresholds in areas with identified GDEs. The GSP generally describes how the identification of GDEs will be further refined, and how new shallow monitoring wells will be constructed to collect additional data; however, there is no description for how this new data will be evaluated in conjunction with the minimum thresholds to evaluate impacts to environmental uses and users. While this does not preclude approval at this time, Department staff recommend the GSP include a more thorough evaluation of the impacts to environmental uses and users related to the groundwater level minimum thresholds, or, at minimum, provide a plan to evaluate impacts to environmental uses and users as additional data become available during GSP implementation (see Recommended Corrective Action 1b).

Additionally, Deficiency 1d requested explanation of how other groundwater users, such as public water systems and state small water systems, were considered in the development of minimum thresholds. In response to this request, the Technical

[28] Eastern San Joaquin 2022 GSP, Appendix 3-D, p. 1598.
[29] Eastern San Joaquin 2022 GSP, Appendix 3-D, p. 1598.

Memorandum included in Appendix 3-D reiterated the domestic and municipal well analysis presented in the original GSP.[30] The GSP states that domestic wells are generally shallower than agricultural and municipal wells, which is why their analysis focuses on domestic wells. This analysis determined the 10th percentile of domestic well depth for all domestic wells (with data available in the Department's Online System of Well Completion Reports [OSWCR] database) within a three-mile radius of each representative monitoring well (or two-mile radius for representative monitoring well 03N07E21L003 due to site-specific hydrogeologic conditions), and used this value as the minimum threshold (unless the historic low groundwater level plus buffer was shallower). For areas served by municipal wells, a similar analysis was done based on nearby municipals wells. Department staff do not believe this analysis to be unreasonable; however, the deficiency specifically requested an explanation for how public water systems and small state water systems were considered.

Department staff suggest that a more detailed analysis of these smaller water systems be included in future GSP updates. The analysis should identify locations for public water systems and state small water systems in the Subbasin that rely on groundwater and evaluate whether minimum thresholds for nearby representative monitoring wells are sufficient to prevent significant and unreasonable impacts to these wells. While it may be assumed by GSAs that these small water systems are deeper than the 10th percentile domestic well depth and, thus, protected by the current minimum thresholds, Department staff would like evidence of this assumption disclosed in the Plan (see Recommended Corrective Action 1c).

Deficiency 1e identified the need for a description of drinking water impacts caused by continued overdraft during Plan implementation. This deficiency generally related to the continued overdraft and lowering of groundwater levels that would be allowed by the GSP in dry water years where minimum thresholds could be exceeded without triggering an undesirable result. The 2022 Plan addresses Deficiency 1e in Appendix 3-D. The information presented in Appendix 3-D indicates that the GSP plans to address long-term overdraft through the implementation of projects, but the GSP does not include any projects or management actions related to short-term impacts associated with drought. The GSP indicates that existing water suppliers and the County Office of Emergency Services have programs or plans in place to address short-term drought-related emergency water supply issues, and that SGMA legislation does not require GSPs to include water supply contingency or dry well mitigation plans.[31] The GSP also states that impacts to drinking water users were considered during the development of minimum thresholds, and with the removal of the water year type requirement, the established minimum thresholds will prevent a continued lowering of groundwater levels which should be sufficiently protective of most shallow domestic well users. The GSP indicates that an adaptive management approach will be utilized, and if impacts to drinking water users are

[30] Eastern San Joaquin 2022 GSP, Appendix 3-D, pp. 1599-1600.
[31] Eastern San Joaquin 2022 GSP, Appendix 3-D, pp. 1601-1603.

identified during GSP implementation, minimum thresholds could be revised, or additional projects or management actions could be implemented.[32] Department staff note that while the removal of the water year type requirement in the identification of undesirable results should lessen the chance for potential impacts to drinking water users, the minimum thresholds still allow for the lowering of groundwater levels below historic lows (ranging from 7.3 to 54.4 feet below historic low, depending on representative monitoring well site). Additionally, up to four of 20 representative monitoring wells are allowed to exceed these minimum thresholds without being considered an undesirable result, potentially resulting in undisclosed impacts to drinking water users across 20 percent of the Subbasin. Due to these factors, and as recommended previously under Recommended Corrective Action 1a, Department staff suggest that impacts to drinking water users (i.e., shallow domestic wells and small water systems) be evaluated using the updated modeling scenarios so that projected impacts under these scenarios can be used to guide future projects or management actions, if warranted.

Deficiency 1f requests that the GSP explain how groundwater quality degradation related to continued lowering of groundwater levels will be assessed. This deficiency was addressed in Technical Memorandum No. 3, included in Appendix 3-E. While the removal of the water year type requirement from the identification of undesirable results lessens the potential for continued lowering of groundwater levels Subbasin-wide, minimum thresholds still allow for groundwater levels to drop below historic lows. The GSP states that the only known correlation between groundwater quality and declining groundwater levels is related to the potential for saline water from the Delta to migrate inland when groundwater levels decline. The GSP states that "[t]hese sustainable management criteria were set specifically to help prevent the further migration of saline water."[33] Department staff cannot identify where the GSP describes how the migration of saline water was evaluated in relation to the groundwater level minimum thresholds, as minimum thresholds were only described as being defined as the shallower of either the 10th percentile of domestic well depth, or the historic low groundwater level minus a buffer that represented the range of historic groundwater level fluctuations, as discussed above. The GSP also states that "[aside from potential saline water migration] there is no evidence or historical data to indicate there is a relationship between lowering of groundwater levels and groundwater quality degradation."[34] While there may currently be no known correlation between groundwater levels and groundwater quality in the Subbasin, the GSP describes that groundwater quality results collected through GSP implementation, and also data from other water quality programs, will be evaluated in areas where groundwater level minimum thresholds are exceeded – and if groundwater quality secondary maximum contaminant levels (SMCLs) or minimum thresholds are also

[32] Eastern San Joaquin 2022 GSP, Appendix 3-D, pp. 1602-1603.
[33] Eastern San Joaquin 2022 GSP, Appendix 3-E, p. 1621.
[34] Eastern San Joaquin 2022 GSP, Appendix 3-E, p. 1621.

exceeded, the Agencies will convene a working group to assess whether groundwater management activities resulted in the groundwater quality exceedances.[35]

Department staff are encouraged by the commitment to evaluate groundwater quality data in areas where groundwater levels exceed minimum thresholds; however, the GSP presents little details on what the evaluation would entail. The GSP describes that groundwater quality degradation related to groundwater level declines will be evaluated in areas where groundwater levels fall below minimum thresholds. Considering that none of the representative monitoring wells in the groundwater level network are also sampled for groundwater quality (as part of the described GSP monitoring efforts), it is unclear how groundwater level declines observed in these wells will be correlated with changing groundwater quality conditions, particularly if no evaluation will be conducted until minimum thresholds are exceeded. In order to evaluate the changes in groundwater quality, sufficient groundwater quality data in the vicinity of the representative monitoring wells must be collected prior to the groundwater level declines occurring. Department staff recommend that as GSP implementation continues, the Agencies develop a more detailed plan describing how this assessment will be conducted, including identifying specific analyses, well locations (either wells already monitored as part of GSP implementation or wells monitored by other programs), sampling frequency, and data gaps (see Recommended Corrective Action 1d).

Deficiency 1f also requests additional information for how the Agencies plan to coordinate with groundwater users regarding groundwater quality degradation, and for how the Agencies plan to coordinate with other regulatory agencies or programs to develop a process to evaluate the effect of declining groundwater levels on groundwater quality in the Subbasin. The GSP provides a summary of how groundwater users will generally be involved or communicated with, including through stakeholder outreach and engagement efforts, a website, a future database management system, and the annual reporting.[36] Regarding coordination with other groundwater quality programs, the revised GSP provides additional management actions to enhance the coordination and evaluation of groundwater quality results among the different programs in the Subbasin.[37] These management actions include establishing a process for regular coordination by having an annual meeting or workshop with other water quality programs and inviting Water Board staff to participate in regular Technical Advisory Committee meetings; developing monitoring data sharing agreements; including water quality data from external programs in the Subbasin's data management system and evaluating these data with groundwater levels to identify whether a correlation exists; and including water quality data from other programs in the annual reporting. Department staff believe these coordination efforts described by the GSP to be sufficient.

[35] Eastern San Joaquin 2022 GSP, Appendix 3-E, p. 1623.
[36] Eastern San Joaquin 2022 GSP, Appendix 3-E, pp. 1623-1624.
[37] Eastern San Joaquin 2022 GSP, Appendix 3-E, pp. 1625-1626.

4.1.3 Conclusion

Overall, Department staff believe the GSAs have taken sufficient action to correct Deficiency 1 by removing the water year type requirement from the definition of undesirable results for the chronic lowering of groundwater levels, further describing the undesirable results, providing updated modeling analyses, and describing new management actions, as described above and in the revised GSP. However, Department staff have identified four recommended corrective actions related to Deficiency 1 that do not preclude approval at this time but would further improve the GSP. GSAs should consider addressing Recommended Corrective Actions 1a through 1d, described below, by the next periodic evaluation.

4.2 Deficiency 2. The GSP does not provide enough information to support the use of the chronic lowering of groundwater level sustainable management criteria and representative monitoring network as a proxy for land subsidence.

4.2.1 Corrective Action

The corrective actions issued by the Department in its January 28, 2022, assessment related to this deficiency are as follows:

> The GSAs must provide detailed information to demonstrate how the use of the chronic lowering of groundwater level minimum thresholds are sufficient as a proxy to detect and avoid significant and unreasonable land subsidence that substantially interferes with surface land uses. Alternatively, the GSAs could commit to utilizing direct monitoring for subsidence, e.g., with remotely sensed subsidence data provided by the Department. In that case, the GSAs should develop sustainable management criteria based on rates and extents of subsidence. Department staff suggest the GSAs consider and address the following issues:
>
> 2a. The GSAs should revise the GSP to identify the total extent and rates of subsidence that critical infrastructure in the Subbasin can tolerate during GSP implementation. Support this identification with information on the effects of subsidence on land surface beneficial uses and users and the amount of subsidence that would substantially interfere with those uses and users.
>
> 2b. The GSAs should revise the GSP to document a significant correlation between groundwater levels and specific amounts or rates of land subsidence. The analysis should account for potential subsidence related to groundwater level declines below historical lows and further declines that would exceed minimum threshold levels (i.e., during non-consecutive non-dry years, if applicable based on the resolution to Deficiency 1, above). This analysis should demonstrate that groundwater level declines allowed during GSP implementation are preventative of the rates and extent of land subsidence considered significant and unreasonable based on the identified infrastructure of concern. If there is not sufficient data to

establish a correlation, the GSAs should consider other options such as direct monitoring of land subsidence (e.g., remotely sensed data provided by the Department, extensometers, GPS stations, etc.) until such time that the GSAs can establish a correlation.

2c. The GSAs should explain how the groundwater level representative monitoring network is sufficient to detect significant and unreasonable rates or extents of subsidence that may substantially interfere with land uses, specifically any identified infrastructure of concern. If the groundwater level monitoring network alone is not adequate, based on specific infrastructure locations, Department staff suggest incorporating continued analysis of available InSAR [Interferometric Synthetic Aperture Radar] data to cover areas with data gaps.

4.2.2 Evaluation

Deficiency 2 was addressed in Technical Memorandum No. 4, included in the GSP as Appendix 3-F.[38] The Technical Memorandum provides additional information related to land subsidence in the Subbasin, including expanded discussions of critical infrastructure that would at risk due to land subsidence and the correlation between groundwater levels and land subsidence. Additionally, the Technical Memorandum proposes new management actions related to the monitoring of land subsidence in the Subbasin.

Deficiency 2a requests that the GSP describe the rate and extent of subsidence that would be considered significant and unreasonable, with respect to infrastructure of concern identified in the Subbasin. The revised GSP provides a general discussion of critical infrastructure types but does not identify specific infrastructure, stating "due to the sensitive nature of the critical infrastructure, specific infrastructure are not named."[39] The GSP does not define specific rates or extents of subsidence that would potentially impact this infrastructure or be considered significant and unreasonable. Regarding the evaluation of land subsidence in relation to critical infrastructure, the GSP only states that "[t]hrough input from OES, the critical infrastructure in the Subbasin can generally tolerate a significant amount of uniform settlement due to subsidence across the Subbasin, though the total amount of settlement that can be tolerated is dependent on the design of the specific infrastructure. Differential settlement across facilities in a locale, on the other hand, will result in more damage."[40] While this does not preclude approval at this time, based on the information provided, Department Staff believe additional information is needed to address Deficiency 2a, as the GSP does not provide a numerical rate and extent of land subsidence that would be associated with significant and unreasonable impacts Subbasin-wide. Department staff have provided an explanation in the conclusion (see Conclusion and Recommended Corrective Action 2).

[38] Eastern San Joaquin 2022 GSP, Appendix 3-F, pp. 1629-1656.
[39] Eastern San Joaquin 2022 GSP, Appendix 3-F, p. 1631.
[40] Eastern San Joaquin 2022 GSP, Appendix 3-F, p. 1632.

Deficiency 2b requests that the GSP be revised to describe the correlation between groundwater levels and land subsidence, to show that the use of groundwater level minimum thresholds as a proxy for land subsidence are protective of the rates and extents of land subsidence considered significant and unreasonable. The GSP reiterates what was presented in the original GSP, stating that "there are no historical records of impacts from land subsidence in the Eastern San Joaquin Subbasin." Additionally, the GSP implies that minimum thresholds for groundwater levels will only allow for the dewatering of geologic units similar to those dewatered historically, which have shown no signs of subsidence historically.[41] Finally, the GSP describes that compressible clays that are prone to subsidence are "not known to be common" in the Subbasin, with the exception of the Corcoran Clay being present in a small are in the southwest corner of the Subbasin.[42] In this area of the Subbasin the top of the Corcoran Clay unit is located at an elevation of approximately -176 feet mean sea level (ft msl). The GSP states that the minimum threshold for representative monitoring well 02S07E31N001M in this area is set well above Corcoran Clay depth, at 1.5 ft msl; however, the GSP has also established a separate groundwater level trigger in this area of -150 ft msl, which is intended to alert the Agencies when the potential for subsidence would become a concern, prior to dewatering the Corcoran Clay.[43]

The GSP indicates that groundwater level minimum thresholds will still be used as a proxy for land subsidence; however, the GSP does not clarify what constitutes an undesirable result for land subsidence. Assuming an undesirable result for land subsidence is defined similarly to that for the chronic lowering of groundwater levels, Department staff recognize that with the removal of the water year type exclusion, the potential for continued Subbasin-wide groundwater level declines below the established minimum thresholds is lessened. However, because groundwater level minimum thresholds can be exceeded in up to four of 20 representative monitoring wells without being considered an indicator of potential undesirable results in the basin, there is the potential to dewater deep geologic units below minimum thresholds which were not evaluated in the GSP with regard to land subsidence. The GSP indicates that the correlation between groundwater levels and land subsidence will be further evaluated during GSP implementation by incorporating data such as continuous global positioning system (CGPS) data, and InSAR data, airborne electromagnetic data, as available, and that the representative monitoring well network or subsidence monitoring methods will be updated as needed.[44] While not precluding approval at this time, Department staff believe that the GSP does not provide sufficient evidence to support the use of groundwater levels as a proxy for land subsidence and have provided an explanation and recommended corrective action in the conclusion (see Conclusion and Recommended Corrective Action 2).

[41] Eastern San Joaquin 2022 GSP, Section 3.3.5.2, p. 313.
[42] Eastern San Joaquin 2022 GSP, Appendix 3-F, p. 1633.
[43] Eastern San Joaquin 2022 GSP, Appendix 3-F, p. 1633.
[44] Eastern San Joaquin 2022 GSP, Appendix 3-F, p. 1634.

Deficiency 2c asks that the GSP describe how the existing groundwater monitoring network is sufficient to detect significant and unreasonable land subsidence in relation to the identified infrastructure of concern. The revised GSP does not attempt to describe how the existing groundwater monitoring network is sufficient; rather, the GSP commits to evaluating other forms of land subsidence monitoring data, such as CGPS and InSAR data. The revised GSP also establishes a trigger value of 0.25 feet of annual land subsidence (based on available InSAR or CGPS data) which will initiate further evaluation to determine whether the subsidence is the result of groundwater management activities. Department staff note that the evaluation process related to determining the effect of groundwater management on subsidence is not described, though the GSP states that the results of the evaluation could potentially lead to additional projects or management actions.[45] Department staff believe that the GSP's incorporation of InSAR data to monitor for land subsidence is a step in the right direction but has provided a recommended corrective action in the conclusion (see Conclusion and Recommended Corrective Action 2).

4.2.3 Conclusion

Due to the lack of historical land subsidence in the Subbasin, and the likely minimal risk for land subsidence in the near-term, Department staff conclude that by adding the evaluation of direct subsidence monitoring data and annual trigger value of 0.25 feet, the Agencies' response to Deficiency 2 is sufficient at this time and does not preclude approval. However, Department staff also believe that the use of groundwater levels as a proxy for land subsidence sustainable management criteria and the use of the representative groundwater level monitoring network to identify undesirable results related to land subsidence to be poorly supported based on the information presented in the GSP. Department staff recommend the use of InSAR data for the land subsidence monitoring network, with supplemental groundwater level data being utilized to evaluate whether detected land subsidence is the result of declining groundwater levels and believe this should be addressed by the first periodic evaluation.

[45] Eastern San Joaquin 2022 GSP, Appendix 3-F, p. 1642.

5 PLAN EVALUATION

As stated in Section 355.4 of the GSP Regulations, a basin "shall be sustainably managed within 20 years of the applicable statutory deadline consistent with the objectives of the Act." The Department's assessment is based on a number of related factors including whether the elements of a GSP were developed in the manner required by the GSP Regulations, whether the GSP was developed using appropriate data and methodologies and whether its conclusions are scientifically reasonable, and whether the GSP, through the implementation of clearly defined and technically feasible projects and management actions, is likely to achieve a tenable sustainability goal for the basin.

The Department staff's evaluation of the likelihood of the Plan to attain the sustainability goal for the Basin is provided below. Department staff consider the information presented in the Plan to satisfy the general requirements of the GSP Regulations.

5.1 ADMINISTRATIVE INFORMATION

The GSP Regulations require each Plan to include administrative information identifying the submitting Agency, describing the plan area, and demonstrating the legal authority and ability of the submitting Agency to develop and implement a Plan for that area.[46]

The GSP was developed by the Eastern San Joaquin Groundwater Authority (ESJGWA), a joint powers authority comprised of 16 individual GSAs in the Subbasin. Each GSA has two appointed representatives on the ESJGWA Board of Directors (Board) - one Board member and one alternate member. The GSP describes that GSP implementation will be conducted though the ESJGWA as the coordinating agency, and that the GSP covers the entire geographic extent of the Subbasin. Decisions regarding Subbasin-wide GSP implementation are generally approved by a majority vote of the 16 Board members; however, a two-thirds supermajority is needed for certain items such as approval of the annual budget, levying of taxes or fees, decisions on curtailment of pumping, and adoption of new rules that govern the ESJGWA.[47] The GSP provides a brief description of each GSA, and also describes the legal authorities of the GSAs and the ESJGWA.[48] In addition to the ESJGWA Board, the GSP describes that an Advisory Committee, made up of one member from each GSA, provides guidance to the Board regarding development of the GSP including groundwater conditions, sustainable management criteria, and projects and management actions.[49] The Subbasin also has a Groundwater Sustainability Workgroup (Workgroup) which also provides input to the Board. The

[46] 23 CCR § 354.2 *et seq*.
[47] Eastern San Joaquin 2022 GSP, Section 1.1.4.2, pp. 43-44.
[48] Eastern San Joaquin 2022 GSP, Section 1.1.4.3, pp. 44-48 and Section 1.1.4.4, p. 48.
[49] Eastern San Joaquin 2022 GSP, Section 1.1.4.2, p. 43.

Workgroup is described by the GSP as being comprised of 23 community members that represent a diverse range of stakeholders in the community.[50]

The GSP describes that the Subbasin encompasses approximately 1,195 square miles and is part of the larger San Joaquin Valley Groundwater Basin. The GSP states that the Plan Area covers the entire Subbasin. The Subbasin is generally bound by Dry Creek on the north, the San Joaquin River on the west, the crystalline bedrock of the Sierra Nevada foothills on the east, and either the San Joaquin County line or the Stanislaus River on the south.[51] Adjacent subbasins include the Consumnes, Solano, and South American to the north, East Contra Costa and Tracy to the west, and the Delta Mendota and Modesto to the south. A map showing the Subbasin and adjacent subbasins is shown in Figure 1 below.

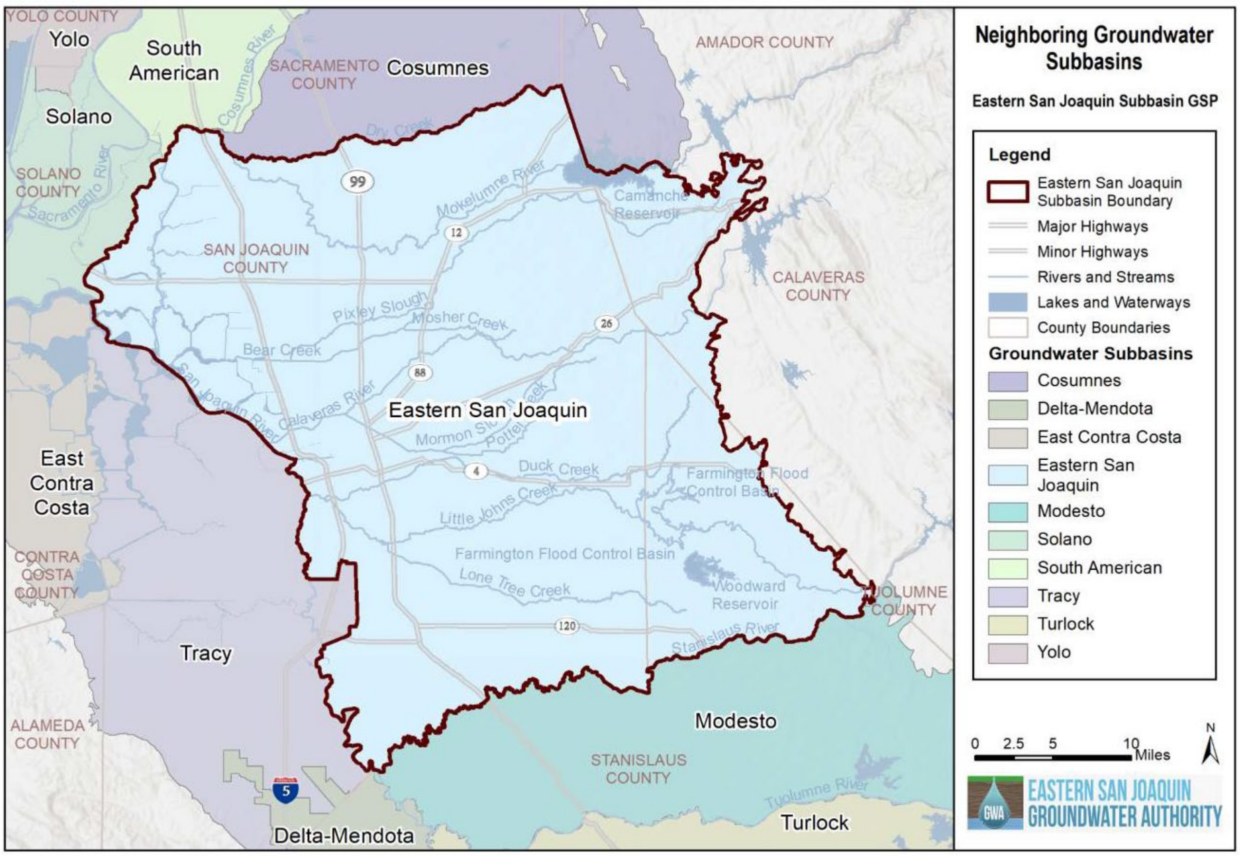

Figure 1. Eastern San Joaquin Subbasin Location Map

The GSP provides various figures displaying jurisdictional boundaries in the Subbasin, including GSAs, Cities, Counties, Federal and State lands, and disadvantaged communities (DACs). The GSP also includes maps and descriptions of land use characteristics including general land use types, crop types, and well density maps for

[50] Eastern San Joaquin 2022 GSP, Section 1.1.4.2, pp. 43-44.
[51] Eastern San Joaquin 2022 GSP, Section 1.2.1.1, pp. 49-53.

domestic, agricultural, and public wells.[52] The GSP describes that the majority of land use in the Subbasin is for agriculture, with the dominant crop types being fruit and nut trees and vine crops.[53]

The GSP lists the general categories of the beneficial uses and users of groundwater in the Subbasin as being consistent with those identified in Water Code §10723.2. Of these general categories, the GSP identifies specific local agencies, DACs, and community water systems that are considered beneficial users in the Subbasin.[54] Environmental users, such as groundwater dependent ecosystems (GDEs) and freshwater species reliant on instream flows are also identified (where data was available).[55] The GSP provides a list of public meetings held during GSP development to obtain input from stakeholders and the community, and also describes additional outreach efforts, such as a website, a stakeholder database, a situation assessment conducted through the Department Facilitation Support Services, and a Stakeholder Outreach and Engagement Plan.[56] Additionally, the GSP describes that the draft GSP was available for a 45-day public comment period (prior to submission to the Department). Public comments received for the GSP and responses to those comments are included as appendices.[57]

The GSP's discussion and presentation of administrative information covers the specific items listed in the GSP Regulations in an understandable format using appropriate data. Staff are aware of no significant inconsistencies or contrary information to that presented in the GSP and therefore have no significant concerns regarding the quality, data, and discussion of this subject in the GSP. The administrative information included in the Plan substantially complies with the requirements outlined in the GSP Regulations.

5.2 Basin Setting

GSP Regulations require information about the physical setting and characteristics of the basin and current conditions of the basin, including a hydrogeologic conceptual model; a description of historical and current groundwater conditions; and a water budget accounting for total annual volume of groundwater and surface water entering and leaving the basin, including historical, current, and projected water budget conditions.[58]

5.2.1 Hydrogeologic Conceptual Model

The GSP Regulations require a descriptive hydrogeologic conceptual model of the basin that includes a written description supported by cross sections and maps.[59] The hydrogeologic conceptual model is a non-numerical model of the physical setting,

[52] Eastern San Joaquin 2022 GSP, Section 1.2.1.1, pp. 52-61.
[53] Eastern San Joaquin 2022 GSP, Section 1.2.1.1, p. 55.
[54] Eastern San Joaquin 2022 GSP, Section 1.3.1, pp. 80-81 and Appendix 1-F, pp. 534-548.
[55] Eastern San Joaquin 2022 GSP, Section 1.3.1, pp. 80, Figure 2-73, p. 209, Appendix 1-G, pp. 550-569.
[56] Eastern San Joaquin 2022 GSP, Section 1.3, pp. 81-92.
[57] Eastern San Joaquin 2022 GSP, Appendix 1-I, pp. 588-944 and Appendix 1-J, pp. 946-992.
[58] 23 CCR § 354.12 *et seq*.
[59] 23 CCR § 354.12 *et seq*.

characteristics, and processes that govern groundwater occurrence within a basin, and represents a GSA's understanding of the geology and hydrology of the basin that support the geologic assumptions used in developing mathematical models, such as those that allow for quantification of the water budget.[60]

The hydrogeologic conceptual model presented in the GSP describes the physical components of the Subbasin and provides a general understanding for how the components relate to the groundwater system and the interaction between surface water and groundwater. The GSP provides maps and descriptions of surficial features including topography, major surface water features, watersheds, soil types, depositional environments, and recharge and discharge areas.[61] The GSP indicates that the Subbasin does not rely on imported surface water and that water for the Subbasin is supplied by either groundwater or local surface water.[62] The GSP describes the regional and local geologic setting, with supporting figures such as a block diagram, geologic map, and five geologic cross-sections. Geologic formations underlying the Subbasin are also identified and described.[63]

The GSP describes that the Subbasin is part of the larger San Joaquin Valley groundwater basin and the lateral boundaries of the Subbasin generally consist of the crystalline bedrock of the Sierra Nevada foothills to the east, Dry Creek to the north, the Mokelumne River to the northwest, the San Joaquin River to the west, and the Stanislaus River to the south.[64] The bottom of the Subbasin is defined as the base of freshwater, which represents the approximate maximum extent of non-saline freshwater beneath the Subbasin. The base of freshwater in the Subbasin varies from approximately 650 to 2,000 feet below ground surface.[65] The GSP identifies three major structural features in the Subbasin: the Stockton Fault, the Vernalis Fault, and the Stockton Arch. The GSP does not indicate whether these structures have any effect on the flow of groundwater; however, based on when they are estimated to have occurred, it appears that the freshwater bearing units were generally deposited during later time periods.[66]

The GSP identifies one principal aquifer that provides groundwater for domestic, agricultural, and municipal supply.[67] The GSP indicates that there are no regionally extensive aquitards in the Subbasin, except for a small area in the southwest portion of

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[60] Department of Water Resources Best Management Practices for the Sustainable Management of Groundwater: Hydrogeologic Conceptual Model, December 2016: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Groundwater-Management/Sustainable-Groundwater-Management/Best-Management-Practices-and-Guidance-Documents/Files/BMP-3-Hydrogeologic-Conceptual-Model_ay_19.pdf.
[61] Eastern San Joaquin 2022 GSP, Section 2.1.4, pp. 109-123.
[62] Eastern San Joaquin 2022 GSP, Section 2.1.4.4, p. 119.
[63] Eastern San Joaquin 2022 GSP, Section 2.1.2, p. 108, Section 2.1.3, p. 109, Section 2.1.5, pp. 123-130, Section 2.1.7, pp. 134-139.
[64] Eastern San Joaquin 2022 GSP, Section 2.1.8, pp. 141-142.
[65] Eastern San Joaquin 2022 GSP, Section 2.1.8.2, p. 142.
[66] Eastern San Joaquin 2022 GSP, Section 2.1.6, p. 131.
[67] Eastern San Joaquin 2022 GSP, Section 2.1.9, p. 142.

the Subbasin that contains the Corcoran Clay. The GSP describes that, in general, the principal aquifer is comprised of laterally extensive and interbedded layers of high and low permeability deposits, and there is evidence to support a hydraulic connection for the entire vertical extent of the aquifer.[68] While only one principal aquifer was defined, the GSP differentiates between shallow, intermediate, and deep water-bearing zones. The shallow zone is comprised of recent alluvium, the Modesto formation, the Riverbank formation, and the upper unit of the Turlock Lake formation. The intermediate zone is comprised of the lower unit of the Turlock Lake formation and the Laguna formation. The deep zone consists of the Mehrten formation. Depths and thicknesses of the geologic formations (and associated aquifer zones) can be visualized on the provided cross sections. The GSP presents estimates of transmissivity, specific yield or storage coefficient, and vertical permeability for each water-bearing zone.[69]

Regarding data gaps and uncertainties associated with the hydrogeological conceptual model, the GSP identified the following: aquifer characteristics (such as hydraulic conductivity, transmissivity, and storage parameters); depth-specific groundwater level data; shallow groundwater level data near surface waters and NCCAGs; groundwater level data in the east and northwest areas of the Subbasin; groundwater level data near major creeks, rivers, and subbasin boundaries to evaluate subsurface flow and groundwater-surface water interaction; depth-specific groundwater quality data, the effect of the Stockton Fault on base of freshwater; and characterization of soil conditions related to recharge.[70] While these data gaps related to the hydrogeologic conceptual model are identified, the GSP provides little details on addressing some of the identified data gaps. The proposed plans to fill data gaps mainly focus on collecting additional groundwater level and groundwater quality data from existing or newly constructed wells during the implementation period and updating or refining the numerical model;[71] however, the GSP does not describe plans for addressing data gaps related to aquifer parameters, soil recharge areas, or the effects of the Stockton Fault on groundwater conditions.

While the GSP does not provide plans to address every data gap identified, overall, the information provided in the GSP that comprises the hydrogeologic conceptual model substantially complies with the requirements outlined in the GSP Regulations. In general, the Plan’s descriptions of the regional geologic setting, the Subbasin’s physical characteristics, the principal aquifer, and hydrogeologic conceptual model appear to utilize the best available science. Department staff are aware of no significant inconsistencies or contrary technical information to that presented in the Plan.

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[68] Eastern San Joaquin 2022 GSP, Section 2.1.9.1.4, p. 146.
[69] Eastern San Joaquin 2022 GSP, Section 2.1.9.1, pp. 142-145.
[70] Eastern San Joaquin 2022 GSP, Section 2.1.10, pp. 159-160.
[71] Eastern San Joaquin 2022 GSP, Section 4.7.5, pp. 330-332.

5.2.2 Groundwater Conditions

The GSP Regulations require a written description of historical and current groundwater conditions for each of the six sustainability indicators and GDEs.[72]

The GSP provides a description of current and historical groundwater level conditions in the Subbasin, and presents supporting documentation in the form of hydrographs, contour maps, and references to historical reports. The GSP describes that, in general, groundwater levels in the Subbasin have shown declining trends throughout much of their period of record. The GSP presents a figure that displays ten hydrographs with at least 40 years of historical data located throughout the Subbasin.[73] Based on the figure, groundwater levels across the Subbasin have generally displayed steady groundwater level declines, with major fluctuations (increases and decreases) generally corresponding to prolonged or extreme wet or dry periods, such as the 1982 to 1984 wet and above normal water years or early 1990s drought period. The GSP describes that, based on information from historical reports, the Subbasin historically had a westerly groundwater flow direction that parallels topography; however, groundwater elevation maps from the 1950s and 1960s displayed a groundwater depression near the City of Stockton that resulted in groundwater flowing east toward the City of Stockton from the Delta.[74] The GSP presents groundwater elevation contour maps based on first quarter 2017 and fourth quarter 2017 data to display current groundwater conditions.[75] Based on these figures, there is currently a large groundwater depression in the middle of the Subbasin, east of the City of Stockton. The GSP notes that this depression is “most significant to achieving sustainability in the Subbasin” (as compared to the groundwater depression in the north originating in the adjacent Consumnes Subbasin). Due to this central groundwater depression, current groundwater flow conditions are generally from the outer edges of the Subbasin towards the center.[76]

Groundwater storage conditions in the Subbasin were estimated using the Eastern San Joaquin Water Resources Model (ESJWRM), which is a numerical model for the Eastern San Joaquin Subbasin based on the Department’s Integrated Water Flow Model (IWFM).[77] The GSP describes that historical changes in groundwater storage were estimated from 1996 to 2015, with a total cumulative change in storage of -0.91 million acre-feet (MAF) during that time period, and an average annual change in storage of -0.05 MAF. Current (2015) fresh (non-saline) groundwater in storage for the Subbasin is estimated to be 53.0 MAF.[78]

[72] 23 CCR § 354.16 (a-f).
[73] Eastern San Joaquin 2022 GSP, Figure 2-34, p. 163.
[74] Eastern San Joaquin 2022 GSP, Section 2.2.1.1, pp. 166-167.
[75] Eastern San Joaquin 2022 GSP, Figure 2-37, p. 168 and Figure 2-38, p. 169.
[76] Eastern San Joaquin 2022 GSP, Section 2.2.1.2, p. 167.
[77] Eastern San Joaquin 2022 GSP, Section 2.2.2, p. 180 and Section 2.3.1, p. 215.
[78] Eastern San Joaquin 2022 GSP, Section 2.2.2, p. 180.

Regarding seawater intrusion, the GSP states that "the Eastern San Joaquin Subbasin is not in a coastal area and seawater intrusion is not present."[79] The GSP acknowledges that under natural conditions brackish tidal water from San Francisco Bay could be brought into the Delta; however, the GSP describes that man-made infrastructure, including the construction of levees and the development of the State Water Project and Central Valley Project, has altered the inward movement of seawater and current management practices aim to maintain freshwater flows in the Delta. While the GSP does not consider seawater intrusion a current concern, salinity is identified as a potential groundwater quality issue and is discussed in the GSP's description of groundwater quality conditions.[80]

The GSP describes that groundwater quality in the Subbasin is generally sufficient for beneficial uses. The GSP identifies salinity, nitrate, arsenic, and point-source pollutants as the main constituents of concern in the Subbasin.[81] Current and historical groundwater quality conditions are evaluated using data from the Groundwater Ambient Monitoring and Assessment (GAMA) Program. Data from the GAMA Program was used to create maps displaying maximum contaminant level (MCL) and SMCL exceedances for salinity, nitrate, and arsenic, grouped by decade. GAMA data was also summarized into tables for each constituent. The GSP uses chloride and total dissolved solids (TDS) data to evaluate salinity in the Subbasin. In general, chloride and TDS exceedances, above their 250 milligram per liter (mg/L) and 500 mg/L SMCLs, respectively, have occurred mainly along the western margin of the Subbasin both historically and in more recent times.[82] Based on data presented in the GSP, the percentage of nitrate and arsenic concentrations detected above their 10 mg/L and 10 microgram per liter MCLs, respectively, has generally increased over time.[83] The GSP does not present any intra-well time series data, so it is unclear whether the changes in the percentage of MCL or SMCL exceedances for salinity, nitrate, or arsenic indicate notable changes in groundwater quality, or whether increased sampling frequency and sampling locations are only identifying areas where groundwater quality exceedances have already been occurring. The GSP describes the presence of various point source pollutants and contaminant plumes in the Subbasin. The GSP notes that these constituents and active sites are generally regulated by the Central Valley Regional Water Quality Control Board (RWQCB), the Department of Toxic Substances Control (DTSC), and the United States Environmental Protection Agency (USEPA).[84] While historical GAMA data for groundwater quality is available and utilized by the GSP, much of the available data lacks well construction information and the GSP identifies depth-discrete groundwater quality data as a data gap.

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[79] Eastern San Joaquin 2022 GSP, Section 2.2.3, p. 182.
[80] Eastern San Joaquin 2022 GSP, Section 2.2.3, p. 182.
[81] Eastern San Joaquin 2022 GSP, Section 2.2.4, p. 182.
[82] Eastern San Joaquin 2022 GSP, Section 2.2.4.1, pp. 182-192.
[83] Eastern San Joaquin 2022 GSP, Section 2.2.4.2, pp. 193-195 and Section 2.2.4.3, pp. 196-198.
[84] Eastern San Joaquin 2022 GSP, Section 2.2.4.4, pp. 199-203.

The GSP presents a minimal discussion on historical and current land subsidence, stating that "there are no historical records of significant and unreasonable impacts from land subsidence in the Eastern San Joaquin Subbasin."[85] In the evaluation of current subsidence, the GSP presents a figure displaying the subsidence data from the Department's InSAR dataset, which displays no areas of land subsidence in the Subbasin between spring 2015 and summer 2017.[86]

The GSP identifies depletions of interconnected surface water in the Subbasin as a data gap. Due to the lack of available data, historical and current depletions of interconnected surface water were evaluated using the historical calibration scenario of the ESJWRM. The GSP describes that the ESJWRM was used to compare monthly groundwater levels to streambed elevations to determine where streams are interconnected.[87] The GSP presents two figures summarizing the model result. Figure 2-71 displays where streams are estimated to be interconnected at least 75 percent of the time or interconnected less than 25 percent of the time.[88] Figure 2-72 displays where streams were generally considered to be gaining (groundwater discharging to stream greater than 75 percent of the time), losing (surface water seeping into groundwater system more than 75 percent of the time), or mixed (gaining or losing less than 75 percent of the time).[89] The GSP does not describe the historical or current volume, rate, or timing of depletions; however, the historical, current, and projected water budgets presented in the GSP provide estimated average annual volumes of depletions (stream seepage) for the major rivers and streams in the Subbasin.[90]

The GSP describes the process used to identify GDEs in the Subbasin and provides multiple figures displaying the locations of GDEs or potential GDEs. The GSP describes that the NCCAG dataset was used as the starting point to identify GDEs. This dataset was then filtered based on groundwater levels and proximity to surface waters. NCCAGs in areas with groundwater levels greater than 30 feet below ground surface were not considered GDEs, as groundwater levels of that depth are considered too deep to be accessed by the vegetation. NCCAGs in close proximity to alternate water sources (including managed wetlands, irrigated agriculture, and perennial surface water bodies) were not considered GDEs, as these communities potentially rely on the alternate water sources rather than groundwater. The GSP notes that, while these NCCAG areas are not considered GDEs initially, additional investigation and ground-truthing of these areas is needed, thus, they have been classified as areas "data gap areas needing future refinement" and could potentially be included as GDEs in the future.[91] Figure 2-74

[85] Eastern San Joaquin 2022 GSP, Section 2.2.5, p. 203.
[86] Eastern San Joaquin 2022 GSP, Figure 2-70, p. 204.
[87] Eastern San Joaquin 2022 GSP, Section 2.2.6, p. 204.
[88] Eastern San Joaquin 2022 GSP, Figure 2-71, p. 206.
[89] Eastern San Joaquin 2022 GSP, Figure 2-72, p. 207.
[90] Eastern San Joaquin 2022 GSP, Table 2-13, p. 226.
[91] Eastern San Joaquin 2022 GSP, Section 2.2.7, pp. 208-211.

displays these GDE data gap areas, and Figure 2-75 displays areas presently considered to be GDEs.[92]

Overall, the Plan sufficiently describes the historical and current groundwater conditions throughout the Subbasin, and the information included in the Plan substantially complies with the requirements outlined in the GSP Regulations.

5.2.3 Water Budget

GSP Regulations require a water budget for the basin that provides an accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the basin, including historical, current, and projected water budget conditions, and the change in the volume of water stored, as applicable.[93]

The water budgets and sustainable yield estimate presented in the GSP were developed using the ESJWRM, a numerical surface water-groundwater model based on the Department's IWFM framework.[94] The GSP presents historical, current, and projected water budgets, and also a water budget for projected conditions under climate change. The historical water budget represents a 20-year period from 1996 to 2015 based on the best available historical data. The current water budget represents the current level of development (based on 2015 urban development footprint), agricultural water demand (based on 2014 cropping patterns), urban water demand (based on 2015 population), and water supply sources (based on average water supply sources from 2012 to 2015) over a 50-year hydrologic period (based on data from 1969 to 2018). The projected water budget is based on the projected changes in population, land use, and water use (not considering projects proposed by the GSP) over a 50-year hydrologic period.[95] The GSP describes the assumptions used for these water budgets and presents the water budget estimates in various tables and charts.[96]

In response to the incomplete determination,[97] the revised GSP provided updated water budget estimates (based on the revised ESJWRM Version 2.0 update) that extended the historical calibration scenario to 25 years, representing the time period from 1996 to 2020, and the projected conditions scenarios to 52 years.[98] Additionally, the revised GSP included an analysis on the effects of implementing 11 "Category A" projects, with and without climate change, on groundwater conditions in the Subbasin and included updated water budget estimates.[99] Based on the water budgets presented in the GSP, the Subbasin is projected to use less groundwater compared to the current groundwater demand, mainly due to the projected expansion of urban land development reducing the

[92] Eastern San Joaquin 2022 GSP, Figure 2-74, p. 212 and Figure 2-75, p. 214.
[93] 23 CCR § 354.18 *et seq*.
[94] Eastern San Joaquin 2022 GSP, Section 2.3.1, p. 215.
[95] Eastern San Joaquin 2022 GSP, Table 2-12, p. 218.
[96] Eastern San Joaquin 2022 GSP, Section 2.3.4, pp. 218-223, Section 2.3.5, pp. 223-248.
[97] https://sgma.water.ca.gov/portal/service/gspdocument/download/7777.
[98] Eastern San Joaquin 2022 GSP, Table 2-16, p. 232, Table 2-17, p. 234, Table 2-18, p. 236.
[99] Eastern San Joaquin 2022 GSP, Appendix 2-B, pp. 1390-1562.

amount of irrigated agriculture.[100] Additionally, the implementation of Category A projects is projected to result in an average annual surplus of groundwater in storage when climate change is not considered; however, with climate change considered an overdraft of 15,700 acre-feet per year is still expected even with the implementation of Category A projects.[101] Selected water budget components are summarized in Table 1 below.

Table 1. Selected Water Budget Estimates[102]

Modeling Scenario	Historical	Current	Projected	Projected with Climate Change	Projected with Category A Projects	Projected with Category A Projects and Climate Change
Model Version	ESJWRM V2	ESJWRM V1	ESJWRM V2	ESJWRM V2	ESJWRM V2	ESJWRM V2
Hydrologic Period	1996-2020	1969-2018	1969-2020	1969-2020	1969-2020	1969-2020
Groundwater Pumping, AFY	709,000	851,000	751,000	833,000	712,900	794,100
Change in GW Storage, AFY	-37,000	-48,000	-16,000	-38,000	5,300	-15,700

The sustainable yield for the Subbasin was estimated using the ESJWRM under conditions describes as the "Sustainable Conditions Scenario." This modeling scenario was based on the projected conditions scenario and was developed by adjusting (reducing) groundwater pumping across the model domain until the 50-year annual average change in groundwater storage was close to or equal to zero.[103] Based on this modeling scenario, the sustainable yield for the Subbasin was estimated to be 715,000 ± 10 percent. The GSP indicates that climate change was not considered in the sustainable yield estimate. Additionally, the GSP notes that while the projected conditions scenario indicates an overdraft of only 34,000 acre-feet per year (based on the ESJWRM Version 1.0), to reach the sustainable yield approximately 78,000 acre-feet per year of additional recharge or reduced groundwater pumping would be needed.[104] Based on the information presented in the GSP, it is unclear if the sustainable yield and the estimated 78,000 acre-feet per year offset are based on the updated modeling from the ESJWRM Version 1.0 or the updated ESJWRM Version 2.0.

The GSP presents various modeling results to estimate the water budgets and sustainable yield for the Subbasin (multiple scenarios from both ESJWRM Version 1.0 and ESJWRM Version 2.0). Department staff recommend that in the first periodic evaluation of the GSP, only water budgets developed from the most recent or best available data be included. As currently presented, it is unclear whether the sustainable yield estimate and estimated groundwater offset required to achieve sustainability are based on the updated modeling results (based on ESJWRM Version 2.0) or are from the

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[100] Eastern San Joaquin 2022 GSP, Section 2.3.5.3, p. 245.
[101] Eastern San Joaquin 2022 GSP, Section 2.3.7.6.2, p. 276, Section 2.3.7.7.2, pp. 280-281.
[102] Eastern San Joaquin 2022 GSP, Section 2.3.5, pp. 223-237, Section 2.3.7.6.2, p. 276, Section 2.3.7.7.2, pp. 280-281.
[103] Eastern San Joaquin 2022 GSP, Section 2.3.6, pp. 248-249.
[104] Eastern San Joaquin 2022 GSP, Section 2.3.6, p. 249.

modeling scenarios presented in the original GSP submitted in 2020 (based on ESJWRM Version 1.0) (see Recommended Corrective Action 3).

Aside from the additional clarification requested in Recommended Corrective Action 3, Department staff conclude the historical, current, and projected water budgets included in the Plan substantially comply with the requirements outlined in the GSP Regulations. The GSP provides the required historical, current, and future accounting and assessment of the total annual volume of groundwater and surface water entering and leaving the Subbasin including an estimate of the sustainable yield of the Subbasin and projected future water demands.

5.2.4 Management Areas

The GSP Regulations provide the option for one or more management areas to be defined within a basin if the GSA has determined that the creation of the management areas will facilitate implementation of the Plan. Management areas may define different minimum thresholds and be operated to different measurable objectives, provided that undesirable results are defined consistently throughout the basin.[105]

The GSP does not designate any management areas in the Subbasin.

5.3 Sustainable Management Criteria

The GSP Regulations require each Plan to include a sustainability goal for the basin and to characterize and establish undesirable results, minimum thresholds, and measurable objectives for each applicable sustainability indicator, as appropriate. The GSP Regulations require each Plan to define conditions that constitute sustainable groundwater management for the basin including the process by which the GSA characterizes undesirable results and establishes minimum thresholds and measurable objectives for each applicable sustainability indicator.[106]

5.3.1 Sustainability Goal

The GSP describes that the sustainability goal for the Subbasin is "to maintain an economically-viable groundwater resource for the beneficial use of the people of the Eastern San Joaquin Subbasin by operating the Subbasin within its sustainable yield or by modification of existing management to address future conditions."[107] The GSP states that sustainability will be achieved through the implementation of both supply and demand type projects. While the GSP acknowledges that groundwater levels may continue to decline throughout GSP implementation, the GSP also states that the Subbasin will be managed to avoid undesirable results during the implementation period.[108]

[105] 23 CCR § 354.20.
[106] 23 CCR § 354.22 *et seq.*
[107] Eastern San Joaquin 2022 GSP, Section 3.1, p. 287.
[108] Eastern San Joaquin 2022 GSP, Section 3.1, p. 287.

5.3.2 Sustainability Indicators

Sustainability indicators are defined as any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results.[109] Sustainability indicators thus correspond with the six undesirable results – chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon, significant and unreasonable reduction of groundwater storage, significant and unreasonable seawater intrusion, significant and unreasonable degraded water quality, including the migration of contaminant plumes that impair water supplies, land subsidence that substantially interferes with surface land uses, and depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water[110] – but refer to groundwater conditions that are not, in and of themselves, significant and unreasonable. Rather, sustainability indicators refer to the effects caused by changing groundwater conditions that are monitored, and for which criteria in the form of minimum thresholds are established by the agency to define when the effect becomes significant and unreasonable, producing an undesirable result.

The following subsections include details about three facets of sustainable management criteria: undesirable results, minimum thresholds, and measurable objectives for each sustainability indicator. GSAs are not required to establish criteria for undesirable results that the agency can demonstrate are not present and are not likely to occur in a basin.[111]

5.3.2.1 Chronic Lowering of Groundwater Levels

The GSP Regulations require the minimum threshold for chronic lowering of groundwater levels to be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results.[112]

The GSP describes that an undesirable result for the chronic lowering of groundwater levels in the Eastern San Joaquin Subbasin is experienced "if sustained groundwater levels are too low to satisfy beneficial uses within the Subbasin over the planning and implementation horizon of this GSP." The GSP also lists potential undesirable results identified by stakeholders as significant and unreasonable:

- Number of wells going dry
- Reduction in the pumping capacity of existing wells
- Increase in pumping costs due to greater lift
- Need for deeper well installations or lowering of pumps

[109] 23 CCR § 351(ah).
[110] Water Code § 10721(x).
[111] 23 CCR § 354.26(d).
[112] 23 CCR § 354.28(c)(1).

- Adverse impacts to environmental uses and users, including interconnected surface waters and GDEs[113]

The GSP describes a quantitative identification of undesirable results for the chronic lowering of groundwater levels as occurring when "at least 25 percent of representative monitoring wells used to monitor groundwater levels (5 of 20 wells in the Subbasin) fall below their minimum level thresholds for two consecutive years."[114] These conditions were described by the GSP as being sufficient to identify a Subbasin-wide pattern of undesirable results, rather than either geographically-localized conditions or temporally isolated events.[115]

Minimum thresholds for the chronic lowering of groundwater levels were established for 20 representative monitoring wells.[116] The GSP describes the process for developing minimum thresholds, which included reviewing historic groundwater levels and existing groundwater-related planning documents, an analysis of nearby domestic or municipal supply well depths, and obtaining input from GSAs, the ESJGWA Advisory Committee, the ESJGWA Workgroup, and other stakeholders. To develop the minimum thresholds, the fall 1992 groundwater levels were first selected, as this period was identified in existing planning documents as a time of historic lows. The fall 1992 groundwater levels were then compared to both fall 2015 and fall 2016 groundwater levels to see whether groundwater levels declined even further during more recent drought periods. The GSAs then confirmed, either anecdotally or through an evaluation of available data, that no undesirable results occurred when groundwater levels were at their historic low values (whichever was deeper of the fall 1992 or fall 2015-2016 periods). Using these historic low groundwater levels as a starting point, a buffer was then added which would allow the groundwater levels to drop below historic low values while allowing operational flexibility. The buffer was developed by calculating the historic range of groundwater level fluctuations for each representative well (the historic high minus the historic low) and subtracting this value from the historic low. These calculated values (the historic low minus the buffer) were presented as the initial minimum threshold values.[117]

The GSP describes that the protection of existing water supply wells was considered a priority when developing the minimum thresholds, so the initial minimum threshold values were then compared to the 10th percentile of domestic well depth for domestic wells (with well construction information in the OSWCR database) within a 3-mile radius of each representative monitoring well.[118] For areas reliant on municipal supply wells, the 10th percentile of municipal supply well depth was used for the analysis. For each representative monitoring well, if the initial minimum threshold value (historic low minus buffer) was shallower than the 10th percentile well depth value, it was considered

113 Eastern San Joaquin 2022 GSP, Section 3.3.1.1.1, pp. 289-290.
114 Eastern San Joaquin 2022 GSP, Section 3.3.1.1.2, p. 290.
115 Eastern San Joaquin 2022 GSP, Section 3.3.1.1.2, p. 290.
116 Eastern San Joaquin 2022 GSP, Table 3-1, p. 296.
117 Eastern San Joaquin 2022 GSP, Section 3.3.1.2, pp. 291-293.
118 Eastern San Joaquin 2022 GSP, Section 3.3.1.2, p. 292.

sufficiently protective of nearby supply wells (domestic or municipal). If the initial minimum threshold value was deeper than the 10th percentile well depth value, then the 10th percentile well depth value was used for the minimum threshold. Overall, the GSP estimates that this analysis should be protective of approximately 90 percent of domestic or municipal wells in the Subbasin.[119] The GSP presents a summary table of the data used for the minimum threshold analysis, which indicates that the final minimum thresholds selected for the 20 representative monitoring wells range from 22.5 to 242.7 feet below ground surface, and the potential groundwater level declines below historic lows range from 7.3 to 54.4 feet.[120] The GSP describes that the final minimum threshold values, even though they allow for groundwater levels declines below historic lows, were considered to be sufficiently protective of undesirable results by the individual GSAs; however, the GSP notes that undesirable results related to GDEs is considered a data gap.[121] Additionally, the GSP describes that an adaptive management approach will be utilized, and if the established minimum thresholds result in impacts to groundwater users during implementation, minimum threshold may be revised, or additional projects or management actions may be implemented.[122]

The GSP defines the measurable objectives for the Subbasin as the deeper value of the fall 1992, fall 2015, or fall 2016 groundwater levels for each representative monitoring well. The GSP describes that these values were selected to allow for operational flexibility and active management of the Subbasin during dry periods without reaching minimum threshold values.[123] The GSP indicates that GSAs identified no undesirable results when historic groundwater levels were at these measurable objective values.[124] Interim milestones presented in the GSP represent stepwise trends from the current conditions (defined as fall 2015 groundwater levels) to the measurable objective, designated in five-year intervals from 2030 to 2040. The GSP indicates that the interim milestones remain the same as current conditions for the first 10 years of GSP implementation. In general, measurable objectives allow for declining groundwater levels compared to current conditions; however, because the current conditions are represented by fall 2015 data and some measurable objectives are also based on fall 2015 data, some representative monitoring wells are already at their measurable objective and, thus, have a goal of keeping groundwater levels at those locations stable through the implementation period. The GSP presents a summary table with current conditions, measurable objectives, and interim milestones for each representative monitoring well.[125]

Department staff conclude that the sustainable management criteria for the chronic lowering of groundwater levels are commensurate with the understanding of current conditions and reasonably protective of the groundwater uses and users in the Subbasin.

[119] Eastern San Joaquin 2022 GSP, Section 3.3.1.2, p. 293.
[120] Eastern San Joaquin 2022 GSP, Appendix 3-A, p. 1564.
[121] Eastern San Joaquin 2022 GSP, Section 3.3.1.1.4, p. 291 and Section 3.3.1.2, p. 292.
[122] Eastern San Joaquin 2022 GSP, Section 3.3.1.2, pp. 293-294.
[123] Eastern San Joaquin 2022 GSP, Section 3.3.1.3, p. 297.
[124] Eastern San Joaquin 2022 GSP, Section 3.3.1.2, p. 292.
[125] Eastern San Joaquin 2022 GSP, Table 3-3, p. 298.

While groundwater levels may continue to decline during implementation, the Plan provides a credible and sufficient assessment of the impacts the minimum thresholds would have on domestic and municipal supply wells by evaluating the 10th percentile well depths and comparing that to the initial minimum threshold values (based on the historic lows with a buffer) to establish the minimum thresholds at individual representative monitoring points which, if not exceeded, are protective of approximately 90-percent of domestic or municipal wells in the Subbasin. However, as highlighted in the recommended corrective actions described in the review of Deficiency 1, the GSP should include some additional supporting technical details that provide further description potential impacts related to the defined minimum thresholds.

5.3.2.2 Reduction of Groundwater Storage

The GSP Regulations require the minimum threshold for the reduction of groundwater storage to be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.[126]

The GSP describes that an undesirable result for the reduction of groundwater storage occurs when "sustained groundwater storage volumes are insufficient to satisfy beneficial uses within the Subbasin over the planning and implementation horizon of this GSP."[127] The GSP describes how the Subbasin contains approximately 53 MAF of fresh groundwater in the aquifer, and historically there have been no undesirable results related to the reduction of groundwater storage. The GSP estimates a total volume of 23 MAF which, if depleted, would result in undesirable results for the Subbasin. This volume was estimated based on the depths of existing well infrastructure and potential future depths to which pumping would reasonably occur.[128] The GSP indicates that a reduction of groundwater in storage of this magnitude is highly unlikely during the implementation period, as modeling results only estimate a -0.91 MAF cumulative change in storage from 1996 to 2015.[129] While it may be unlikely to reduce groundwater in storage by 23 MAF before projects are implemented and sustainability is achieved, Department staff believe this estimate to be misleading, as there would likely be significant and unreasonable impacts prior to reaching a depletion of 23 MAF. For example, the GSP appears to be implying that a reduction of less than 23 MAF (e.g., 22 MAF) would not result in significant and unreasonable impacts to shallow groundwater users. While it is understandable that groundwater level sustainable management criteria will likely prevent reductions of groundwater in storage of this magnitude, Department staff feel that the estimate provided by the GSP is unreasonable and misleading regarding impacts to beneficial uses and users and should be revised. Department staff recommend the GSP provide a revised

[126] 23 CCR § 354.28(c)(2).
[127] Eastern San Joaquin 2022 GSP, Section 3.3.2.1.1, p. 299.
[128] Eastern San Joaquin 2022 GSP, Section 3.3.2.1.2, p. 299.
[129] Eastern San Joaquin 2022 GSP, Section 2.2.2, p. 180.

estimate for the reduction of groundwater storage volume that is considered an undesirable result. Alternatively, the GSP could highlight how the maximum reduction of groundwater storage related to the chronic lowering of groundwater level minimum thresholds would not result in significant and unreasonable impacts related to groundwater storage and omit the 23 MAF estimate (see Recommended Corrective Action 4).

The GSP proposes to use sustainable management criteria developed for the chronic lowering of groundwater levels as a proxy for reductions of groundwater storage. These criteria include the same minimum thresholds, measurable objectives, interim milestones, and representative monitoring network as described above for groundwater levels. The GSP indicates that if groundwater levels are maintained at the minimum threshold values across the Subbasin, the resulting reduction of groundwater in storage is estimated to be 1.2 MAF, which would not be considered an undesirable result.[130] Overall, Department staff conclude that the use of groundwater levels as a proxy for the reduction of groundwater storage to be appropriate, as the potential impacts related to reductions of groundwater storage are similar to those described for the chronic lowering of groundwater levels. Additionally, the GSP indicated that no undesirable results related to the reduction of groundwater in storage have occurred historically, thus, once sustainability is achieved and groundwater levels are maintained near measurable objective levels (which are generally based on historic lows), there should be no associated undesirable results.

5.3.2.3 Seawater Intrusion

The GSP Regulations require the minimum threshold for seawater intrusion to be defined by a chloride concentration isocontour for each principal aquifer where seawater intrusion may lead to undesirable results.[131]

The GSP describes that an undesirable result related to seawater intrusion is experienced "if sustained groundwater salinity levels caused by seawater intrusion and due to groundwater management practices are too high to satisfy beneficial uses within the basin over the planning and implementation horizon of this GSP."[132] The GSP describes that the Subbasin is not in a coastal area and seawater intrusion is not currently present because Delta management practices have limited the inward movement of seawater to maintain freshwater flows in the Delta.[133] The GSP states that undesirable results related to seawater intrusion are not expected to occur in the future; however, the GSP acknowledges that because the Subbasin is adjacent to the Delta, changes in Delta management practices or sea level rise due to climate change could potentially result in seawater intrusion in the future.

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[130] Eastern San Joaquin 2022 GSP, Section 3.3.2.2, pp. 299-300.
[131] 23 CCR § 354.28(c)(3).
[132] Eastern San Joaquin 2022 GSP, Section 3.3.4.1.1, p. 306.
[133] Eastern San Joaquin 2022 GSP, Section 2.2.3, p. 182.

The GSP defines sustainable management criteria for seawater intrusion with the use of a pre-defined chloride isocontour line.[134] This line is described as "a demarcation of where the ESJGWA would consider seawater intrusion an undesirable result."[135] The minimum threshold for seawater intrusion is defined as this isocontour line at a chloride concentration value of 2,000 mg/L. The GSP identifies an undesirable result related to seawater intrusion as occurring when a 2,000 mg/L chloride isocontour line created using current data from the groundwater quality monitoring network crosses this pre-defined isocontour line. The measurable objective for seawater intrusion is defined using a 500 mg/L isocontour line demarked using the same isocontour line as the minimum threshold. The GSP indicates that interim milestones will follow a linear trend in five-year increments between the current conditions and the measurable objectives; however, the Plan provides no estimates of current conditions, so it is unclear whether measurable objectives proposed to allow for further degradation of groundwater quality or propose to improve groundwater quality over the implementation period.

Based on the figure, the pre-defined isocontour line is located in the western portion of the Subbasin and bisects the cities of Stockton and Manteca. The Plan does not provide a description for how the 2,000 mg/L threshold value would prevent significant and unreasonable impacts to groundwater users. Considering that the "recommended" SMCL for chloride is 250 mg/L and the SMCL "upper limit" is 500 mg/L, a chloride concentration of almost 2,000 mg/L (yet staying below the minimum threshold) would appear to be a significant degradation of groundwater quality that is not discussed by the Plan, particularly because the western portion of the Subbasin where seawater intrusion could potentially occur contains the Subbasin's larger cities where a larger portion of population may depend on groundwater for potable uses.

While Department staff believe the methodology and use of a chloride isocontour line to define sustainable management criteria to be reasonable and agree that seawater intrusion into the Subbasin may be unlikely in the near term, the Plan does not provide sufficient explanation describing how impacts to beneficial uses and users were considered when selecting the 2,000 mg/L minimum threshold. Department staff recommend the GSP provide additional explanation for how the 2,000 mg/L chloride isocontour line will prevent significant and unreasonable impacts to beneficial uses and users of groundwater. Even though seawater intrusion may be unlikely in the Subbasin, the currently defined minimum thresholds could allow for groundwater beneath the cities of Stockton and Manteca to approach chloride concentrations of almost 2,000 mg/L. If the GSAs consider this to be insignificant, considering the upper limit SMCL for chloride is 1,000 mg/L, the justification should be described and disclosed in the Plan. Additionally, the Plan should provide the current chloride conditions and interim milestones for seawater intrusion. As currently presented, the Plan does not describe these values and Department staff cannot determine whether the proposed measurable objective based on

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[134] Eastern San Joaquin 2022 GSP, Figure 3-4, p. 307.
[135] Eastern San Joaquin 2022 GSP, Section 3.3.4.2, p. 307.

the 500 mg/L chloride isocontour line result in groundwater quality degradation or improvement over the implementation period (see Recommended Corrective Action 5).

5.3.2.4 Degraded Water Quality

The GSP Regulations require the minimum threshold for degraded water quality to be the degradation of water quality, including the migration of contaminant plumes that impair water supplies or other indicator of water quality as determined by the Agency that may lead to undesirable results. The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin. In setting minimum thresholds for degraded water quality, the Agency shall consider local, state, and federal water quality standards applicable to the basin.[136]

The GSP describes that an undesirable result for degraded groundwater quality "is experienced if SGMA-related groundwater management activities cause significant and unreasonable impacts to the long-term viability of domestic, agricultural, municipal, environmental, or other beneficial uses over the planning and implementation horizon of this GSP."[137] The GSP identifies salinity, arsenic, nitrate, and various point source contaminants as the main constituents of concern in the Subbasin; however, sustainable management criteria are only defined for salinity (through the measurement of total dissolved solids concentrations).[138] The GSP describes that nitrate, arsenic, and point source contaminants are generally regulated through other programs and agencies, such as the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and the Irrigated Lands Regulatory Program (ILRP), and other programs through the RWQCB, DTSC, and USEPA.[139] Additionally, the GSP describes how currently there is no known causal nexus between nitrate or arsenic and groundwater management activities.[140] Even though no sustainable management criteria were established for some constituents of concern, the GSP describes that data from other programs will be evaluated in conjunction with groundwater level data to determine whether groundwater management activities or SGMA-related projects result in impacts relating to these constituents.[141] The GSP also commits to collecting arsenic and nitrate data from the Subbasin's groundwater quality network to evaluate trends and potentially establish sustainable management criteria for these constituents in the future, if warranted.[142]

The GSP defines sustainable management criteria for degraded water quality using TDS as an indicator of salinity. An undesirable result is defined as when more than 25 percent of representative groundwater quality monitoring wells (at least 3 of 10) exceed the minimum threshold for two consecutive years and where these concentrations are the

[136] 23 CCR § 354.28(c)(4).
[137] Eastern San Joaquin 2022 GSP, Section 3.3.3.1.1, p. 300.
[138] Eastern San Joaquin 2022 GSP, Section 2.2.4, p. 182.
[139] Eastern San Joaquin 2022 GSP, Section 3.3.3.1.1, p. 301.
[140] Eastern San Joaquin 2022 GSP, Section 2.2.4.2, p. 193 and Section 2.2.4.3, p. 196.
[141] Eastern San Joaquin 2022 GSP, Appendix 3-E, p. 1623.
[142] Eastern San Joaquin 2022 GSP, Section 3.3.3.4, p. 305.

result of groundwater management activities. The GSP indicates that changes to groundwater quality will be evaluated on an annual basis to determine whether groundwater management has contributed to groundwater quality degradation.[143] The GSP describes the potential causes of undesirable results and the possible effects on beneficial users and land use if undesirable results were to occur.[144]

The GSP defines the minimum threshold for TDS as a concentration of 1,000 mg/L for all groundwater quality representative monitoring wells. The GSP describes that the minimum threshold was developed with stakeholder input and based on concerns for both drinking water and agricultural users. The GSP states that the minimum threshold is equal to the State Water Resources Control Board Division of Drinking Water's (DDW) SMCL "upper limit" for TDS, which is a value defined for aesthetic reasons, rather than public health concerns. Additionally, the Plan describes that the major crops grown in the Subbasin can generally tolerate TDS ranges from 900 mg/L to 4,000 mg/L, thus, the 1,000 mg/L minimum threshold values is considered protective of the majority of Subbasin crops.[145]

Measurable objectives for degraded groundwater quality are defined as 600 mg/L TDS concentrations for all groundwater quality representative monitoring wells. The GSP describes that, while the DDW's SMCL "recommended limit" is defined as 500 mg/L, this value is based on aesthetic concerns and 600 mg/L is generally considered adequate for both drinking water and agricultural purposes. The Plan provides a table displaying current conditions for the representative monitoring wells (based on the average TDS concentrations for data available in recent years) compared to measurable objectives and interim milestones. The current conditions range from 280 mg/L to 510 mg/L TDS, indicating that the measurable objective allows for declining groundwater quality throughout the implementation period. The Interim milestones are defined based on a linear trend from the current conditions to the measurable objectives.

Department staff conclude that the proposed sustainable management criteria appear reasonable, even though the measurable objectives generally allow for a decline in groundwater quality compared to current conditions. While the GSP only sets sustainable management criteria for TDS, the commitment to monitoring for arsenic and nitrate and the proposed groundwater quality evaluation, coordination, data management, and reporting processes outlined by the Plan[146] and discussed previously in the review of Deficiency 1 appear to be sufficient to identify groundwater quality degradation that may occur in the future and can be adaptively managed by the GSAs.

5.3.2.5 Land Subsidence

SGMA defines the undesirable result for subsidence to be significant and unreasonable land subsidence that substantially interferes with surface land uses, caused by

[143] Eastern San Joaquin 2022 GSP, Section 3.3.3.1.2, p. 301.
[144] Eastern San Joaquin 2022 GSP, Section 3.3.3.1.3, p. 301 and Section 3.3.3.1.4, p. 302.
[145] Eastern San Joaquin 2022 GSP, Section 3.3.3.2, p. 302.
[146] Eastern San Joaquin 2022 GSP, Section 3.3.3.2, p. 304.

groundwater conditions occurring throughout the basin.[147] The GSP Regulations require the minimum threshold for land subsidence to be the rate and extent of subsidence that substantially interferes with surface land uses and may lead to undesirable results.[148] Minimum thresholds for subsidence shall be supported by the identification of land uses and property interests that have been affected or are likely to be affected by land subsidence in the basin, including an explanation of how the Agency has determined and considered those uses and interests, and the Agency's rationale for establishing minimum thresholds in light of those effects and maps and graphs showing the extent and rate of land subsidence in the basin that defines the minimum threshold and measurable objectives.[149]

The GSP states that an undesirable result for land subsidence "is experienced if the occurrence of land subsidence substantially interferes with beneficial uses of groundwater and infrastructure within the Subbasin over the planning and implementation horizon of this GSP."[150] The GSP identifies general types of critical infrastructure in the Subbasin as:

- Major highways, roadways, and bridges
- Canals, pipelines, and levees
- Electrical transmission lines
- Schools
- Fire stations
- Hospitals and other medical facilities
- Law enforcement facilities (police stations, jails, correctional facilities)
- Water and wastewater treatment, distribution, and storage facilities
- Communication facilities[151]

While general infrastructure types are identified by the Plan, specific locations of infrastructure and the rate and extent of subsidence that would potentially cause impacts to the different infrastructure types was not described. The GSP indicates that specific infrastructure was not identified due to "the sensitive nature of the critical infrastructure."[152] The GSP indicates that the San Joaquin County Office of Emergency Services was consulted to determine the total subsidence the critical infrastructure can tolerate. From these discussions, the GSP only describes that the critical infrastructure can tolerate "a significant amount of uniform settlement due to subsidence across the Subbasin, though the total amount of settlement that can be tolerated is dependent on the design of the specific infrastructure."[153]

[147] Water Code § 10721(x)(5).
[148] 23 CCR § 354.28(c)(5).
[149] 23 CCR §§ 354.28(c)(5)(A-B).
[150] Eastern San Joaquin 2022 GSP, Section 3.3.5.1.1, p. 308.
[151] Eastern San Joaquin 2022 GSP, Section 3.3.5.1.1, p. 308.
[152] Eastern San Joaquin 2022 GSP, Appendix 3-F, p. 1631.
[153] Eastern San Joaquin 2022 GSP, Section 3.3.5.1.1, p. 309.

The GSP does not provide a quantifiable metric that would identify undesirable results related to land subsidence. The GSP only states that "[a]n undesirable result occurs when subsidence substantially interferes with beneficial uses of groundwater and surface land uses." Additionally, the GSP states that undesirable results related to land subsidence will be identified using data collected from the (groundwater level) representative monitoring network, data collected by individual GSAs, and additional available data such as continuous GPS, InSAR, and data from UNAVCO's Plate Boundary Observatory Program.[154] While the potential for land subsidence in the Subbasin may be low based on the absence of historical land subsidence, GSP Regulations require that undesirable results be defined using a quantitative combination minimum threshold exceedances (see Recommended Corrective Action 2).

The representative groundwater level monitoring network and associated minimum thresholds are used as a proxy to define minimum thresholds for land subsidence. These minimum thresholds, based on the historic low water levels plus a buffer or the 10th percentile domestic/municipal well depth, allow for groundwater levels to drop below historic lows by approximately 7 to 54 feet, depending on well location. The GSP describes that these groundwater levels are considered protective of impacts caused by land subsidence because if the minimum thresholds are not exceeded, the additional declines in groundwater levels below historic lows are limited to geologic units that have historically not been prone to subsidence.[155] While Department staff believe this argument understandable, the GSP does not provide an analysis that takes into consideration potential minimum threshold exceedances, which could be allowed in the representative monitoring wells based on the proposed metrics used to identify an undesirable result for the chronic lowering of groundwater levels (i.e., an undesirable result is defined as minimum threshold exceedances in 5 of 20 monitoring wells for two consecutive years).

In addition to the use of groundwater levels as a proxy for land subsidence minimum thresholds, measurable objectives and interim milestones for groundwater levels are used as a proxy to define those same metrics for land subsidence.[156] Measurable objectives are based on the historic low groundwater levels and interim milestones are defined as a linear trend from the current conditions to the measurable objectives. Based on these values, if groundwater levels were maintained at the measurable objectives (i.e., historic lows), the potential for land subsidence would, in theory, be minimal.

The GSP states that the use of groundwater levels as a proxy is necessary "given the relative lack of direct monitoring for land subsidence in the Subbasin." The GSP also describes how additional land subsidence monitoring data (such as CGPS and InSAR data) will be evaluated in conjunction with groundwater levels to further evaluate the

[154] Eastern San Joaquin 2022 GSP, Section 3.3.5.1.2, p. 309.
[155] Eastern San Joaquin 2022 GSP, Section 3.3.5.1.2, p. 310.
[156] Eastern San Joaquin 2022 GSP, Section 3.3.5.1.2, p. 310.

correlation.[157] In general, Department staff conclude these statements are contradictory, and it is unclear as to why the GSP does not establish sustainable management criteria for land subsidence using the available InSAR dataset that provides direct monitoring for land subsidence Subbasin-wide (see Recommended Corrective Action 2).

Even though the GSP proposes to use groundwater levels as a proxy for land subsidence minimum thresholds, the Plan also defines a "trigger value" of 0.25 feet of annual subsidence (from direct land subsidence monitoring data sources) that will initiate an analysis to determine whether subsidence is related to groundwater management activities. Based on results of this analysis, additional projects or management actions could be implemented.[158] Department staff conclude the commitment to evaluating direct subsidence monitoring data to be a step in the right direction; however, the GSP provides no details on the proposed "analysis" that will be conducted.

Based on the information presented in the GSP, Department staff agree that the potential for land subsidence in the Subbasin is generally lower than neighboring Subbasins that contain regionally extensive thick units of compressible clays, such as the Corcoran Clay. However, GSP Regulations require that minimum thresholds be defined by a rate and extent of land subsidence that could substantially interfere with land uses and may lead to undesirable results. While GSP Regulations allow for groundwater levels to be used as a proxy for other sustainability indicators, the GSP fails to provide the necessary supporting evidence sufficient to show how the established minimum thresholds and, particularly, the identification of undesirable results which allow minimum thresholds to be exceeded, will prevent significant and unreasonable impacts caused by land subsidence.

5.3.2.6 Depletions of Interconnected Surface Water

SGMA defines undesirable results for the depletion of interconnected surface water as those that have significant and unreasonable adverse impacts on beneficial uses of surface water and are caused by groundwater conditions occurring throughout the basin.[159] The GSP Regulations require that a Plan identify the presence of interconnected surface water systems in the basin and estimate the quantity and timing of depletions of those systems.[160] The GSP Regulations further require that minimum thresholds be set based on the rate or volume of surface water depletions caused by groundwater use, supported by information including the location, quantity, and timing of depletions, that adversely impact beneficial uses of the surface water and may lead to undesirable results.[161]

The GSP defines an undesirable result related to depletions of interconnected surface water as "depletions that result in flow or levels of major rivers and streams that are

[157] Eastern San Joaquin 2022 GSP, Section 3.3.5.1.2, p. 310.
[158] Eastern San Joaquin 2022 GSP, Section 3.3.5.1.2, p. 310.
[159] Water Code § 10721(x)(6).
[160] 23 CCR § 354.16(f).
[161] 23 CCR § 354.28(c)(6).

hydrologically connected to the basin such that the reduced surface water flow or levels have a significant and unreasonable adverse impact on beneficial uses and users of the surface water within the Subbasin over the planning and implementation horizon of this GSP."[162] The GSP indicates that depletions leading to undesirable results could result in a reduction in the flows in major rivers and streams such that there is insufficient surface water available to support diversions or to meet regulatory environmental flow requirements. The GSP identifies the Calaveras River, Dry Creek, the Mokelumne River, the San Joaquin River, and the Stanislaus River as the major rivers and streams that are potentially interconnected to the groundwater system in the Subbasin. Of these, the GSP indicates that the Mokelumne, Stanislaus, and San Joaquin rivers have defined regulatory flow requirements that are managed through various upstream reservoirs. The GSP notes that smaller creeks and streams in the Subbasin were not considered in the evaluation of depletions of interconnected surface water, as they are "substantially used for the conveyance of irrigation water."[163]

The GSP does not estimate the quantity, location, or timing of depletions that would result in significant and unreasonable impacts to surface water diverters or environmental users. Additionally, the GSP does not quantify what would be considered an undesirable result in terms of depletion. Instead, the GSP proposes to use the already defined groundwater level sustainable management criteria as a proxy for depletions of interconnected surface water (including minimum thresholds, measurable objectives, and interim milestones). Rather than defining groundwater level thresholds that are a proxy for the specific quantity of depletion that could cause undesirable results, the GSP argues that the minimum thresholds developed for chronic lowering of groundwater levels (which were informed by factors including domestic well depths), would protect against stream depletion undesirable results. In other words, the GSP implies that undesirable quantities of stream depletion, whatever that would be, would not occur unless groundwater levels fell below the chronic lowering of groundwater level minimum thresholds and, because that scenario would trigger an undesirable result related to the chronic lowering of groundwater levels, an undesirable result for depletions of interconnected surface water would be preemptively avoided.

In supporting the argument that groundwater level minimum thresholds would prevent undesirable results related to depletions of interconnected surface water, the GSP attempts to quantify the additional depletions that would be associated with groundwater level undesirable results. The GSP appears to quantify these additional depletions solely by comparing depletions estimated in the projected conditions modeling scenario to depletions estimated in the historical conditions modeling scenario (rather than by estimating depletions specifically associated with groundwater levels at minimum threshold values). As described previously, the historical conditions scenario represents the historical water budget and hydrologic conditions for a 20-year period from 1996 to

[162] Eastern San Joaquin 2022 GSP, Section 3.3.6.1.2, p. 311.
[163] Eastern San Joaquin 2022 GSP, Section 3.3.6.1, p. 311.

2015. The projected conditions scenario represents a 50-year period with the projected groundwater and surface water demand based on projected future changes in land use, population, and water supplies. While not many details are presented, the GSP states that the additional depletions occurring in the projected conditions scenario average 50,000 acre-feet per year compared to the historical conditions scenario.[164] The GSP indicates that these additional depletions are approximately one percent of total annual stream outflows and, thus, argues that depletions of this magnitude are not likely to cause impacts. Department staff conclude, generally, that arguments stating a particular effect is small relative to a large annual amount are not compelling. Comparing depletion quantity due to groundwater use in any Subbasin to the total annual surface water outflow from a large watershed will, in most, if not all, cases, show that the depletion quantity is small relative to the total annual outflow. Comparing to the total annual outflow is not, as a long-term solution to groundwater management, the only relevant metric. It ignores potential temporal or seasonal effects, where flows during certain (e.g., drier) times of the year may have a higher potential to be unreasonably or significantly affected by depletions that may appear small at other times or in the aggregate.

While Department staff generally conclude the GSP's discussion of stream depletion sustainable management criteria to be lacking sufficient detail, Department staff at this time do not believe that this issue substantially affects the immediate and near-term implementation of the GSP's management regime or the likelihood of the Subbasin to achieve its sustainability goals within 20 years. Based on the water budgets presented in the GSP and the additional modeling results which estimate the effects of implementing Category A projects (described in Section 5.5 below), the Subbasin's management strategy should result in reduced groundwater use over the GSP implementation period as compared to the current or baseline groundwater demand. Department staff recognize that, in general, when there is an interconnection between the surface water and groundwater systems, a reduction in groundwater use will generally have an associated reduction of streamflow depletions over the long term. Department staff also recognize that depletions of interconnected surface water has been identified as a data gap area by the GSP.

Due to these factors, Department staff do not consider the shortcoming of the current plan to preclude approval. Department staff understand that quantifying depletions of interconnected surface water from groundwater extractions is a complex task that likely requires developing new, specialized tools, models, and methods to understand local hydrogeologic conditions, interactions, and responses. During the initial review of GSPs, Department staff have observed that most GSAs have struggled with this requirement of SGMA. However, staff believe that most GSAs will more fully comply with regulatory requirements after several years of Plan implementation that includes projects and management actions to address the data gaps and other issues necessary to understand, quantify, and manage depletions of interconnected surface waters. Department staff

[164] Eastern San Joaquin 2022 GSP, Section 3.3.6.2, p. 312.

further advise that at this stage in SGMA implementation GSAs address deficiencies related to interconnected surface water depletion where GSAs are still working to fill data gaps related to interconnected surface water and where these data will be used to inform and establish sustainable management criteria based on timing, volume, and depletion as required by the GSP Regulations (see Recommended Corrective Action 6a).

The Department will continue to support GSAs in this regard by providing, as appropriate, financial and technical assistance to GSAs, including the development of guidance describing appropriate methods and approaches to evaluate the rate, timing, and volume of depletions of interconnected surface water caused by groundwater extractions. Once the Department's guidance related to depletions of interconnected surface water is publicly available, GSAs, where applicable, should consider incorporating appropriate guidance approaches into their future periodic evaluations to the GSP (see Recommended Corrective Action 6a). GSAs should consider availing themselves of the Department's financial or technical assistance, but in any event must continue to fill data gaps, collect additional monitoring data, and implement strategies to better understand and manage depletions of interconnected surface water caused by groundwater extractions and define segments of interconnectivity and timing within their jurisdictional area (see Recommended Corrective Action 6b). Furthermore, GSAs should coordinate with local, state, and federal resources agencies as well as interested parties to better understand the full suite of beneficial uses and users that may be impacted by pumping induced surface water depletion (see Recommended Corrective Action 6c).

5.4 MONITORING NETWORK

The GSP Regulations describe the monitoring network that must be developed for each basin including monitoring objectives, monitoring protocols, and data reporting requirements. Collecting monitoring data of a sufficient quality and quantity is necessary for the successful implementation of a groundwater sustainability plan. The GSP Regulations require a monitoring network of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the basin and evaluate changing conditions that occur through implementation of the Plan.[165] Specifically, a monitoring network must be able to monitor impacts to beneficial uses and users,[166] monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds,[167] capture seasonal low and high conditions,[168] include required information such as location and well construction, and include maps and tables clearly showing the monitoring site type, location and frequency.[169] Department staff encourage GSAs to collect monitoring data as specified in the GSP, fill data gaps

[165] 23 CCR § 354.32.
[166] 23 CCR § 354.34(b)(2).
[167] 23 CCR § 354.34(b)(3).
[168] 23 CCR § 354.34(c)(1)(B).
[169] 23 CCR §§ 354.34(g-h).

identified in the GSP prior to the first periodic evaluation,[170] update monitoring network information as needed, follow monitoring best management practices,[171] and submit all monitoring data to the Department's Monitoring Network Module immediately after collection including any additional groundwater monitoring data that is collected within the Plan area that is used for groundwater management decisions. Staff note that if GSAs do not fill their identified data gaps, the GSA's basin understanding may not represent the best available science for use to monitor basin conditions.

The monitoring network for the chronic lowering of groundwater levels includes 127 existing wells that will be measured semi-annually in March and October. The 127 wells are categorized into either the representative monitoring well network with 20 wells that will be used to evaluate compliance with sustainable management criteria, or the broad monitoring network with 107 wells that will be used to collect supplemental data throughout the Subbasin. The GSP includes figures that show the well locations and also tables that summarize well details such as well names, well construction information (if available), and monitoring agencies.[172] The GSP estimates that the spatial density of the combined groundwater level network is 10.6 wells per 100 square miles, and the representative monitoring well network is 1.7 wells per 100 square miles.[173] The GSP identifies data gaps for the groundwater level monitoring network as areas near streams and Subbasin boundaries, near the groundwater depression in the central portion of the Subbasin, and depth-discrete groundwater level data (i.e., a lack of multi-completion monitoring wells).[174] Additionally, data gaps identified for the hydrogeologic conceptual model indicated that there are groundwater level data gaps in the east and northwest portions of the Subbasin, and also for shallow groundwater levels near NCCAGs.[175] The GSP indicates that the plan to address these data gaps includes the construction of 12 new monitoring wells. Two of the new wells will be multi-completion monitoring wells, with one located along the northern boundary near Dry Creek, and the other located in the central portion of the Subbasin. The remaining 10 new wells will be shallow wells near streams, Subbasin boundaries, and the central groundwater depression.[176] Proposed well locations are displayed on a map with the existing monitoring network well locations.[177]

Groundwater storage will be monitored using the groundwater level monitoring network.[178] Because groundwater levels are used as a proxy for groundwater storage sustainable management criteria, Department staff believe that the use of the

[170] 23 CCR § 354.38(d).
[171] Department of Water Resources, 2016, Best Management Practices and Guidance Documents.
[172] Eastern San Joaquin 2022 GSP, Figure 3-2, p. 295, Figure 4-1, p. 319, Table 4-1, p. 316, Appendix 4-A, pp. 1657-1661.
[173] Eastern San Joaquin 2022 GSP, Table 4-3, p. 322.
[174] Eastern San Joaquin 2022 GSP, Section 4.7.1, p. 329.
[175] Eastern San Joaquin 2022 GSP, Section 2.1.10, p. 160.
[176] Eastern San Joaquin 2022 GSP, Section 4.7.5, p. 330.
[177] Eastern San Joaquin 2022 GSP, Figure 4-3, p. 331.
[178] Eastern San Joaquin 2022 GSP, Section 4.2, p. 322.

groundwater level monitoring network to evaluate changing storage conditions is appropriate.

The degraded groundwater quality network consists of 31 wells, all of which are also included as part of the broad groundwater level monitoring network. Wells in the groundwater quality network are divided into a representative monitoring well groundwater quality network with 10 wells and a broad groundwater quality network with the remaining 21 wells. The GSP provides maps showing the locations of wells in the representative monitoring well and broad monitoring networks and summarizes well names and construction information in tables.[179] The GSP states that the density of the combined groundwater quality network is 2.6 wells per 100 square miles and the representative monitoring well network is 0.8 wells per 100 square miles.[180] The GSP describes that the wells in the representative monitoring well and broad networks will be sampled semi-annually for TDS, cations and anions (including nitrate and chloride), arsenic, and various field parameters.[181] Based on the maps, all wells in the representative monitoring well network are located in the western portion of the Subbasin, and the majority of the broad network wells are also located in the western portion of the Subbasin with the exception of two wells located in the northeast. The GSP describes that the representative monitoring well locations were purposefully limited to these western areas where TDS concentrations in groundwater were historically high, or adjacent to these areas to observe potential movement of high TDS groundwater.[182]

The GSP identifies data gaps in the groundwater quality network including the spatial distribution of wells, well construction data to evaluate depth-discrete groundwater quality, the different monitoring frequencies between different agencies or programs, and the monitoring of additional constituents outside of salinity.[183] In general, some of the proposed monitoring efforts already address some of these data gaps, such as the semi-annual monitoring frequency and the monitoring for constituents other than TDS. The GSP also plans to add the 12 new monitoring wells, discussed previously for the groundwater level monitoring network, to the groundwater quality network. Based on the locations of proposed groundwater quality monitoring wells, the spatial distribution of the network should be improved compared to the existing network, but a large groundwater quality monitoring data gap in the central portion of the Subbasin appears to still exist even after the incorporation of the proposed new wells. Department staff believe the proposed groundwater quality network to be insufficient to identify baseline conditions across the Subbasin. Proposed new monitoring wells will fill some of the data gaps in the eastern portion of the Subbasin; however, based on their locations shown on Figure 4-3, there will still be a large groundwater quality data gap in the central portion of the

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[179] Eastern San Joaquin 2022 GSP, Figure 3-3, p. 303, Figure 4-1, p. 325, Table 4-5, p. 323, Table 4-6, p. 326.
[180] Eastern San Joaquin 2022 GSP, Table 4-8, p. 328.
[181] Eastern San Joaquin 2022 GSP, Section 4.3, p. 322.
[182] Eastern San Joaquin 2022 GSP, Section 4.3.1, p. 323.
[183] Eastern San Joaquin 2022 GSP, Section 4.7.2, p. 329.

Subbasin where the GSP has identified a large groundwater depression. Additionally, it is unclear why the GSP is relying on the construction of new wells to monitor groundwater quality in the eastern portion of the Subbasin, considering existing groundwater level wells have been identified in these areas, and there is likely many other options to monitor groundwater quality from existing agricultural or domestic wells. Department staff recommend that existing wells be evaluated to be included as part of the groundwater quality monitoring network to fill data gaps in the eastern portion of the Subbasin, until newly proposed monitoring wells are constructed. Additionally, Department staff recommend the final groundwater quality network identify a monitoring location in the central portion of the Subbasin where the existing groundwater depression was identified (see Recommended Corrective Action 7).[184]

The GSP states that the groundwater quality network will be used to evaluate seawater intrusion in the Subbasin through the measurement of chloride concentrations. Seawater intrusion sustainable management criteria is based on a chloride isocontour line that will be developed using data from the groundwater quality network. The GSP is unclear on whether chloride concentrations from both the representative monitoring well and broad groundwater quality networks, or only the representative monitoring well groundwater quality network will be used to develop the isocontour line. Figure 3-4, which displays the chloride isocontour line displays all groundwater quality monitoring wells;[185] however, the GSP states "[t]he seawater intrusion monitoring network uses the same monitoring wells and monitoring strategies as the groundwater quality representative monitoring network. Chloride concentrations will be monitored at the degraded water quality representative monitoring networks wells to develop a chloride isocontour line."[186] Department staff believe that the sole use of the representative monitoring well groundwater quality network (10 wells) is likely insufficient to interpolate the isocontour line as shown, as there do not appear to be enough representative monitoring wells on the western side of the isocontour (see Recommended Corrective Action 8).

As described in the evaluation of Deficiency 2, the GSP proposes to use the representative groundwater level monitoring network as a proxy for land subsidence. The GSP proposes to evaluate other forms of direct land subsidence monitoring data, such as InSAR and CGPS, as available, to identify areas where land subsidence may be occurring and to further evaluate the correlation between land subsidence and groundwater levels. As described in the evaluation of Deficiency 2 and in Recommended Corrective Action 2, Department staff believe that the representative groundwater level monitoring network is insufficient to identify undesirable results from land subsidence, particularly because minimum threshold exceedances are allowed to occur in up to four of 20 representative monitoring wells without being considered an undesirable result.

[184] Eastern San Joaquin 2022 GSP, Figure 4-3, p. 331.
[185] Eastern San Joaquin 2022 GSP, Figure 3-4, p. 307.
[186] Eastern San Joaquin 2022 GSP, Section 4.4, p. 328.

The GSP proposes to use the representative groundwater level monitoring network to monitor for depletions of interconnected surface water. The GSP also indicates that available stream gauge data will be evaluated to identify potential impacts to beneficial uses and users of surface water; however, the GSP does not identify stream gauge locations. The GSP identifies depletions of interconnected surface water as a data gap and acknowledges that there is a lack of shallow groundwater monitoring wells near the Subbasin's major rivers and streams. The GSP indicates that new shallow groundwater monitoring wells near streams will be constructed to fill data gaps.[187] Department staff believe that as the Agencies address Recommended Corrective Action 6, the monitoring network will also be updated as a result of identifying location, quantity, and timing of stream depletion due to ongoing.

While Department staff have some recommended corrective actions regarding the monitoring networks for seawater intrusion, land subsidence, and depletions of interconnected surface water, in general, the description of the monitoring network included in the Plan substantially complies with the requirements outlined in the GSP Regulations. Overall, the Plan describes in sufficient detail a monitoring network that promotes the collection of data of sufficient quality, frequency, and distribution to characterize groundwater and related surface water conditions in the Subbasin and evaluate changing conditions that occur through Plan implementation. The GSP provides a good explanation for the conclusion that the monitoring network is supported by the best available information and data and is designed to ensure adequate coverage of sustainability indicators. The Plan also describes existing data gaps and the steps that will be taken to fill data gaps and improve the monitoring network. Department staff consider the information presented in the Plan to satisfy the general requirements of the GSP Regulations regarding monitoring network.

5.5 Projects and Management Actions

The GSP Regulations require a description of the projects and management actions the submitting agency has determined will achieve the sustainability goal for the basin, including projects and management actions to respond to changing conditions in the basin.[188]

To achieve the sustainability goal and avoid undesirable results, the GSP proposes projects and management actions in a manner that is consistent and substantially complies with the GSP Regulations.[189]

In general, the GSP describes that the management strategy of the Subbasin is to achieve sustainability through the implementation of projects that either offset groundwater use by supplementing with additional surface water supplies or provide additional recharge to the groundwater basin. The GSP identifies some demand conservation projects;

[187] Eastern San Joaquin 2022 GSP, Section 4.7.3, p. 329.
[188] 23 CCR § 354.44 *et seq*.
[189] 23 CCR § 354.44 *et seq*.

however, they are relatively small in terms of total groundwater offset. The ultimate goal of the projects is to offset the estimated 78,000 acre-feet per year of groundwater recharge or reduced pumping demand needed to reach the sustainable yield estimate.

The GSP presents numerous projects that could be implemented for the Subbasin to reach its sustainable yield estimate. Initially, the GSP presented a list, maps, and descriptions of 23 projects categorized as "Planned", "Potential", and "Longer Term or Conceptual".[190] In response to the incomplete determination, the GSAs presented an updated project list that grouped projects into Category A or Category B projects. The updated list presented 26 total projects with 11 Category A projects – considered to be projects that are likely to be implemented within the next five years and have existing water rights, and 15 Category B projects – considered to be projects that will not be implemented in the next five years, but could be pursued if additional groundwater offset is needed to reach sustainability and the projects appear feasible after additional planning and studies are conducted.[191] In addition to the updated project list, the GSP included updated modeling scenarios that estimate the effects of Category A projects on the projected future water budget. Based on the modeling results, implementing all Category A projects will result in an average annual groundwater storage surplus for the Subbasin of 5,300 acre-feet per year in the projected groundwater budget without climate change.[192] However, with climate change considered, modeling results indicate an average annual groundwater storage deficit of 15,700 acre-feet per year, even with the implementation of all Category A projects.[193] Based on these results, the GSP acknowledges that additional projects of management actions may be needed to reach the sustainable yield estimate.

The GSP indicates that there are currently no plans for groundwater demand management actions; however, the GSP states that GSAs may implement management actions in the future should conditions warrant.[194] The GSP describes existing conservation or demand management actions that have been in place prior to GSP development through various Urban Water Management Plans and Agricultural Water Management Plans in the Subbasin.[195] Additionally, the GSP describes various adaptive management strategies that may be considered if it appears that Subbasin's proposed projects are not enough on their own for the Subbasin to reach sustainability. These potential adaptive management strategies include groundwater extraction fees, rotational or permanent fallowing of crop lands, conservation programming for demand reduction, and mandatory demand reduction.[196]

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[190] Eastern San Joaquin 2022 GSP, Section 6.1, pp. 341-376.
[191] Eastern San Joaquin 2022 GSP, Section 6.5, pp. 380-385.
[192] Eastern San Joaquin 2022 GSP, Section 2.3.7.6.2, p. 276.
[193] Eastern San Joaquin 2022 GSP, Section 2.3.7.7.2, p. 281.
[194] Eastern San Joaquin 2022 GSP, Section 6.3, p. 376.
[195] Eastern San Joaquin 2022 GSP, Section 6.3, pp. 377-378.
[196] Eastern San Joaquin 2022 GSP, Section 6.4, pp. 378-379.

The Plan adequately describes proposed projects and management actions in a manner that is generally consistent and substantially complies with the GSP Regulations.[197] The projects and management actions, which focus largely on projects that offset groundwater use with additional surface water supplies or projects that increase groundwater recharge, are directly related to the sustainable management criteria and present a generally feasible approach to achieving the sustainability goal of the Subbasin.

As projects and management actions are implemented, the Department expects that progress be included in annual reports and any addition or removal of project and management actions be documented in future periodic evaluations.

5.6 Consideration of Adjacent Basins/Subbasins

SGMA requires the Department to "…evaluate whether a groundwater sustainability plan adversely affects the ability of an adjacent basin to implement their groundwater sustainability plan or impedes achievement of sustainability goals in an adjacent basin."[198] Furthermore, the GSP Regulations state that minimum thresholds defined in each GSP be designed to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.[199]

The Eastern San Joaquin Subbasin has seven adjacent subbasins, the Delta Mendota, Consumnes, East Contra Costa, Modesto, Solano, South American, and Tracy subbasins. All adjacent Subbasins are high and medium priority subbasins, which are currently required to be managed under a GSP.

The Plan does not include a discussion of its potential impacts to the adjacent subbasins; however, the GSP does indicate that various inter-basin coordination meetings have taken place with the Consumnes, Tracy, Modesto, South American, Solano, and East Contra Costa subbasins. Of these subbasins, Eastern San Joaquin is the only critically overdrafted basin, thus, at the time of GSP development, these meetings mainly discussed elements of the Eastern San Joaquin GSP, and efforts to coordinate in the future.[200] While potential impacts to adjacent subbasins are not discussed, the GSP's water budget estimates include subsurface outflows and inflows between adjacent basins.[201] A public comment from the Sacramento County GSA, on behalf of the Consumnes Subbasin, encourages increased coordination for future subsurface flow estimates related to the water budgets, addressing data gaps related to surface water / groundwater interaction along Dry Creek, and potentially re-evaluating the minimum threshold for representative monitoring well 04N07E20H003 to reduce the potential for subsurface flow from the Consumnes to the Eastern San Joaquin Subbasin. No additional comments relating to impacts to adjacent basins were received by the Department.

[197] 23 CCR §§ 354.44 *et seq*.
[198] Water Code § 10733(c).
[199] 23 CCR § 354.28(b)(3).
[200] Eastern San Joaquin 2022 GSP, Section 1.3.5, p. 94.
[201] Eastern San Joaquin 2022 GSP, Section 2.3.5, p. 230.

Based on information available at this time, Department staff have no reason to believe that groundwater management in the Eastern San Joaquin Subbasin will adversely affect groundwater conditions in the adjacent subbasins at this time. Department staff will continue to review periodic evaluations to the Plan to assess whether implementation of the Eastern San Joaquin Subbasin Groundwater Sustainability Plan is potentially impacting adjacent basins.

5.7 Consideration of Climate Change and Future Conditions

The GSP Regulations require a GSA to consider future conditions and project how future water use may change due to multiple factors including climate change.[202]

Since the original GSP was adopted and submitted in 2020, climate change conditions have advanced faster and more dramatically. It is anticipated that the hotter, dryer conditions will result in a loss of 10 percent of California's water supply. As California adapts to a hotter, drier climate, GSAs should be preparing for these changing conditions as they work to sustainably manage groundwater within their jurisdictional areas. Specifically, the Department encourages GSAs to explore how the proposed groundwater level thresholds have been established in consideration of groundwater level conditions in the basin based on current and future drought conditions. The Department encourages GSAs to also explore how groundwater level data from the existing monitoring network will be used to make progress towards sustainable management of the basin given increasing aridification and effects of climate change, such as prolonged drought. Lastly, the Department encourages GSAs to continually coordinate with the appropriate groundwater users, including but not limited to domestic well owners and state small water systems, and the appropriate overlying county jurisdictions developing drought plans and establishing local drought task forces[203] to evaluate how the Agency's groundwater management strategy aligns with drought planning, response, and mitigation efforts within the basin.

[202] 23 CCR § 354.18.
[203] Water Code § 10609.50.

6 STAFF RECOMMENDATION

Department staff believe sufficient action has been taken by the GSAs to the deficiencies identified. Department staff recommend **APPROVAL** of the 2022 Plan with the recommended corrective actions listed below. The Plan conforms with Water Code Sections 10727.2 and 10727.4 of SGMA and substantially complies with the GSP Regulations. Implementation of the Plan will likely achieve the sustainability goal for the Eastern San Joaquin Subbasin. The GSAs have identified several areas for improvement of its Plan and Department staff concur that those items are important and should be addressed as soon as possible. Department staff have identified recommended corrective actions that should be considered by the GSAs for the first periodic evaluation of its GSP. Addressing these recommended corrective actions will be important to demonstrate that implementation of the Plan is likely to achieve the sustainability goal. The recommended corrective actions include:

RECOMMENDED CORRECTIVE ACTION 1

The GSP does not provide a sufficient evaluation of the potential impacts to various beneficial uses and users of groundwater related to the chronic lowering of groundwater level minimum thresholds and criteria used to identify undesirable results. The following items should be addressed:

1a. Department staff recommend the Agencies explain the selection of 25 percent of exceedances as considered undesirable, including details describing the groundwater conditions and how those conditions constitute a significant and unreasonable effect of beneficial uses and users.

Department staff also recommend that the updated modeling results be used to quantify and disclose the potential impacts to groundwater well users during projected conditions where minimum thresholds are exceeded but undesirable results do not occur. In addition to impacts to domestic and municipal wells, this evaluation should include impacts to smaller water systems reliant on groundwater wells. Department staff also recommend that the GSAs review the Department's April 2023 guidance document titled Considerations for Identifying and Addressing Drinking Water Well Impacts guidance to assist its adaptive management efforts.

1b. Department staff recommend the GSP include a more thorough evaluation of the impacts to environmental uses and users related to the groundwater level minimum thresholds, or, at minimum, describe a plan to perform this evaluation in the future when additional data become available.

1c. The GSP should evaluate the minimum thresholds in relation to the depths of nearby public water systems and state small water systems reliant on groundwater wells. While it may be reasonable to assume that wells in these systems are generally deeper than domestic wells, which were part of the minimum threshold analysis, Department staff recommend that an evaluation of these smaller water systems be disclosed by the GSP.

1d. Department staff recommend the Agencies develop a more detailed plan describing how the assessment of groundwater quality in relation to declining groundwater levels will be conducted, including identifying specific analyses, well locations (either wells already monitored as part of GSP implementation or wells monitored by other programs), sampling frequency, and data gaps.

Recommended Corrective Action 2

Until a correlation between groundwater levels and land subsidence is established, the GSP should use direct subsidence monitoring data, such as InSAR or CGPS, to define sustainable management criteria (minimum thresholds and undesirable results). In general, the Agencies describe that land subsidence has never been a problem in the Subbasin and imply that land subsidence should not be a problem in the future. If this is accurate, setting land subsidence minimum thresholds using direct monitoring data should not trigger undesirable results and would also be the easiest pathway to developing sustainable management criteria for land subsidence, since a correlation between groundwater levels and land subsidence would no longer need to be established.

Department staff recommend Agencies clearly describe how potential subsidence associated with groundwater level declines below minimum thresholds would not have the potential to cause significant and unreasonable impacts and undesirable results to related to subsidence and the use of InSAR data for the land subsidence monitoring network, with supplemental groundwater level data being utilized to evaluate whether detected land subsidence is the result of declining groundwater levels. The use of InSAR data is also recommended for use in establishing a rate and extent in defining significant and unreasonable impacts considered not to cause undesirable results to the Subbasin.

Recommended Corrective Action 3

Department staff recommend that in the first periodic evaluation of the GSP, only water budgets developed from the most recent or best available data be included. As currently presented, it is unclear whether the sustainable yield estimate and estimated groundwater offset required to achieve sustainability are based on the updated modeling results (based on ESJWRM Version 2.0) or are from the modeling scenarios presented in the original GSP submitted in 2020 (based on ESJWRM Version 1.0).

Recommended Corrective Action 4

Department staff recommend the GSP provide a revised estimate for the reduction of groundwater storage volume that is considered an undesirable result. Alternatively, the GSP could highlight how the maximum reduction of groundwater storage related to the chronic lowering of groundwater level minimum thresholds would not result in significant and unreasonable impacts related to groundwater storage and omit the 23 MAF estimate.

RECOMMENDED CORRECTIVE ACTION 5

Department staff recommend the GSP provide additional explanation for how the 2,000 mg/L chloride isocontour line will prevent significant and unreasonable impacts to beneficial uses and users of groundwater. Additionally, the Plan should provide the current chloride conditions and interim milestones for seawater intrusion.

RECOMMENDED CORRECTIVE ACTION 6

Department staff understand that estimating the location, quantity, and timing of stream depletion due to ongoing, Subbasin-wide pumping is a complex task and that developing suitable tools may take additional time; however, it is critical for the Department's ongoing and future evaluations of whether GSP implementation is on track to achieve sustainable groundwater management. The Department plans to provide guidance on methods and approaches to evaluate the rate, timing, and volume of depletions of interconnected surface water and support for establishing specific sustainable management criteria in the near future. This guidance is intended to assist GSAs to sustainably manage depletions of interconnected surface water.

In addition, the GSA should work to address the following items by the first periodic evaluation:

a. Work to establish undesirable results, minimum thresholds, and measurable objectives consistent with the GSP Regulations. Measurable objectives are to use the same metric used for minimum thresholds, including quantifying the location, quantity, and timing of depletions of interconnected surface water due to groundwater extraction. Consider utilizing the interconnected surface water guidance, as appropriate, when issued by the Department.

b. Continue to fill data gaps, collect additional monitoring data, and implement the current strategy to manage depletions of interconnected surface water and define segments of interconnectivity and timing. The monitoring network should be updated to reflect any corresponding changes and approaches.

c. Prioritize collaborating and coordinating with local, state, and federal regulatory agencies as well as interested parties to better understand the full suite of beneficial uses and users that may be impacted by pumping induced surface water depletion within the GSA's jurisdictional area.

RECOMMENDED CORRECTIVE ACTION 7

Department staff recommend that existing wells be evaluated to be included as part of the groundwater quality monitoring network to fill data gaps in the eastern portion of the

Subbasin, until newly proposed monitoring wells are constructed. Additionally, Department staff recommend the final groundwater quality network identify a monitoring location in the central portion of the Subbasin where the existing groundwater depression was identified.

RECOMMENDED CORRECTIVE ACTION 8

The GSP currently states that only groundwater quality wells from the representative monitoring network will be utilized to create the chloride isocontour line that will be used to evaluate seawater intrusion sustainable management criteria. As currently depicted, very few representative monitoring wells are on the western side of the isocontour line. Department staff recommend that development of the chloride isocontour line utilize all groundwater quality wells in the western portion of the Subbasin, as appropriate considering well construction information.

TECHNICAL MEMORANDUM NO. 1 – Groundwater Levels

TO:	Paul Gosselin, California Department of Water Resources Deputy Director
CC:	Ashley Couch, on behalf of the Eastern San Joaquin Groundwater Authority
PREPARED BY:	Emily Honn and Nicole Koerth, Woodard & Curran
DATE:	November 2024
RE:	Eastern San Joaquin Groundwater Authority Response to DWR's July 6, 2023 Approved Determination Letter for the 2022 Revised GSP - Technical Memorandum No. 1, Response to DWR Recommended Corrective Action No. 1

On July 27, 2022, the Groundwater Sustainability Agencies (GSAs) submitted the Eastern San Joaquin Groundwater Subbasin Revised 2022 Groundwater Sustainability Plan (GSP or Plan) for the San Joaquin Valley – Eastern San Joaquin Subbasin (Subbasin) to the California Department of Water Resources (DWR) in response to DWR's incomplete determination letter dated January 28, 2022. In a July 6, 2023 letter, DWR staff concluded that the GSAs had taken sufficient actions to correct deficiencies identified by DWR and approved the 2022 Revised Plan (see **Appendix 3-B of the GSP**). In Section 6 of the letter, DWR staff also identified recommended corrective actions (RCAs) for the GSAs to address by the Plan's first periodic evaluation.

This technical memorandum (TM) is in response to RCA #1 related to groundwater levels. This TM is organized into the following sections:

1) Overview of Recommended Corrective Action #1
2) Approach to Recommended Corrective Action #1
3) Update to Groundwater Level Minimum Thresholds
4) Impacts Analysis
5) Plan for Future Assessment of Degraded Groundwater Quality related to Groundwater Levels
6) Conclusions
7) References

1. OVERVIEW OF RECOMMENDED CORRECTIVE ACTION #1

The following was the text included in Section 6 of DWR's July 2023 Determination Letter:

The GSP does not provide a sufficient evaluation of the potential impacts to various beneficial uses and users of groundwater related to the chronic lowering of groundwater level minimum thresholds and criteria used to identify undesirable results. The following items should be addressed:

- ***1a.*** *Department staff recommend the Agencies explain the selection of 25 percent of exceedances as considered undesirable, including details describing the groundwater conditions and how those conditions constitute a significant and unreasonable effect of beneficial uses and users.*

  Department staff also recommend that the updated modeling results be used to quantify and disclose the potential impacts to groundwater well users during projected conditions where minimum thresholds are exceeded but undesirable results do not occur. In addition to impacts to domestic and municipal wells, this evaluation should include impacts to smaller water systems reliant on groundwater wells. Department staff also recommend that the GSAs review the Department's April 2023 guidance document titled Considerations for Identifying and Addressing Drinking Water Well Impacts guidance to assist its adaptive management efforts.

- ***1b.*** *Department staff recommend the GSP include a more thorough evaluation of the impacts to environmental uses and users related to the groundwater level minimum thresholds, or, at minimum, describe a plan to perform this evaluation in the future when additional data become available.*

- ***1c.*** *The GSP should evaluate the minimum thresholds in relation to the depths of nearby public water systems and state small water systems reliant on groundwater wells. While it may be reasonable to assume that wells in these systems are generally deeper than domestic wells, which were part of the minimum threshold analysis, Department staff recommend that an evaluation of these smaller water systems be disclosed by the GSP.*

- ***1d.*** *Department staff recommend the Agencies develop a more detailed plan describing how the assessment of groundwater quality in relation to declining groundwater levels will be conducted, including identifying specific analyses, well locations (either wells already monitored as part of GSP implementation or wells monitored by other programs), sampling frequency, and data gaps.*

2. APPROACH TO RECOMMENDED CORRECTIVE ACTION #1

In response to RCA #1, a comprehensive evaluation of impacts to the beneficial users of groundwater in the Eastern San Joaquin Subbasin (Subbasin) as a result of the established groundwater level sustainable management criteria (SMC) was completed for the 2025 Periodic Evaluation of the Subbasin's GSP and for inclusion in a GSP amendment (2024 Amended GSP). Impacts on the following beneficial users were incorporated into the revised analyses to address RCA #1a-c:

- Domestic Wells (included in the original (2020) GSP, and amended (2024) GSP)
- Groundwater Dependent Ecosystems (GDEs)
- Public Water Systems and Community Water Systems

Impacts to wells that public water systems, and specifically small community water systems, rely on were assessed in a manner similar to that used for domestic wells in the 2020 GSP (RMC #1c, Section 4.1). Impacts to potential GDEs were preliminarily evaluated in a manner similar to that used for public water systems and domestic wells (RCA #1b, Section **Error! Reference source not found.**). These updated well and potential GDE impacts analyses were then evaluated across a range of undesirable result definitions in order to provide more context and support for why the threshold in the 2020 GSP is considered reasonable (RCA #1a, Section 4.2).

Lastly, a plan was developed to evaluate the relationship between declining groundwater levels and degrading water quality, long-term (RCA #1d, Section 5). Analysis of water quality data in the Subbasin is included in more detail in the Groundwater Quality TM (TM No. 3), but the portion relevant to addressing RCA #1d is included in Section 0 of this TM.

3. UPDATE TO GROUNDWATER LEVEL MINIMUM THRESHOLDS

The groundwater level minimum thresholds (MTs) in the 2020 GSP were calculated as the shallower of the following:

- 1992, 2015, or 2016 groundwater level low + buffer equal to 100% of historical range
- 10^{th} percentile of domestic well depths within a 3-mile radius[1]

To be more consistent with the requirements and expectations expressed by DWR, the new groundwater level minimum thresholds were adjusted during the Periodic Evaluation and subsequent GSP Amendment to be calculated as the shallower of the following:

- 2015 groundwater level low + buffer equal to 100% of historical range
- 10^{th} percentile of domestic well depths within a 3-mile radius[2]

Table 1 shows the current wells that make up the representative monitoring network (RMN) for groundwater levels with the minimum thresholds established in the 2020 GSP, how they were initially calculated, the revised minimum thresholds, and how they were calculated in the 2024 Amended GSP. **Figure 1** shows where these wells are located within the Subbasin.

With this change, the minimum threshold was increased (raised) at six wells, resulting in a more protective minimum threshold than was established in the 2020 GSP for the same wells. These six wells averaged a 7.6-foot increase in their minimum threshold values. This change also resulted in a lower minimum threshold at three wells, by an average of approximately 1.7 feet. Overall, the new minimum thresholds are more protective of beneficial uses within the Subbasin.

Additionally, two new multi-completion wells have been added to the RMN for groundwater levels: SEWD-01 and NSJWCD-01. These wells were recently constructed under DWR's Technical Support Services (TSS) program. Table 2 summarizes the construction information for the new monitoring wells. These wells will be monitored starting in WY 2025. SEWD-01 contains two boreholes: the deeper one has two completions and the shallower one has three. NSJWCD-01 also contains two boreholes: the shallower one has four completions and the deeper one has two.

These new wells fill a data gap; however, there are insufficient groundwater level observations to establish sustainable management criteria (SMCs) for these new wells. Bi-annual collection of groundwater levels at these sites will continue to fill the data gap. SMCs will be established at these representative monitoring sites after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs.

[1] One well is analyzed using a 2-mile radius

[2] One well is still analyzed using a 2-mile radius

Minimum thresholds for these and other new wells that may be constructed in the future will be established based on adjusted recent groundwater levels from a dry/critical year. The adjustment of groundwater levels is the difference in simulated groundwater levels in ESJWRM between Water Year 2015 (a dry year) and the recent dry/critical year when groundwater level observations are measured. The calculation for the minimum threshold is:

$$Minimum\ Threshold = Observed\ Recent\ Dry/Critical\ GWL - \ (Simulated\ Recent\ Dry\ Year\ GWLs - Simulated\ 2015\ GWLs)$$

As a hypothetical example, suppose Water Year 2027 is a critical year and the observed groundwater elevation for Well A is 75 feet mean sea level (msl) in 2027. Assuming that the simulated groundwater elevations in ESJWRM at Well A increase by 8 feet between 2015 and 2027. The minimum threshold would be 75 feet minus 8 feet, or 67 feet msl.

Conversely, measurable objectives will be established from an adjustment in groundwater levels from a wet year. The adjustment will add the difference in simulated groundwater levels from ESJWRM between Water Year 2011 (a wet year) and a recent wet year when groundwater level observations are collected. The calculation for measurable objectives is:

$$Measurable\ Objectives = Observed\ Recent\ Wet\ GWL + \ (Simulated\ Recent\ Wet\ Year\ GWL - Simulated\ 2011\ GWLs)$$

As a hypothetical example, suppose Water Year 2026 is a wet year, and the observed groundwater elevation for Well A is 82 feet msl that year. Suppose that the simulated groundwater elevations in ESJWRM at Well A decrease by 15 feet between Water Year 2011 and 2026. The measurable objective would be 82 feet minus negative 15 feet, equaling 97 feet msl.

In the absence of historical data, this methodology is meant to estimate historical conditions as closely as possible.

Table 1: Updated Minimum Thresholds for Groundwater Levels

CASGEM Well ID	Local Well ID	Original GSP Minimum Threshold (ft MSL)	Original GSP Minimum Threshold Source	2025 GSP Minimum Threshold (ft MSL)	2025 GSP Minimum Threshold Source
378824N1210000W001	01S09E05H002	-49.8	Dom well	-49.8	Dom well
379316N1211665W001	01N07E14J002	-114.4	GWL	-93.9	GWL
380067N1213458W003	Swenson-3	-26.6	GWL	-26.6	GWL
380206N1210943W001	02N08E15M002	-124.1	Dom well	-124.1	Dom well
Not in CASGEM	#3 Bear Creek	-72.3	GWL	-73.8	GWL
Not in CASGEM	Lodi City Well #2	-38.5	GWL	-34.4	GWL
Not in CASGEM	Manteca 18	-16.0	GWL	-19.0	GWL
381843N1212261W001	04N07E20H003M	-81.7	GWL	-80.5	GWL
380909N1212153W001	03N07E21L003	-100.0	GWL	-94.0	GWL
Not in CASGEM	Hirschfeld (OID-8)	8.0	GWL	7.9	GWL
377909N1208675W001	Burnett (OID-4)	60.7	GWL	60.8	GWL
377136N1212508W001	02S07E31N001	1.5	GWL	0.8	GWL
377810N1211142W001	02S08E08A001	0.6	GWL	0.6	GWL
380578N1212017W001	02N07E03D001	-122.8	Dom well	-113.7	GWL
379661N1210011W001	01N09E05J001	-86.8	Dom well	-86.8	Dom well
379976N1212308W001	02N07E29B001	-130.1	Dom well	-130.1	Dom well
381559N1213727W001	04N05E36H003	-31.1	GWL	-31.1	GWL
381317N1213524W001	03N06E05N003	-35.1	GWL	-35.1	GWL
381816N1213723W001	04N05E24J004	-31.2	GWL	-31.2	GWL
378163N1208321W001	01S10E26J001M	43.7	GWL	43.7	GWL
378846N1208816W001	01S10E04C001M	50.0	GWL	54.7	GWL
382345N1212261W001 -	NSJWCD-01	NA	NA	TBD	TBD
379794N1211083W001 -	SEWD-01	NA	NA	TBD	TBD

Table 2: New Wells to be Added to the GWL Representative Monitoring Network

Well Name	Well Depth/Planned Well Depth (ft below ground surface)	Description
SEWD-01	SEWD-01-A (North): 165 SEWD-01-B (North): 405 SEWD-01-C (South): 580 SEWD-01-D (South): 900 SEWD-01-E (South): 1,200	• TSS Well within Stockton East Water District GSA • Drilled and developed in 2021
NSJWCD-01	NSJWCD-01-A (Shallow): 190 NSJWCD-01-B (Shallow): 360 NSJWCD-01-C (Shallow): 590 NSJWCD-01-D (Shallow): 780 NSJWCD-01-E (Deep): 1,250 NSJWCD-01-F (Deep): 1,635	• TSS Well within North San Joaquin Water Conservation District • Drilled in 2020, developed in 2021

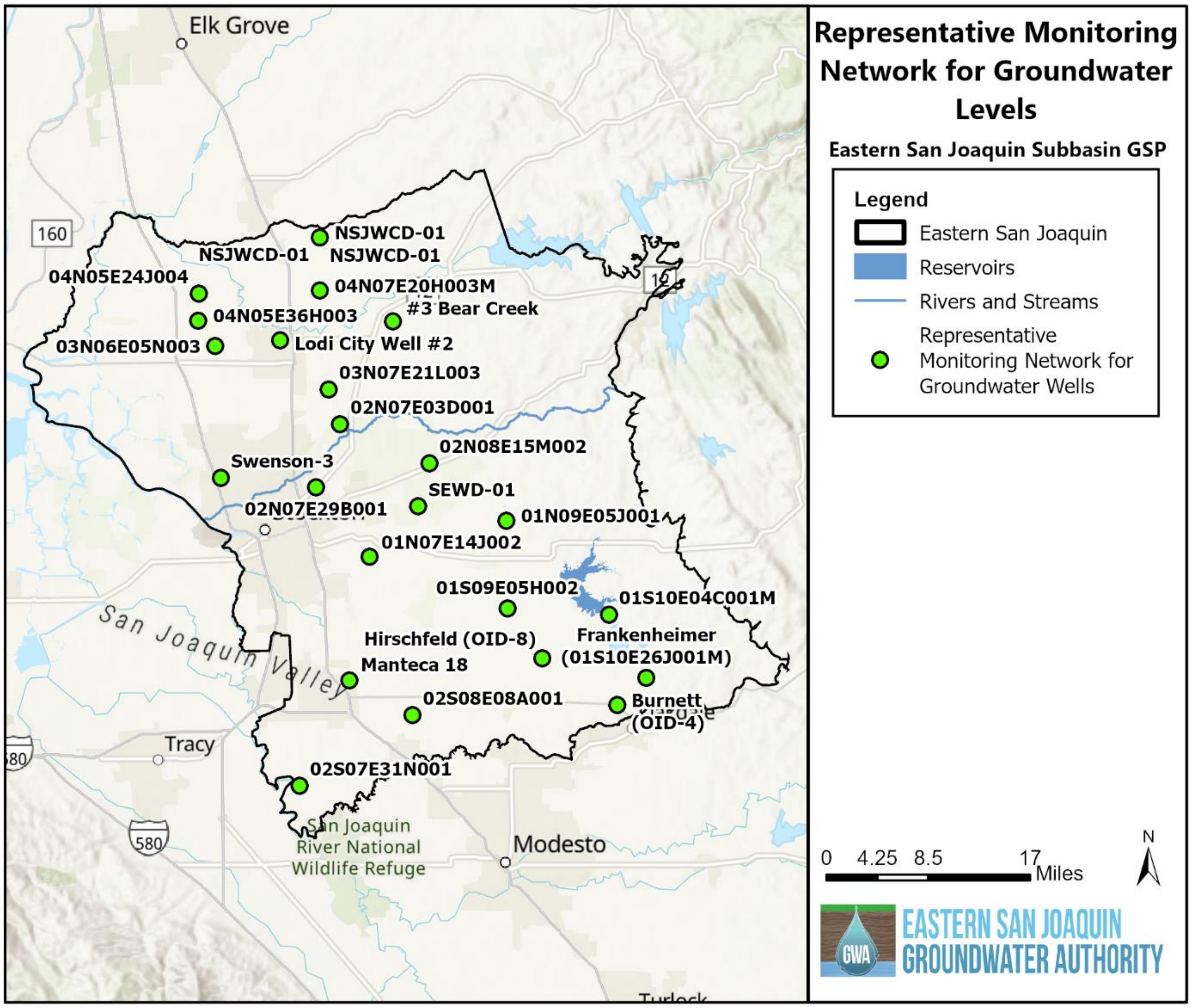


Figure 1: Representative Monitoring Network for Groundwater Levels

4. IMPACTS ANALYSIS

4.1 Well Impacts Analysis Methods

An inventory of all wells within the Eastern San Joaquin Subbasin was compiled by their use, type, and depth. This list was then filtered by the following attributes:

- Only active wells.
- Well depths are known.
- Only wells drilled after 1974 (in order to only consider wells that are within their usable lifespan, assumed to be approximately 50 years)

The remaining wells were then sorted into each of the following type categories:

- Domestic wells
- Public Supply Wells
- Public Supply Wells that are within a Community Water System (CWS)

State small water systems are defined as systems that serve 5 to 14 service connections and do not regularly serve drinking water to more than an average of 25 individuals daily for more than 60 days out of the year (California State Water Resources Control Board, 2021). State small water systems have fewer connections and serve fewer permanent residents than community water systems (CWS). However, since the location and depth of wells that state small water systems rely on is not readily available, this analysis conservatively looks more broadly at what wells are within CWS service areas within the Subbasin. It is assumed that if there are impacts to CWS, then there likely will be impacts to state small water systems.

A 3-mile radius around each monitoring location was delineated to represent an "Impact Zone" of that representative monitoring well (RMW). For simplicity and to be most conservative, it was assumed that groundwater levels, and therefore their impact, are uniform within the Impact Zone. For example, in this analysis, a domestic well that is 2 miles away from the RMW location is assumed to be impacted to the same degree as a well that is 0.5 miles away. **Table 3** shows the total number of wells, by type, within each RMW's Impact Zone. The range in well depths, as well as the average well depth, are also shown by type.

Figure 2 and **Figure 3** show the impact zones for each RMW for domestic wells and public supply wells, respectively. These impact zones are shown overlying the inventory of wells that meet the above criteria for each well group. **Figure 4** shows the same, but with public supply wells that are within a CWS.

The depth of the 10th percentile well depth was determined for all wells within the Impact Zone for each well type. This threshold represents the depth at which 90% of the wells would be deeper within each Impact Zone. This is consistent with how the domestic well impacts component of the minimum threshold calculation was completed in the 2020 GSP, but is now applied to domestic wells, public supply wells, and public supply wells that fall within a CWS. The 10th percentile depth for each well type was then compared to the lowest groundwater level observed in 2015 plus a buffer of 100% of the historical range, or the minimum threshold at wells "assumed" to drop to their minimum threshold. The 2015 low groundwater elevation is considered to be the worst-case scenario in this analysis and therefore the results represent the most conservative assumptions.

Table 3: Well Detail for Impacts Analysis, by Type

Well Type	Total Number within 3-mile Radius Impact Zone of RMWs	Well Depth Range within 3-mile Radius Impact Zone of RMWs (ft bgs)	Well Depth Average within 3-mile Radius Impact Zone of RMWs (ft bgs)
Domestic Wells	4,855	5 to 1300	248
Public Supply Wells	165	72 to 856	357
Public Supply Wells – Community Water System	58	72 to 720	382

ft bgs = feet below the ground surface

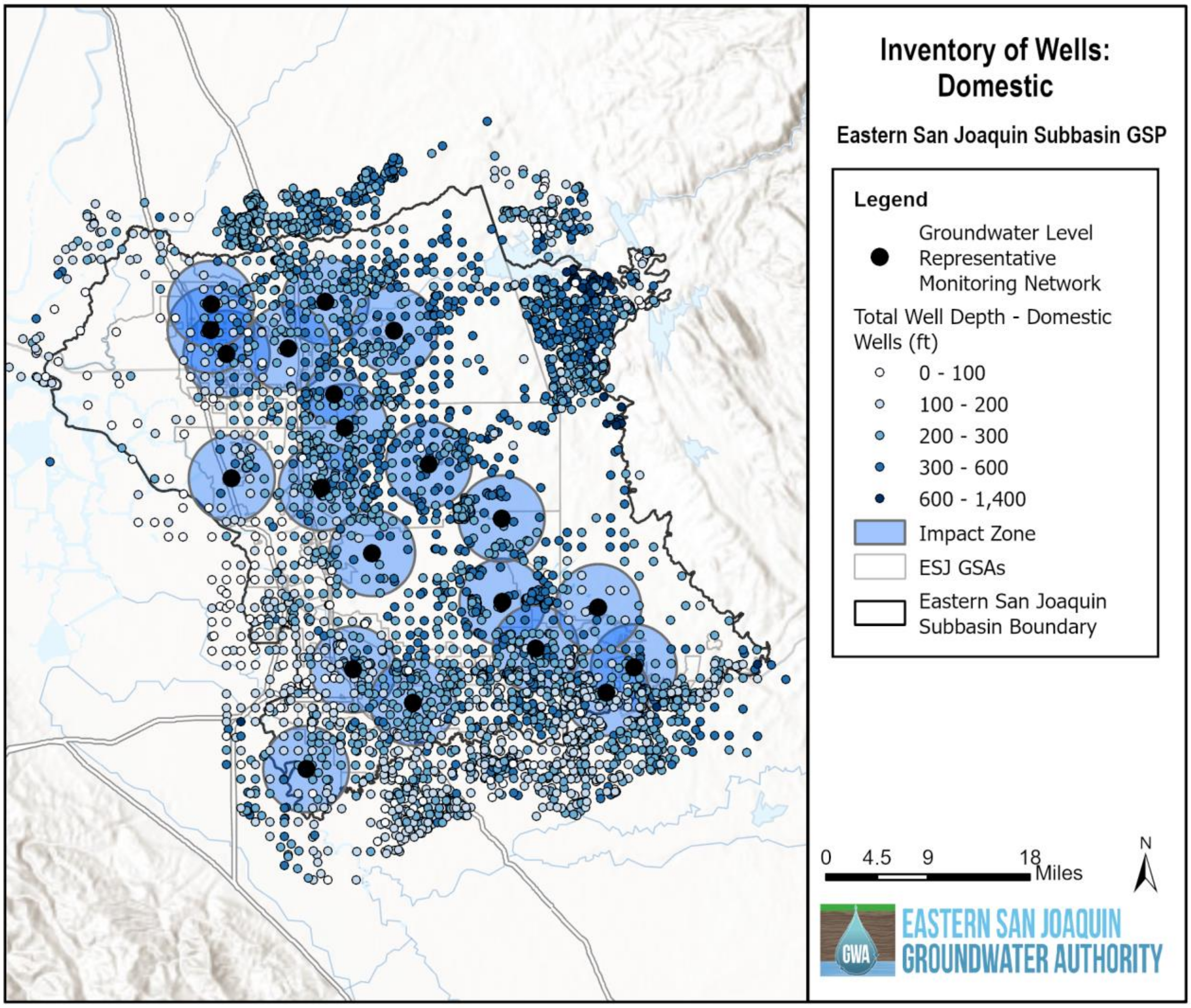


Figure 2: Inventory of Domestic Wells with Identified Impact Zones around each RMW

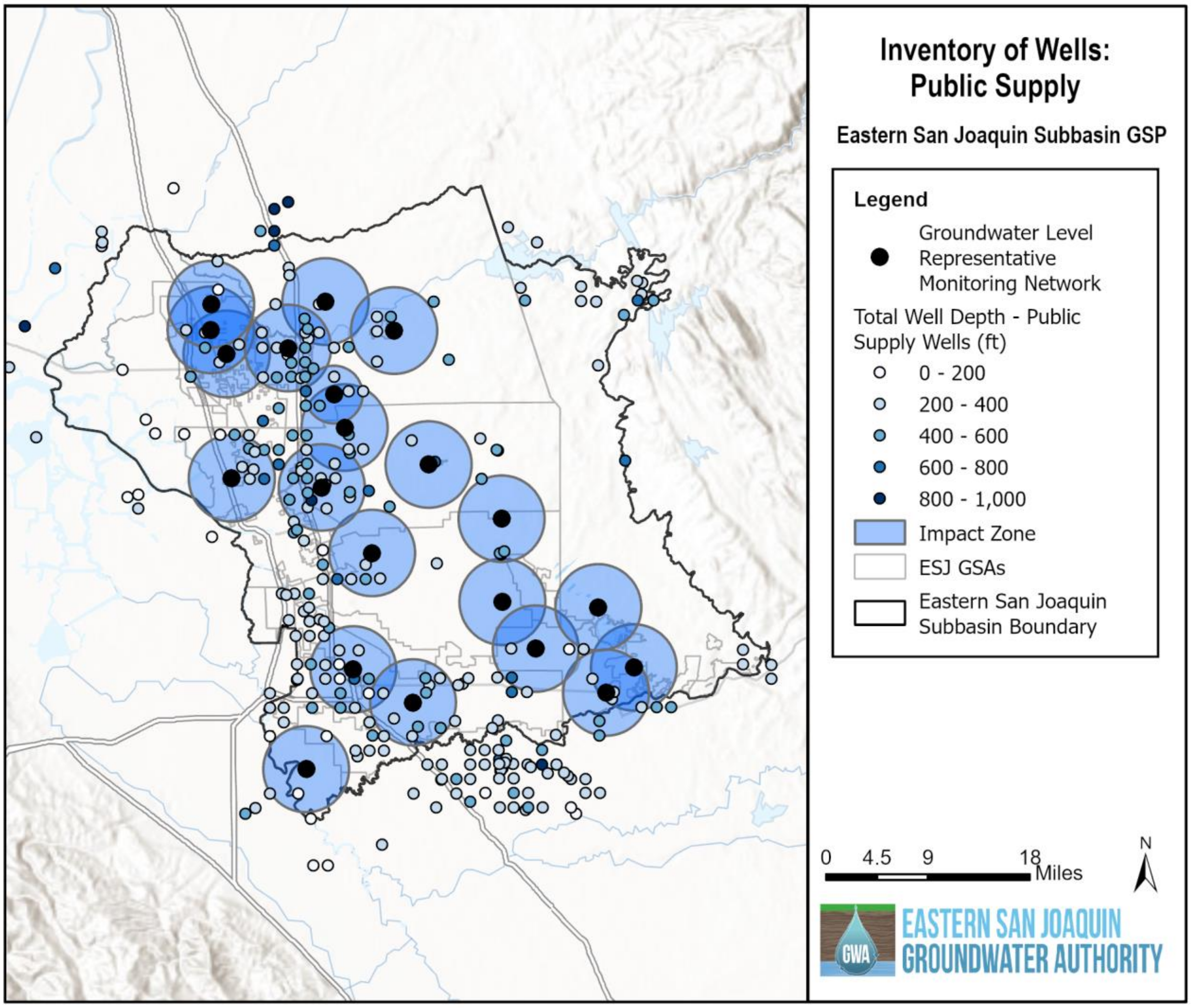


Figure 3: Inventory of Public Supply Wells with Identified Impact Zones around each RMW

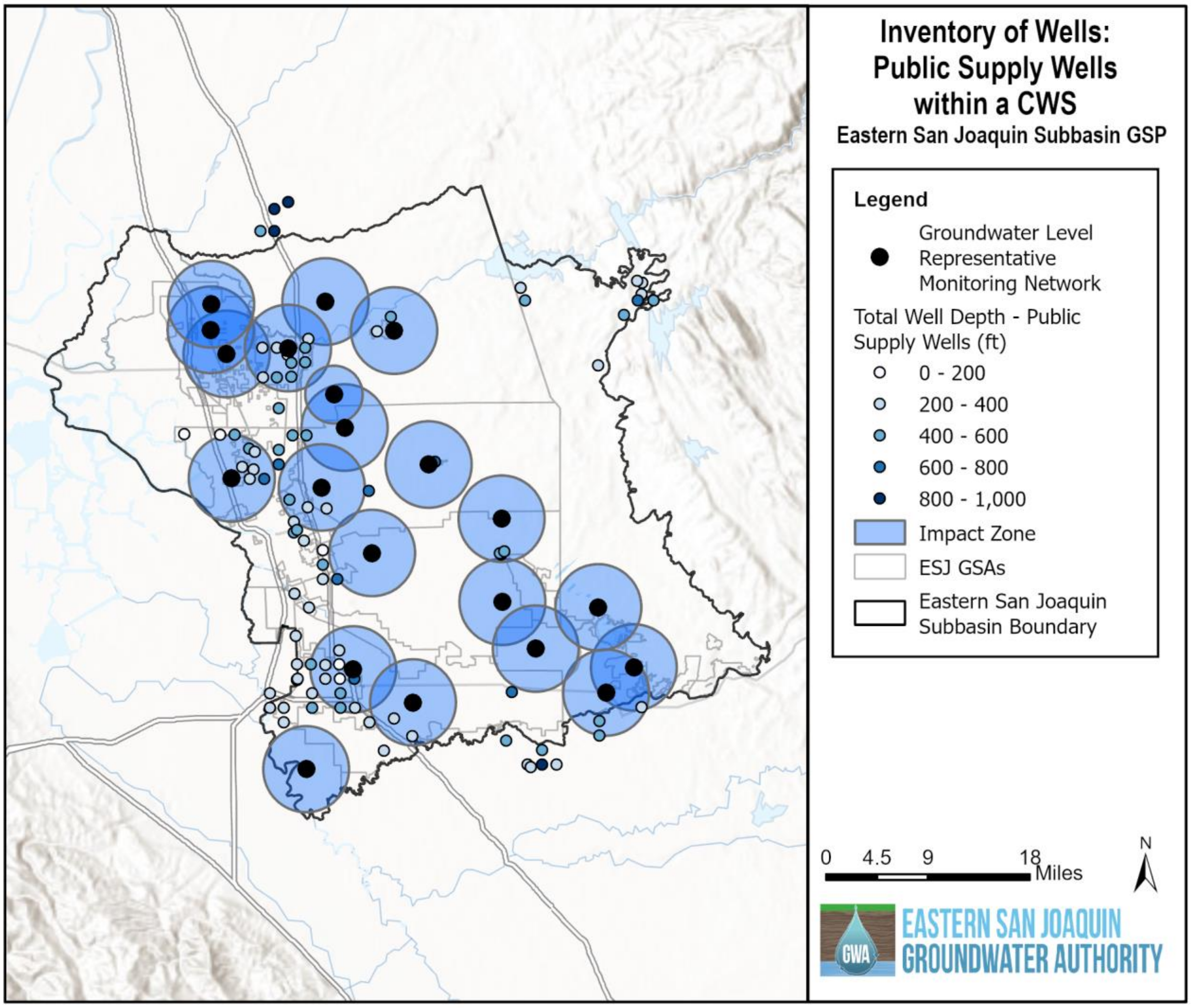


Figure 4: Inventory of Public Supply within a Community Water System (CWS) with Identified Impact Zones around each RMW

4.2 Well Impacts Analysis Results

The impacts analysis completed for domestic wells, public supply wells, and groundwater dependent ecosystems was evaluated across a range of different definitions of undesirable results. The GSP defined the undesirable result for groundwater levels to be:

Undesirable Result = 25% of the 20 Representative Monitoring Network Wells drop to their minimum threshold for 2 consecutive years[1]

A series of scenarios were assessed based on different definitions of what the undesirable result represents. Specifically, the different undesirable result scenarios that were evaluated assumed, of the 21 RMWs for groundwater levels from the 2022 GSP:

- 10 wells drop to their minimum threshold, representing 48% of the RMWs.
- 8 wells drop to their minimum threshold, representing 38% of the RMWs.
- 5 wells drop to their minimum threshold, representing 24% of the RMWs[2].
- 3 wells drop to their minimum threshold, representing 14% of the RMWs.

This analysis conservatively only considered the impacts from a single year of undesirable results, rather than two consecutive years.

Table 4 through Error! Reference source not found. show the results of the impacts analysis described in the previous sections, reported by representative monitoring network well. **Table 4** through **Table 6** presents the results of the well impacts analysis; **Table 4** for domestic wells, **Table 5** for public supply wells, and **Table 6** for public supply wells in community water systems. The number of wells of each type that may go dry is shown for each scenario. A well within each Impact Zone is considered to go dry if the groundwater level at the representative monitoring network well drops below the total completion depth of the well.

In each scenario, the wells that have groundwater levels drop to their minimum threshold were selected based on how close their 2015 low groundwater level was to the minimum threshold. For example, a representative network well with a groundwater level 1 ft away from the minimum threshold would be selected over a well that has groundwater levels 10 ft over its minimum threshold. In each scenario, the number of wells with groundwater levels that are assumed to drop to their minimum threshold represent the 10 closest wells to their minimum threshold.

The total number of wells shown in the second column indicates the number of wells within each representative network well radius that is of that particular well type. Columns 3 through 6 represent the number of those wells that are shallower than the groundwater level or the minimum threshold, if that is a well that was selected for use in the simulation.

[1] There was an additional well added to the RMN for groundwater levels in 2021. Two more wells are being added in the 2024 GSP, as described in Section 3 of this document. The minimum thresholds for these wells will be established in a future GSP.
[2] Note: The 2020 GSP had 20 RMWs, and therefore five wells resulted in an undesirable result definition of 25%. For the purposes of comparison, the same five wells are used, but the percentage is reported as 5/21 = approximately 24% in this study.

Two additional evaluation radii or rings were added to the analysis to ensure that impacts in sensitive areas are being incorporated beyond the RMWs: Along the San Joaquin River and in the Bay Delta area. The centroid of these additional radii is not an actual well location and serves for a hypothetical comparison to understand what the impacts in those areas may be using the same approach. The groundwater level used at these additional rings is the lowest simulated by ESJWRM in 2015. Since the rings are not centered around an actual well, there are no observed groundwater levels at these two locations.

Table 4 through **Table 6** indicate that in all undesirable result scenarios, less than 2% of wells of each type may go dry. An undesirable result where groundwater levels in 48% of RMWs reach their MTs represents the largest impact to both domestic wells and public supply wells, with a declining percentage of impact to domestic and public supply wells with each less protective scenario (where fewer RMWs exceed their MTs). For community water systems, the impact is the same in all scenarios, with 1 out of 58 total CWS wells impacted. Further investigation would be required to assess whether this single impacted well is a well that is relied upon by a state small water system. At the current undesirable result definition, <1% of domestic and public supply wells and <2% of community water system wells are estimated to go dry. Even if 10 RMWs were to drop to their minimum threshold, it is estimated that < 2% of domestic and/or public supply wells would go dry.

Table 4: Impacts on Domestic Wells under Various Undesirable Results Scenarios

	DOMESTIC WELLS				
	Number of Rep MN Wells at MT:	10	8	5	3
	% of Rep MN Wells at MT:	**48%**	**38%**	**24%**	**14%**
	Total Number of Wells Within Radius	Number of Dry Domestic Wells			
01S09E05H002	*139*	2	1	1	1
01N07E14J002	*120*	0	0	0	0
Swenson-3	*62*	0	0	0	0
02N08E15M002	*144*	2	2	2	2
#3 Bear Creek	*165*	0	0	0	0
Lodi City Well #2	*196*	3	0	0	0
Manteca 18	*328*	5	5	2	2
04N07E20H003M	*321*	0	0	0	0
03N07E21L003	*121*	0	0	0	0
Hirschfeld (OID-8)	*524*	7	7	7	7
Burnett (OID-4)	*479*	10	10	4	4
02S07E31N001	*175*	2	2	2	1
02S08E08A001	*303*	6	6	6	2
02N07E03D001	*363*	0	0	0	0
01N09E05J001	*162*	0	0	0	0
02N07E29B001	*627*	1	1	1	1
04N05E36H003	*97*	0	0	0	0
03N06E05N003	*142*	3	3	1	1
04N05E24J004	*74*	0	0	0	0
01S10E26J001M	*268*	2	2	2	2
01S10E04C001M	*45*	0	0	0	0
Additional Ring at River	*286*	1	1	1	1
Additional Ring at Delta	*10*	0	0	0	0
TOTALS (Within Rep MN Radii)	***4855***	**43**	**39**	**28**	**23**
	% of Domestic Wells Dry (Within Rep MN Radii)	0.9%	0.8%	0.6%	0.5%

Table 5: Impacts on Public Supply Wells under Various Undesirable Results Scenarios

	PUBLIC SUPPLY WELLS				
	Number of Rep MN Wells at MT:	10	8	5	3
	% of Rep MN Wells at MT:	**48%**	**38%**	**24%**	**14%**
	Total Number of Wells Within Radius	Number of Dry Public Supply Wells			
01S09E05H002	*0*	0	0	0	0
01N07E14J002	*5*	0	0	0	0
Swenson-3	*7*	0	0	0	0
02N08E15M002	*2*	0	0	0	0
#3 Bear Creek	*4*	0	0	0	0
Lodi City Well #2	*28*	1	0	0	0
Manteca 18	*17*	0	0	0	0
04N07E20H003M	*8*	0	0	0	0
03N07E21L003	*4*	0	0	0	0
Hirschfeld (OID-8)	*5*	0	0	0	0
Burnett (OID-4)	*5*	0	0	0	0
02S07E31N001	*2*	0	0	0	0
02S08E08A001	*11*	0	0	0	0
02N07E03D001	*11*	0	0	0	0
01N09E05J001	*3*	0	0	0	0
02N07E29B001	*24*	1	1	1	1
04N05E36H003	*9*	0	0	0	0
03N06E05N003	*13*	0	0	0	0
04N05E24J004	*4*	0	0	0	0
01S10E26J001M	*3*	0	0	0	0
01S10E04C001M	*0*	0	0	0	0
Additional Ring at River	*15*	0	0	0	0
Additional Ring at Delta	*1*	0	0	0	0
TOTALS (Within Rep MN Radii)	***165***	**2**	**1**	**1**	**1**
	% of Public Supply Wells Dry (Within Rep MN Radii)	1.2%	0.6%	0.6%	0.6%

Table 6: Impacts on Public Supply Wells in Community Water Systems under Various Undesirable Results Scenarios

	COMMUNITY WATER SYSTEM WELLS				
	Number of Rep MN Wells at MT:	10	8	5	3
	% of Rep MN Wells at MT:	**48%**	**38%**	**24%**	**14%**
	Total Number of Wells Within Radius	Number of Dry CWS Wells			
01S09E05H002	*0*	0	0	0	0
01N07E14J002	*0*	0	0	0	0
Swenson-3	*7*	0	0	0	0
02N08E15M002	*1*	0	0	0	0
#3 Bear Creek	*2*	0	0	0	0
Lodi City Well #2	*15*	1	0	0	0
Manteca 18	*13*	0	0	0	0
04N07E20H003M	*1*	0	0	0	0
03N07E21L003	*0*	0	0	0	0
Hirschfeld (OID-8)	*0*	0	0	0	0
Burnett (OID-4)	*2*	0	0	0	0
02S07E31N001	*0*	0	0	0	0
02S08E08A001	*4*	0	0	0	0
02N07E03D001	*3*	0	0	0	0
01N09E05J001	*3*	0	0	0	0
02N07E29B001	*3*	0	1	1	1
04N05E36H003	*0*	0	0	0	0
03N06E05N003	*3*	0	0	0	0
04N05E24J004	*0*	0	0	0	0
01S10E26J001M	*1*	0	0	0	0
01S10E04C001M	*0*	0	0	0	0
Additional Ring at River	*5*	0	0	0	0
Additional Ring at Delta	*0*	0	0	0	0
TOTALS (Within Rep MN Radii)	***58***	**1**	**1**	**1**	**1**
	% of CWS Wells Dry (Within Rep MN Radii)	1.7%	1.7%	1.7%	1.7%

4.3 Potential GDE Impacts Analysis Methods

In the Eastern San Joaquin Subbasin, the primary environmental beneficial users are groundwater dependent ecosystems (GDEs). Sufficiently high groundwater levels are required to maintain connection between groundwater levels and the root zones of these ecosystems.

GDEs are defined in the GSP Emergency Regulations as the following based on the California Code of Regulations (CCR) Title 23 § 351 (m):

> *"Groundwater dependent ecosystem" refers to ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface."*

4.3.1 Potential GDE Mapping

In the 2020 GSP, potential GDEs were mapped across the Subbasin. The mapping relied on the Natural Communities Commonly Associated with Groundwater (NCCAG) database, from which additional refinements were made to remove areas that met the following criteria:

- Areas where groundwater levels were deeper than 30 feet below the ground surface (ft bgs).
- Areas with access to alternate water supplies that may not be dependent on groundwater (i.e., communities close to managed wetlands, irrigated agriculture, or perennial surface water bodies).

The resulting desktop mapping was then considered by GSA staff and technical workgroup members before inclusion in the GSP. Further detail on this approach to mapping potential GDEs is described in Section 2.2.7 of this GSP Amendment.

Before conducting the analysis to evaluate the potential impacts of the groundwater level SMC on potential GDEs, it was verified that no changes to the NCCAG dataset within the ESJ Subbasin have been made since 2020. The NCCAG database still represents the most comprehensive source of potential GDEs within this Subbasin. Polygons in the NCCAG dataset were removed where the vegetative community's average maximum rooting depths do not intersect with groundwater. In other words, if the vegetation is not able to access groundwater within its rooting depth, then it is assumed that the ecosystem is not a potential GDE. This average maximum rooting depth is estimated to be 30 feet below ground surface for the majority of phreatophytes (The Nature Conservancy, 2021). The original mapping completed as part of the 2020 GSP was retained in this GSP Amendment.

The map of potential GDEs included in the 2020 GSP is shown in **Figure 5**Error! Reference source not found..

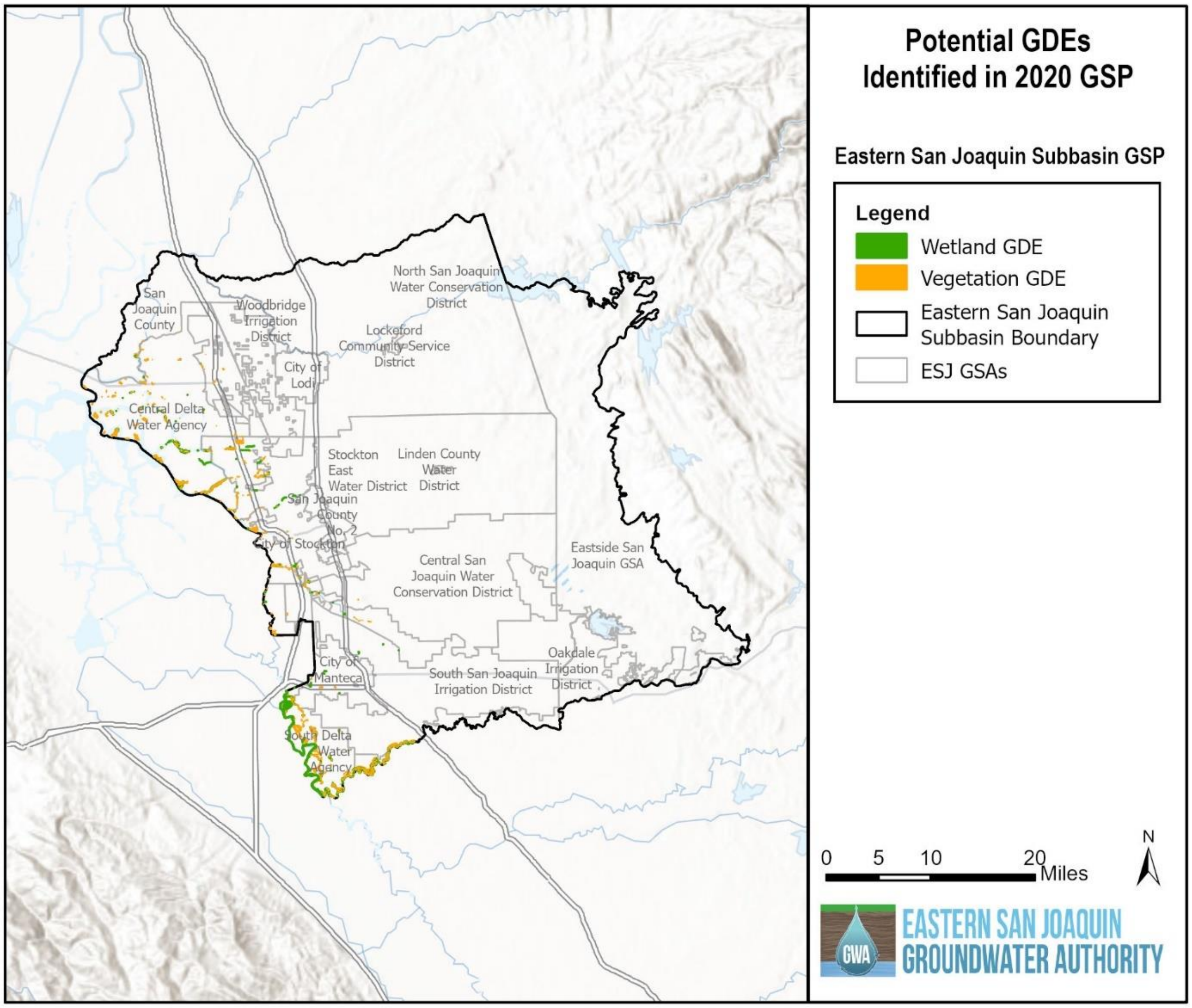


Figure 5: Mapping of Potential Groundwater Dependent Ecosystems

4.3.2 Impacts to Potential GDEs

While not a comprehensive analysis of potential GDE impacts across the Subbasin, impacts to potential GDEs were assessed in a manner consistent with the analysis completed for well impacts. The delineated polygons in the NCCAG dataset represent mapping of vegetation, wetlands, springs, and seeps across California compiled from 48 publicly available State and Federal agency datasets. The size of the polygon is determined for each ecological grouping using databases that gather information through aerial imagery, remote sensing, and field inspection. The total number of potential GDE polygons identified in the NCCAG dataset within each Impact Zone radii was counted. A count of potential GDEs polygons was assessed, rather than an acreage, due to concerns about how reliable the exact acreages are of the polygon delineations in the NCCAG dataset.

The rooting depth threshold plays a similar role as the 10th percentile threshold in the well impacts analysis by defining at what groundwater level there is an impact or not. It is assumed that if the groundwater level falls below the above thresholds in an Impact Zone, all identified potential GDEs within the Impact Zone would be impacted. Like in the well impact analysis, the impacts are conservatively assumed to be uniform throughout the full Impact Zone. If a potential GDE falls anywhere within an Impact Zone, it is designated as either potentially "impacted" or "not impacted," depending on where the groundwater level falls in relation to the rooting depth threshold (30 feet below ground surface).

The average simulated water level in 2015 was used to evaluate potential GDE impacts, to maintain consistency with the timing of the filters originally applied in the 2020 GSP. The depth to water dataset used in the 2020 GSP was not available and as a result the simulated water levels used in the 2024 GSP for the impacts analysis are similar but not the same as was used in the 2020 mapping. Using a single year from a model simulation is not ideal, but was selected to be as consistent as possible with the approach taken to develop the mapping. This caveat is discussed in further detail in Section 4.4.1.

It should be noted that the analysis presented herein is based on desktop work only. Field study beyond this analysis will be required to determine the presence, extent, and status of potential GDEs in the Subbasin to inform future assessment.

4.4 Potential GDE Impacts Analysis Results

The results of the impact analysis on potential GDEs are presented in this section, along with a description of its limitations. Impact Zones where potential GDE impacts may occur, as indicated by this desktop analysis, are shown in the Error! Reference source not found.. The count represents the number of identified polygons that may potentially be impacted within each Impact Zone. Under the 48% and 38% undesirable result scenarios described in Section 4.2, there are four Impact Zones that could be at risk of impacting a total of 28 potential GDEs; under the remaining two scenarios, there are three Impact Zones that could be at risk of impacting 14 potential GDEs. The percentage of potential GDEs impacted represents the number of potential GDE polygons at risk of impact compared to the total 602 potential GDE polygons identified across all Impact Zones in the Subbasin. Under the current undesirable result definition (5 RMN wells drop to their minimum threshold), this analysis shows that approximately 2.3% of the potential GDEs within Impact Zones could be impacted. As previously noted, these results are from a desktop only analysis, and do not incorporate any field verification. Therefore, they should be interpreted accordingly as an initial step toward identifying impacts to potential GDEs.

Section 4.4.1 details the limitations and data gaps included in this analysis.

Table 7: Impacts on Potential Groundwater Dependent Ecosystems under Various Undesirable Results Scenarios

Number of Rep MN Wells at MT:	*10*	*8*	*5*	*3*
% of Rep MN Wells at MT:	**48%**	**38%**	**24%**	**14%**
Representative Monitoring Network Impact Zones that May be Impacted	Count of Potential GDEs that May be Impacted			
Manteca 18	*8*	*8*	*8*	*8*
02N07E29B001	*1*	*1*	*1*	*1*
04N05E36H003	*14*	*14*	*0*	*0*
03N06E05N003	*5*	*5*	*5*	*5*
TOTALS (Within Rep MN Radii)	28	28	14	14
% of Potential GDEs that May be Impacted, of 602 Potential GDEs Subbasin-wide	**4.7%**	**4.7%**	**2.3%**	**2.3%**

While field verification will be needed to best assess the potentially impacted sites in **Table 8**, a preliminary assessment of Google Earth imagery was completed as a validation check. **Figure 7**, **Figure 8**, and **Figure 6** show the three Impact Zones where potential GDE impacts are identified under the existing undesirable result scenario: Manteca 18, 02N07E29B001, and 03N06E05N003. In each of these figures, the outlines of the potential GDE polygons are exaggerated in size to better be able to see on this scale, and do not reflect the true size of the potential GDE.

Figure 7 indicates that within the Manteca 18 Impact Zone there are five potential wetland GDE sites and three areas of potential habitat dominated by Valley Oaks that may exist along Lone Tree Slough. Upon further investigation using satellite imagery, the potential wetlands identified may be more likely ponded water on private property. It is difficult to ascertain whether these ponds support an ecosystem fed by shallow groundwater rather than applied water. The ecosystems along the Lone Tree Slough likely do not depend solely on groundwater, given their proximity to water available from the slough. Even if the water in Lone Tree Slough is not perennial, these sites are also adjacent to irrigated agriculture and may be receiving water from these neighboring agricultural areas. These sites may not be potential GDEs, but would require field verification to assess with certainty.

Figure 8 indicates that within the 02N07E29B001 Impact Zone there is one potential wetland GDE. It is difficult to discern in aerial imagery whether this small section of the Calaveras River beneath the rail bridge should be considered a wetland. Most of the Calaveras River is generally considered to be a losing stream (Appendix 3-F) and therefore it may be questionable whether this wetland is fed by groundwater. Field verification is needed to assess whether this site is a GDE.

Figure 6 indicates that within the 03N06E05N003 Impact Zone there are two areas of potential vegetative GDEs. The area at the far west of the Impact Zone is dominated by Fremont Cottonwood and the area northeast of there is dominated by Hardstem Bulrush. The potential GDE dominated by Fremont Cottonwood is adjacent to irrigated agriculture and an irrigation canal and therefore may not depend on groundwater but rather be receiving water from these neighboring agrictultural areas. The potential GDE dominated by Hardstem Bulrush is a group of polygons adjacent to an Interstate 5 onramp and offramp.

Some of the polygons are also adjacent to irrigated agriculture to the west, while others not directly. It is difficult to determine using aerial imagery whether these ecosystems would have access to an alternative source of water beyond groundwater. Field verification is needed to assess whether these sites are in fact GDEs.

Table 8 contains the locations and supplemental description of each of the NCCAG polygons discussed in the previous paragraphs. The locations shown are the centroid of the NCCAG polygon in decimal degrees.

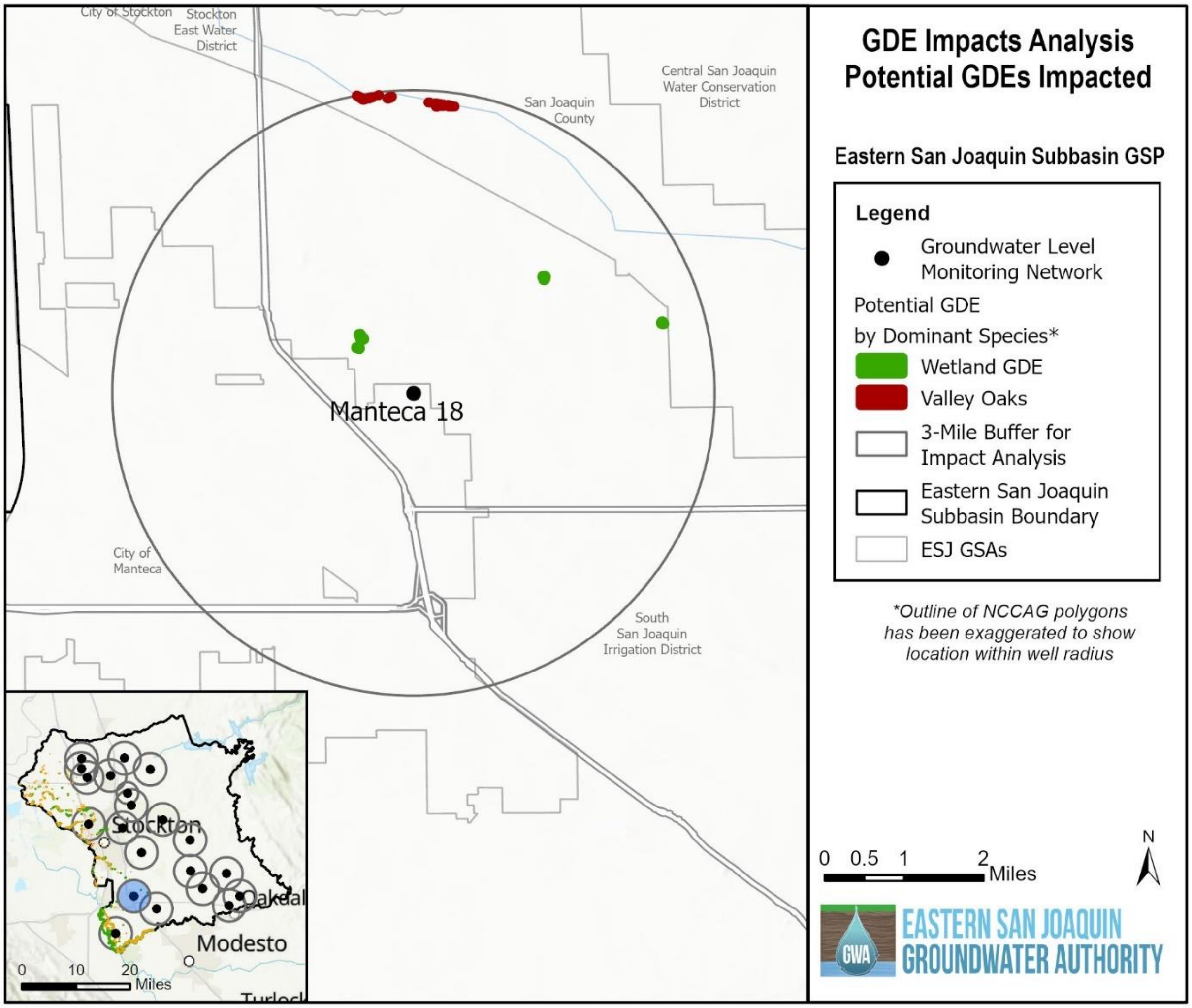


Figure 6: Map of Impact Zone for GWL Rep MN Manteca 18

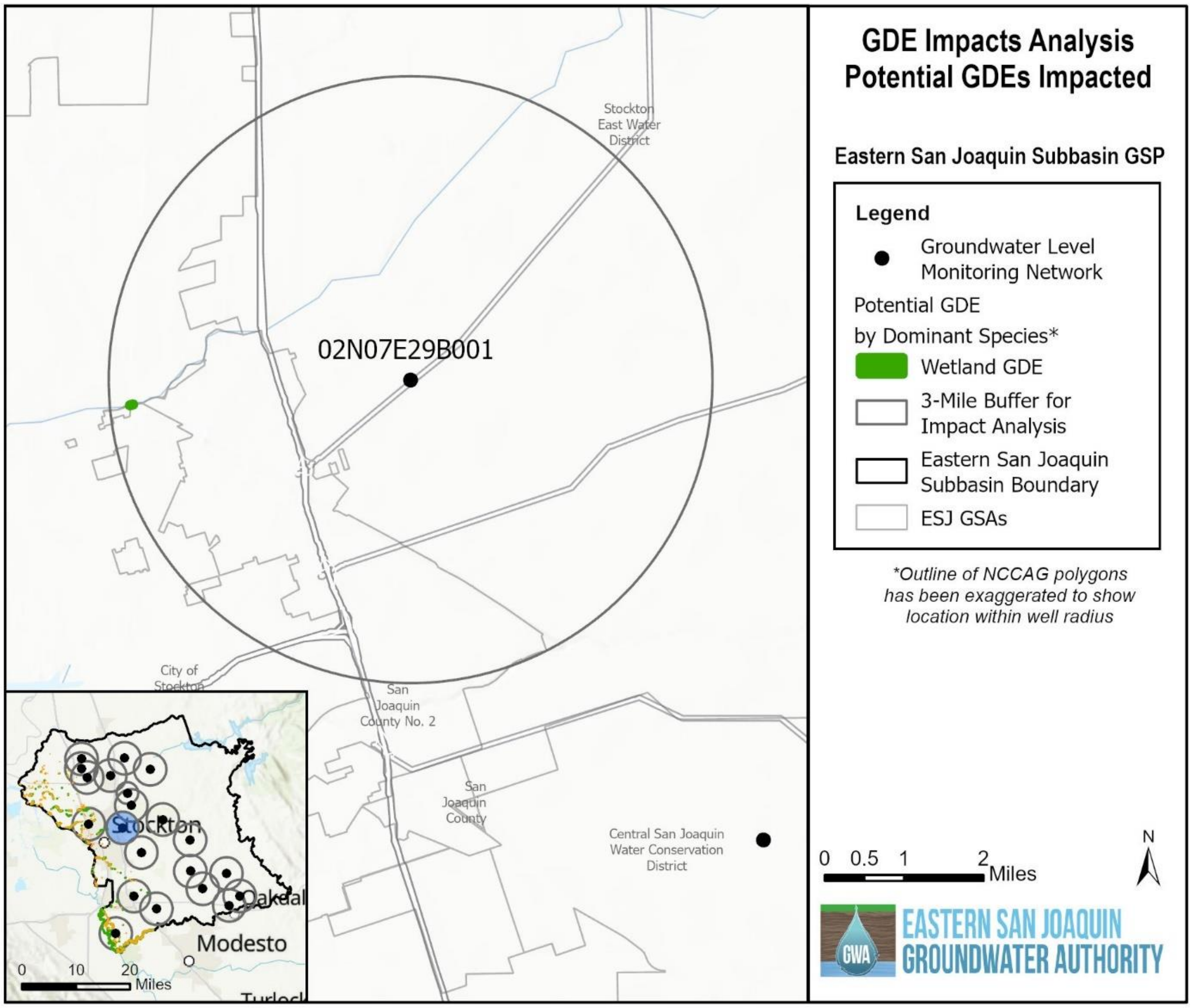


Figure 7: Map of Impact Zone for GWL Rep MN 02N07E29B001

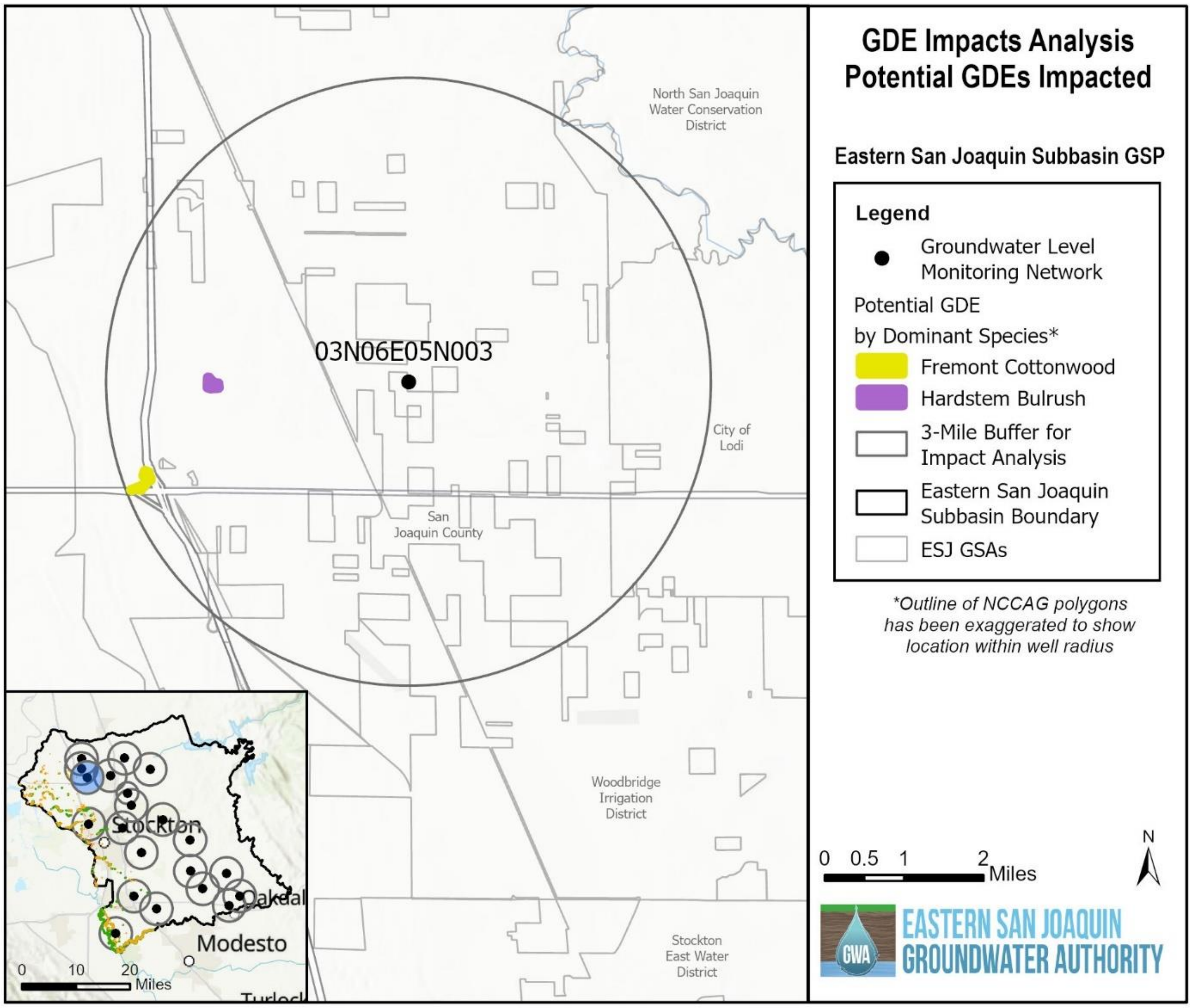


Figure 8: Map of Impact Zone for GWL Rep MN 03N06E05N003

Table 8: Locations of Identified Potential Impacted GDEs

Impact Zone	Dominant Species (Common Name)	Dominant Species (Scientific Name)	Wetland Description	Latitude of NCCAG Polygon Centroid (Decimal Degrees)	Longitude of NCCAG Polygon Centroid (Decimal Degrees)
02N07E29B001			Riverine, Lower Perennial, Unconsolidated Bottom, Permanently Flooded	37.994	-121.282
03N06E05N003	Fremont Cottonwood	Populus fremontii		38.1178	-121.4
03N06E05N003	Fremont Cottonwood	Populus fremontii		38.117	-121.401
03N06E05N003	Hardstem Bulrush	Schoenoplectus acutus		38.1313	-121.388
Manteca 18	Valley Oak	Quercus lobata		37.8555	-121.184
Manteca 18	Valley Oak	Quercus lobata		37.8557	-121.186
Manteca 18	Valley Oak	Quercus lobata		37.8569	-121.198
Manteca 18			Palustrine, Emergent, Persistent, Seasonally Flooded	37.8208	-121.201
Manteca 18			Palustrine, Emergent, Persistent, Seasonally Flooded	37.8309	-121.167
Manteca 18			Palustrine, Emergent, Persistent, Seasonally Flooded	37.8221	-121.2
Manteca 18			Palustrine, Emergent, Persistent, Seasonally Flooded	37.8227	-121.2
Manteca 18			Palustrine, Emergent, Persistent, Seasonally Flooded	37.8244	-121.145

4.4.1 Limitations and Outstanding Data Gaps for Analysis of Potential GDEs

Many of the data gaps identified in the 2020 GSP with regards to evaluating potential GDEs still exist as of the 2024 GSP Amendment. Efforts have been made to address these data gaps, as described in Chapter 7 of this GSP. The five new shallow nested wells installed that comprise the new interconnected surface water representative monitoring network will provide valuable data to assess shallow groundwater conditions along riparian corridors. These wells have not yet been monitored, but data collection will begin with the adoption of the 2024 GSP Amendment.

As of the preparation of this analysis, the following limitations to this analysis and outstanding data gaps should be considered in the interpretation of the presented results.

- The impact analysis included in this TM is a desktop only analysis: No field survey has been completed to ground-truth these findings. Field surveys to verify the locations and extent of GDEs should be completed to verify both the mapping used in this analysis and the findings of this analysis.
- The relationship between shallow aquifers and deeper aquifers is still poorly understood: GDEs are, by definition, dependent on water from shallow aquifers and the majority of data available in the Subbasin is from deeper aquifers where production is occurring for drinking or irrigation water. This analysis (conservatively) assumes that the groundwater levels measured in the deeper aquifers at the RMN wells are representative of conditions in all areas of the Impact Zones. This is an imperfect assumption that does not account for how groundwater levels behave along streams because: 1) There is no consideration for the nature of the interaction with the stream or 2) for any localized confining or semi-confining units that may cause perched water tables or other variability in the shallow subsurface.
- The simulated depth to water threshold was model-estimated: 2015 simulated water levels were used in this impact analysis to be consistent with what was done in the 2020 GSP. This poses a limitation to the analysis because it is challenging to model a system with such complexity, at such a local scale. Simulated groundwater levels are not calibrated uniformly across all areas of the Subbasin. Calibration is especially challenging in the shallow subsurface, in which this analysis takes place, due to the lack of shallow groundwater level data available to calibrate to.
- The definition of what an ecosystem is in the NCCAG dataset carries a number of assumptions: The size of the polygons in NCCAG is based on how an ecosystem is defined within the dataset, and this incorporates a variety of assumptions into the identification of a potential GDE. For example, two stretches of stream may have similar densities of potential GDEs in the field, but if one reach has more individual species than the other, the two reaches may be classified as more individual GDE polygons despite their similar densities. Therefore, the size of the NCCAG polygons as well as the actual count of GDE polygons should be interpreted cautiously.
- The ability to distinguish between percolating surface water and emerging groundwater is difficult: This is a challenge at both the local scale and the regional scale. Site specific studies are required to make this distinction at the ecosystem scale. At the regional scale, Appendix 3-F makes a preliminary assessment of gaining and losing portions of the Subbasin's rivers and streams. The analysis showed that on some rivers, gaining and losing portions of the stream can be very variable, such as on the Stanislaus River. However, the analysis contained in that appendix is preliminary and completed without substantial guidance from DWR on how to quantify surface waters that are interconnected. Further detail on the information gaps related to that analysis is detailed in that appendix.
- The lack of overlap between monitoring well locations and locations of potential GDEs: The groundwater level RMN does not substantially overlap with locations potential GDEs may be found. As stated earlier, the groundwater level RMN was designed for tracking conditions primarily in the

principal aquifer where pumping occurs, not for tracking shallow aquifer conditions that potential GDEs would rely on. A new interconnected surface water RMN was developed with six newly constructed wells from which shallow groundwater level measurements will be collected across the Subbasin starting in Fall 2024 (Appendix 3-G). However, these wells are also not co-located to where the identified potential GDEs are (except for the Delta well) because they also were not designed to specifically evaluate GDEs. Therefore, without substantial shallow monitoring data near potential GDE sites, appropriate evaluation of impacts to potential GDEs is difficult.

4.4.2 Plans to Fill Data Gap

To better understand the current conditions of potential GDEs within the Subbasin, additional study is necessary to assess the potential GDEs that currently exist within the Subbasin, as well as the source of their water. For the sites identified as potential GDEs, the following future studies will be completed in order to fill the data gap identified so that GDEs can be more effectively evaluated:

- Evaluate variations between shallow and deep groundwater level measurements at wells in close proximity to rivers and potential GDE areas, including existing nested wells and newly installed shallow wells included in the interconnected surface water RMN.
- Conduct field identification for vegetation, wetlands, and wildlife in conjunction with descriptions of local hydrology, including where saturated soils exist, where there is standing surface water, and documentation of evidence of a high water table in the soil. An evaluation of source water for each potential GDE will be evaluated by the biologist.

These two studies will be completed prior to the preparation of the 2030 Periodic Evaluation. If there is strong evidence of GDEs within the Subbasin, the appropriate project and management action(s) will be developed in order to address any site-specific data gaps. This will allow for focused study of potential GDE areas to conserve resources by limiting close study to the highest priority areas. If applicable, a project and management action will be included in a 2030 GSP amendment based on the outcome of these studies.

4.5 Impacts Analysis Conclusion

Impacts to domestic wells are generally more protective of impacts to other wells because they are on average shallower than public supply wells. For this reason, domestic well impacts were incorporated into the calculation of the minimum thresholds in the 2020 GSP, 2022 GSP, and now maintained in the 2024 GSP. Determining the locations of potential GDEs with certainly is difficult to assess with the existing tools. Using the NCCAG dataset, the preliminary potential GDE impacts analysis included in this TM indicates that the groundwater level SMC are also generally protective of ecosystems dependent on groundwater.

The full impacts analyses included as part of this response to DWR's recommend corrective actions and the Periodic Evaluation further confirms the original assessment showing that the original 25% threshold undesirable result is protective of domestic wells, public supply wells, and potential groundwater dependent ecosystems (to the extent to which they are known) in the Subbasin.

5. PLAN FOR FUTURE ASSESSMENT OF DEGRADED GROUNDWATER QUALITY RELATED TO GROUNDWATER LEVELS

Within the Subbasin, there is not significant overlap between wells with available data that are sampled for groundwater levels and quality. An initial analysis of historical observations for nearby wells, however, indicated that there is no obvious relationship between declining groundwater levels and degraded groundwater quality (total dissolved solids [TDS] and chloride). **Figure 9** shows the location of three pairs of wells that are within relatively close proximity to each other where groundwater levels and groundwater quality data could be compared. An initial trends analysis is included in **Figure 10, Figure 11**, and **Figure 12** for these three sets of wells. These charts were interpreted cautiously as water quality may vary significantly even within small distances. At each well pair, groundwater levels are from a groundwater level RMW, and groundwater quality data are from a GAMA well. Both TDS and chloride are shown, as these are the two constituents that will be monitored in the new representative network for groundwater quality.

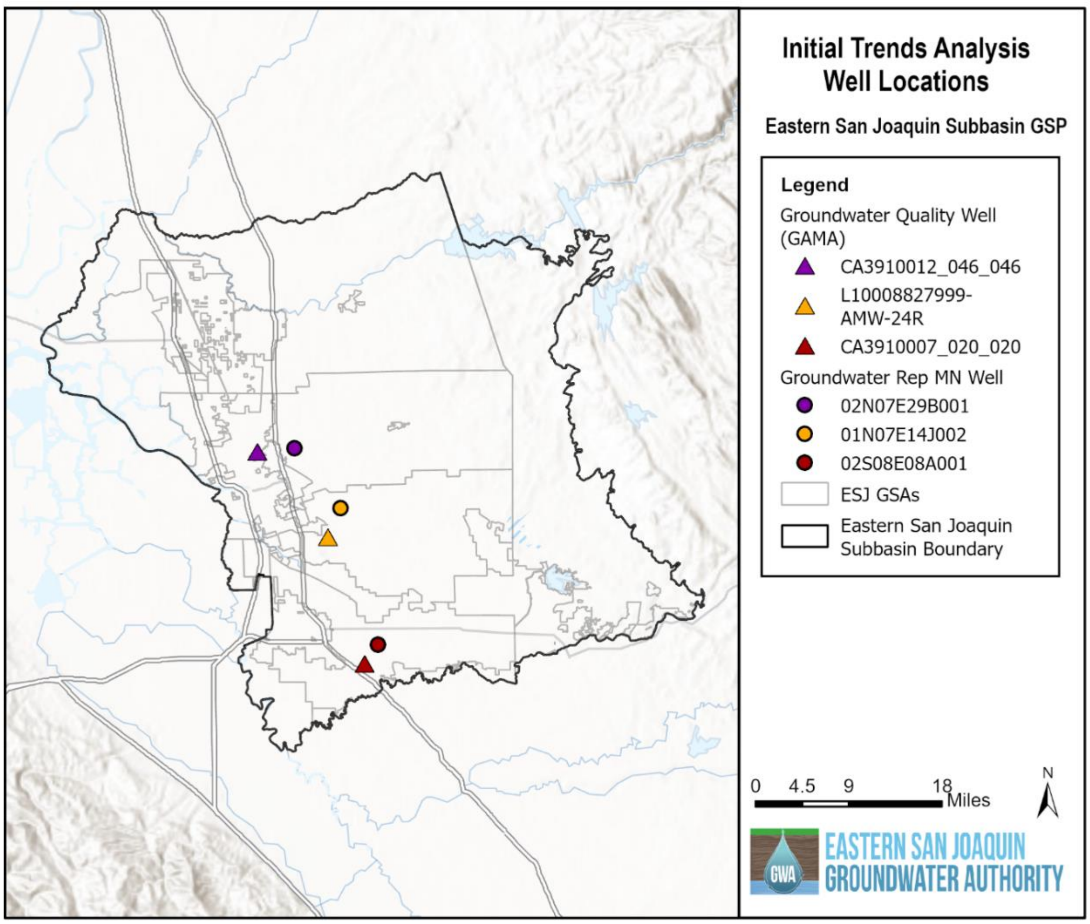
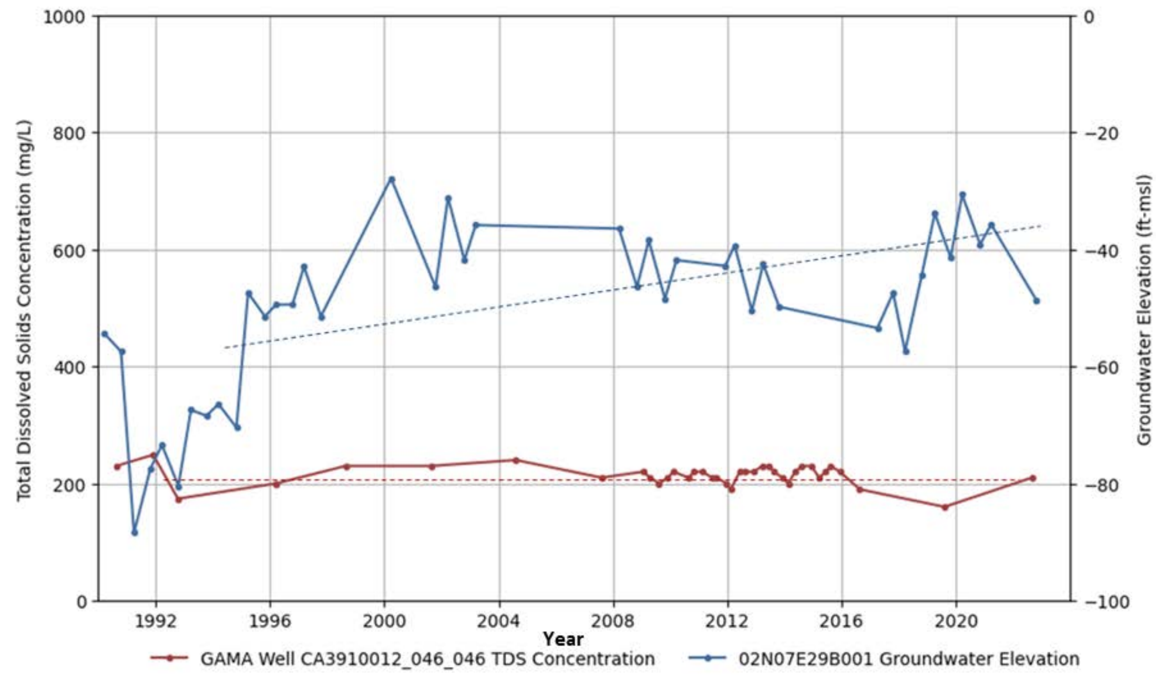


Figure 9: Well Location Map for Initial Trends Analysis



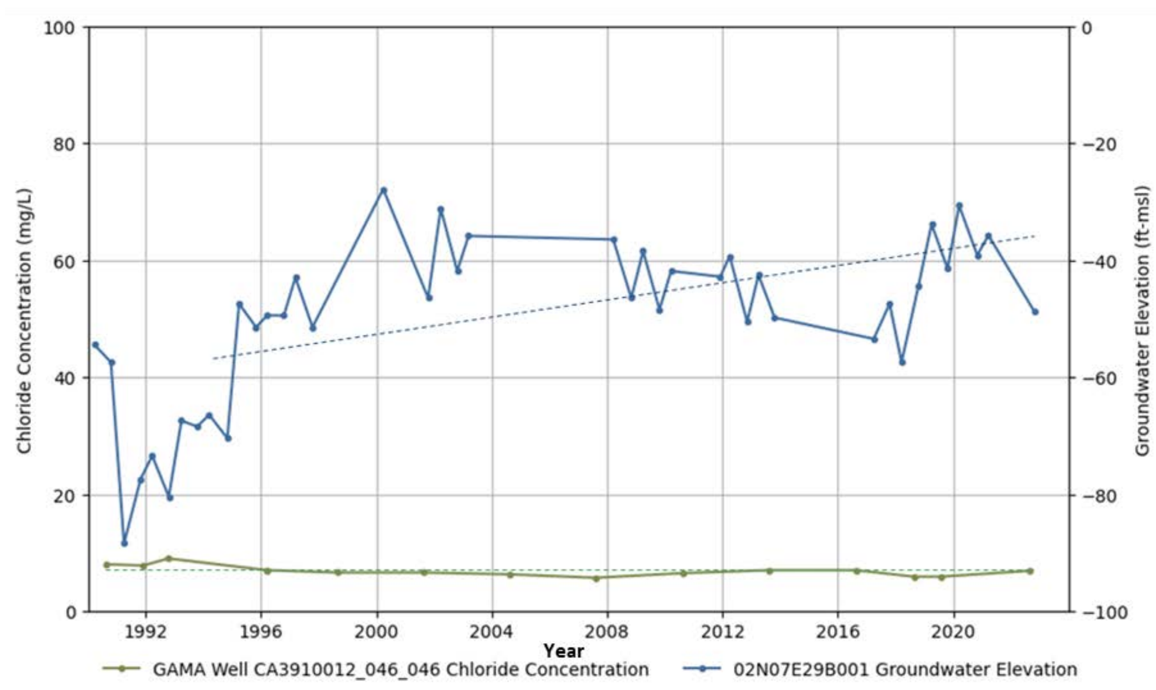


Figure 10: Initial Trend Analysis at Wells in Close Proximity: CA3910012_046_046 and 02N07E29B001

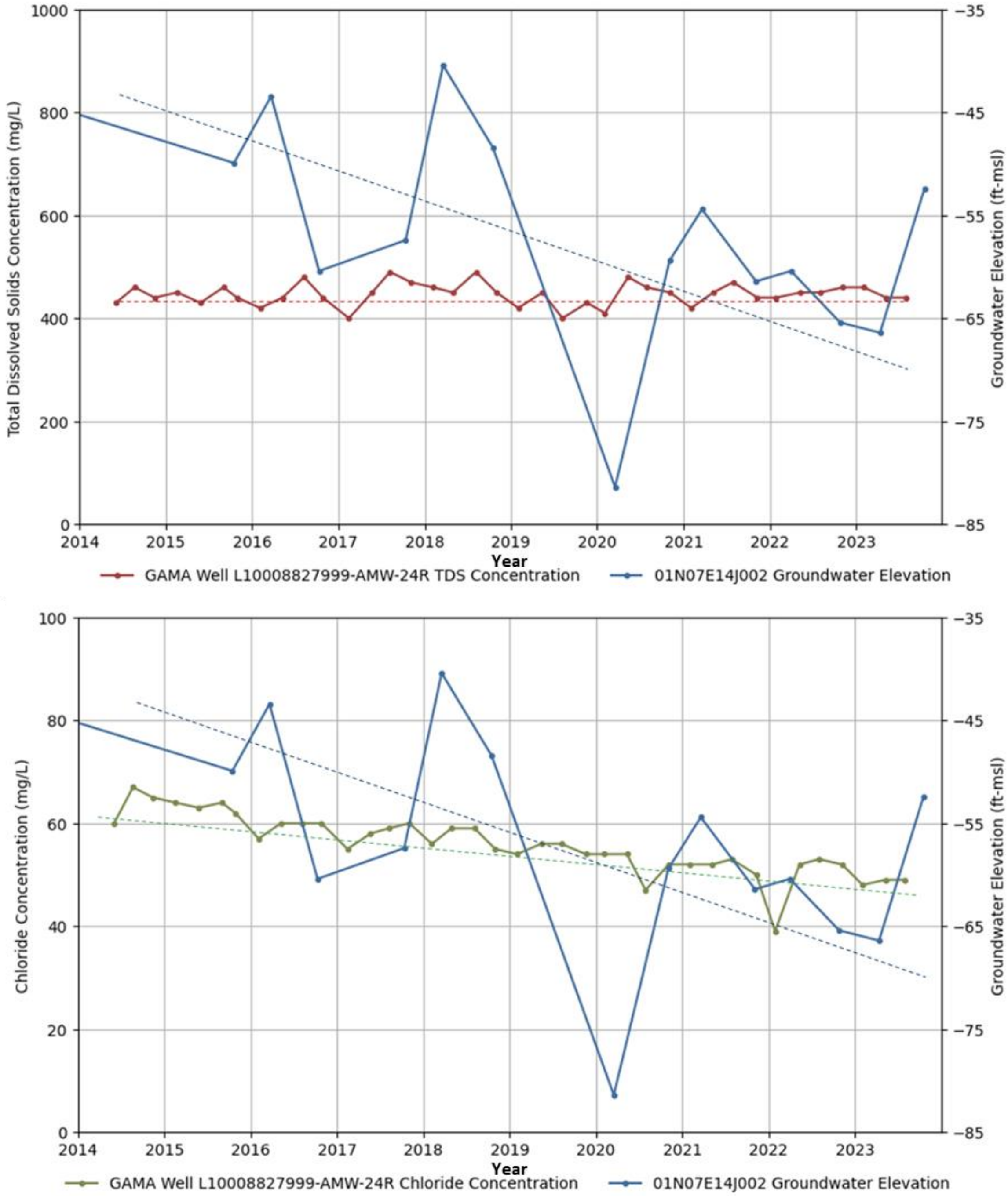
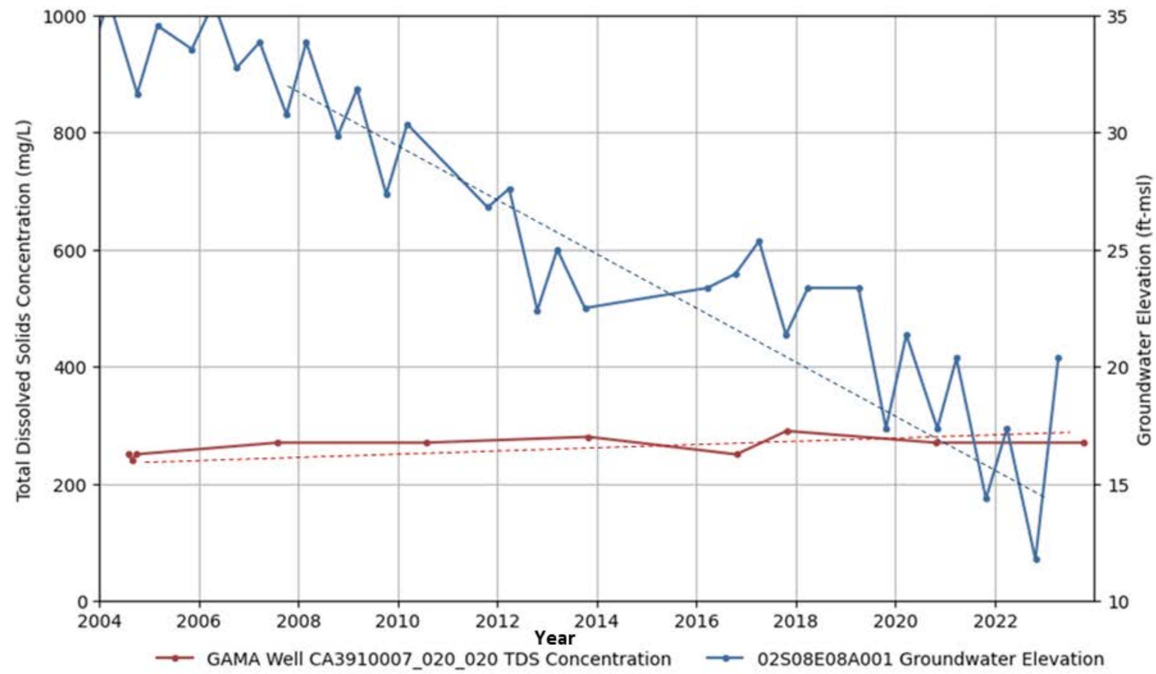


Figure 11: Initial Trend Analysis at Wells in Close Proximity: L10008827999-AMW-24R and 01N07E14J002



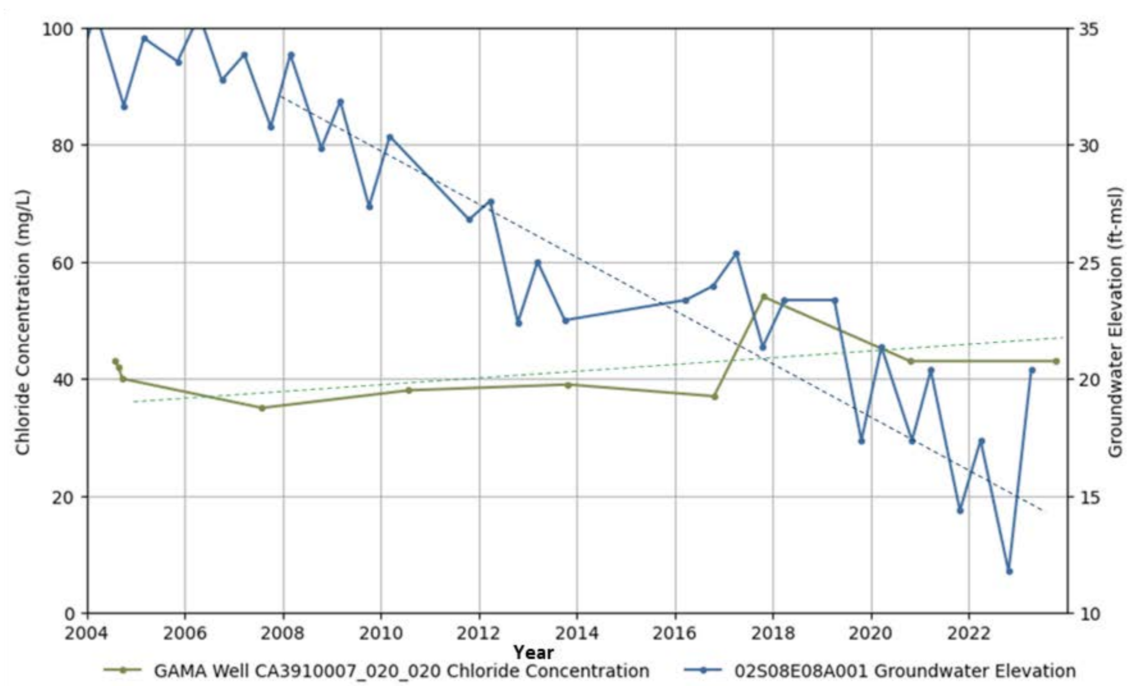


Figure 12: Initial Trend Analysis at Wells in Close Proximity: CA3910007_020_020 and 02S08E08A001

For future assessment of the relationship between groundwater levels and groundwater quality, three wells were selected as part of the new representative monitoring network for groundwater quality (detailed in

TM No. 3), that are also within the representative monitoring network for groundwater levels. These wells are shown in **Table 9.** This overlap will allow a direct relationship between groundwater levels and groundwater quality to be evaluated as the GSP continues to be implemented. Similar hydro- and chemo-graphs for TDS and chloride will be reported for these three wells in future annual reports. An evaluation of trends will be completed each year to ensure that any interactions between these two sustainability indicators can be identified as early as possible. Additional wells may also be reported on if there is sufficient quality or level data available at another well within the Subbasin.

Table 9: Wells to be Used in Annual Trend Analysis

Representative Monitoring Network Well (Groundwater Levels Network and New Groundwater Quality Network)	**Monitoring Agency**	**Screen Interval** (if known)
Swenson-3	City of Stockton	Clustered 1: 482-502 ft bgs 2: 294-314 ft bgs 3: 194-204 ft bgs
Lodi City Well #2	City of Lodi	110 – 309 ft bgs
Hirschfield (OID-8)	Oakdale Irrigation District	Well Depth = 408 ft

6. CONCLUSIONS

The following summarizes the responses to each part of Recommended Corrective Action 1.

1a) Well (domestic and public supply) and potential GDE impacts analyses were calculated over a range of undesirable result scenarios, ranging from more to less protective than the current definition. The analyses justify the use of 25% in the definition of undesirable results because it represents a compromise between maintaining operational flexibility within the Subbasin while also remaining protective of wells and potential GDEs.

1b) An impacts analysis was completed to evaluate impacts to potential GDEs in a similar manner to the well impacts analyses presented in the 2020 GSP for domestic wells. This desktop analysis showed that while additional study and field verification will be needed, the current undesirable result definition is expected to be protective of impacts to potential GDEs.

1c) The analyses included in the 2020 and 2022 GSPs ensured that domestic well protection was prioritized in the establishment of the groundwater level minimum thresholds. In response to DWR's RCA #1, a similar approach was taken to also evaluate potential impacts to public supply wells and state small water systems. These analyses demonstrate that impacts to all three of these well groups are minimal under the current established minimum thresholds and corresponding undesirable result definition.

1d) Going forward, a trends analysis relating groundwater levels and groundwater quality at a minimum of three wells will be included in future annual reports. These three wells are a part of the existing groundwater level representative monitoring network and part of the new groundwater quality representative monitoring network. This will ensure that any relationship between declining groundwater levels and degrading water quality may be detected as early as possible.

7. REFERENCES

California State Water Resources Control Board. (2021). *Decision tree for classification of water systems*. Retrieved from https://waterboards.ca.gov/drinking_water/certlic/drinkingwater/docs/class_dec_tree.pdf

The Nature Conservancy. (2021). *Plant Rooting Database*. Retrieved from https://www.groundwaterresourcehub.org/where-we-work/california/plant-rooting-depth-database/

ATTACHMENT 2

ATTACHMENT 2

TECHNICAL MEMORANDUM NO. 2 – Subsidence

TO: Paul Gosselin, California Department of Water Resources Deputy Director

CC: Ashley Couch, on behalf of the Eastern San Joaquin Groundwater Authority

PREPARED BY: Liz DaBramo and Astrid Guerrero, Woodard & Curran

DATE: November 2024

RE: Eastern San Joaquin Groundwater Authority Response to DWR's July 6, 2023 Approved Determination Letter for the 2022 Revised GSP - Technical Memorandum 2, Response to DWR Recommended Corrective Action No. 2

On July 27, 2022, the Groundwater Sustainability Agencies (GSAs) submitted the Eastern San Joaquin Groundwater Subbasin Revised 2022 Groundwater Sustainability Plan (GSP or Plan) for the San Joaquin Valley – Eastern San Joaquin Subbasin (Subbasin) to the California Department of Water Resources (DWR) in response to DWR's incomplete determination letter dated January 28, 2022. In a July 6, 2023 letter, DWR staff concluded that the GSAs had taken sufficient actions to correct deficiencies identified by DWR and approved the 2022 Revised Plan (see **Appendix 3-B in the GSP**). In Section 6 of the letter, DWR staff also identified recommended corrective actions (RCAs) for the GSAs to address by the Plan's first periodic evaluation.

This technical memorandum (TM) is in response to RCA # 2 related to subsidence. This TM is organized into the following sections:

1) Overview of Recommended Corrective Action #2
2) Approach to Recommended Corrective Action #2
3) Subsidence Data
4) Representative Monitoring Network (RMN)
5) Sustainability Goal
6) Sustainable Management Criteria (SMC)

1. OVERVIEW OF RECOMMENDED CORRECTIVE ACTION #2

The following is the text included in Section 6 of DWR's July 2023 Determination Letter:

Until a correlation between groundwater levels and land subsidence is established, the GSP should use direct subsidence monitoring data, such as InSAR or CGPS, to define sustainable management criteria (minimum thresholds and undesirable results). In general, the Agencies describe that land subsidence has never been a problem in the Subbasin and imply that land subsidence should not be a problem in the future. If this is accurate, setting land subsidence minimum thresholds using direct monitoring data should not trigger undesirable results and would also be the easiest pathway to developing sustainable management criteria for land subsidence, since a correlation between groundwater levels and land subsidence would no longer need to be established.

Department staff recommend Agencies clearly describe how potential subsidence associated with groundwater level declines below minimum thresholds would not have the potential to cause significant and unreasonable impacts and undesirable results related to subsidence and the use of InSAR data for the land subsidence monitoring network, with supplemental groundwater level data being utilized to evaluate whether detected land subsidence is the result of declining groundwater levels. The use of InSAR data is also recommended for use in establishing a rate and extent in defining significant and unreasonable impacts considered not to cause undesirable results to the Subbasin.

2. APPROACH TO RECOMMENDED CORRECTIVE ACTION #2

The 2020 GSP initially defined Sustainable Management Criteria (SMC) for inelastic land subsidence by using groundwater levels as a proxy. To address DWR's identified Recommended Corrective Action #2, direct subsidence monitoring data were collected to develop a subsidence-specific representative monitoring network (RMN) and set new SMCs for improved monitoring and management. Direct subsidence monitoring data included Continuous Global Positioning System (CGPS), Interferometric Synthetic Aperture Radar (InSAR), and survey benchmark vertical displacement data. Analyses were conducted to determine whether significant inelastic land subsidence is currently occurring or has historically occurred in the Subbasin. Subsidence rates across the Subbasin were visualized for both CGPS vertical displacement data and InSAR data sets.

Sustainability goals for inelastic land subsidence were established based on impacts to critical infrastructure, the likelihood of undesirable results, and historical subsidence rates. Major roads and water conveyance infrastructure were identified as critical infrastructure, as discussed in Section 5.1. Undesirable results were defined as those causing significant and unreasonable impacts to identified critical infrastructure. New subsidence SMC (undesirable results [UR], minimum thresholds [MTs], measurable objectives [MOs], and interim milestones [IMs]) were developed for cumulative vertical ground surface displacement and 5-year rolling average subsidence rates to identify significant and unreasonable conditions. Additionally, a new representative monitoring network with direct subsidence measurements (as land surface elevation changes) is proposed. Historical subsidence rates and groundwater levels were also examined for potential correlation to confirm that groundwater levels below MTs would not have the potential to cause significant and unreasonable impacts and undesirable results related to subsidence. The sections below detail the findings and results of this approach.

3. SUBSIDENCE DATA

Subsidence datasets used to address DWR's RCA #2 include (1) CGPS vertical displacement data from the DWR Sustainable Groundwater Management Act (SGMA) Data Viewer, (2) InSAR subsidence rates from the SGMA Data Viewer, and (3) survey benchmarks from U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers (ACOE), California Department of Transportation (CalTrans), the San Joaquin County Department of Public Works, and local agencies. There are no DWR or USGS extensometers in the Eastern San Joaquin Subbasin. The datasets used are detailed further below.

3.1 CGPS Stations

Vertical displacement data from CGPS stations were downloaded from the DWR SGMA Data Viewer (DWR, 2024). CGPS Stations were selected based on recent data availability, location in the Subbasin, and monitoring status.

Four CGPS stations from UNAVCO and the Scripps Orbit and Permanent Array Center (SOPAC) were available on the SGMA Data Viewer. The two SOPAC CGPS stations considered were P273 and P309. Station P309, in the northeast region of the Subbasin north of the Calaveras River, has a period of record from March 4, 2006, to January 19, 2024. Station P273, in the northwest region of the Subbasin, has data from November 10, 2005, to December 28, 2020. P273 lies in the Delta region of the Subbasin. To set new SMCs, monitoring for inelastic land subsidence in the Subbasin focuses on the non-Delta area as the Delta region contains peaty soils which can subside due to peaty soil oxidation. Peat oxidation occurs when the peaty soils dewater and come into contact with air, causing the soils to break down and compress, and is not a mechanism caused by groundwater overdraft. Consequently, P273 was eliminated from the monitoring network under the SMCs as subsidence in this area likely stems from land reclamation rather than groundwater pumping (SGMA's focus).

The two UNAVCO CGPS stations considered were CNDR and MTWK. CNDR, in the western region of the Subbasin, has data from April 30, 1999, to February 14, 2006, but is no longer monitored and deemed insufficient for monitoring subsidence. MTWK, in the southern region of the Subbasin south of the city of Manteca, has data from December 12, 2019, to January 19, 2024. This is the closest CGPS station to the Corcoran Clay. Clay-rich zones are prioritized for monitoring since groundwater over-extraction in these areas can lead to dewatering and compression of the clay aquitards and inelastic land subsidence.

Several additional CGPS stations from the University of Nevada Geodetic Laboratory (UNGL) were also considered for subsidence monitoring (UNGL, 2024). These stations provide additional sites for subsidence analysis and the RMN. However, these stations have drawbacks, such as data gaps, and discontinuous monitoring, and are used on an academic/research basis that may result in increased monitoring gaps. Station CA15 is located north of the city of Stockton and has a continuous period of record between September 2013 and October 2021. Station CMNC is located along the southern edge of the Camanche Reservoir and has observations in 2020 and between February 2022 through January 2024. These locations also provided additional spatial coverage to the UNAVCO and SOPAC CGPS stations.

In summary, CGPS Station P309 (SOPAC), MTWK (UNAVCO), CMNC (UNGL), and CA15 (UNGL) were deemed sufficient in combination with published InSAR data to set new subsidence SMCs and the required subsidence-specific RMN. These four CGPS stations will be included in the Subbasin's RMN.

Figure 1 through **Figure 4** show time series graphs of subsidence for the four selected CGPS stations in this analysis. Between 2015 and 2023, all of the CGPS stations showed less than one foot of subsidence was observed throughout the Subbasin. The accuracy of GPS data is estimated to be ± 2 inches (DWR, 2018).

Figure 1 shows a time series graph of subsidence for CGPS Station MTWK. The graph indicates a slight downward trend, reflecting a small increase in subsidence in the Subbasin. From January 2023 to July 2023, subsidence increased slightly more, though overall subsidence remains minimal. The trend line's slope of -0.0295 inches per month (or -0.354 inches per year) confirms that subsidence is occurring in the Subbasin, but at insignificant levels. Additionally, the upward trend of the line at the end of 2023/early 2024 indicates rebound and demonstrates that the subsidence is, to some degree, elastic in nature.

Figure 1: CGPS Station MTWK – Subsidence Time Series

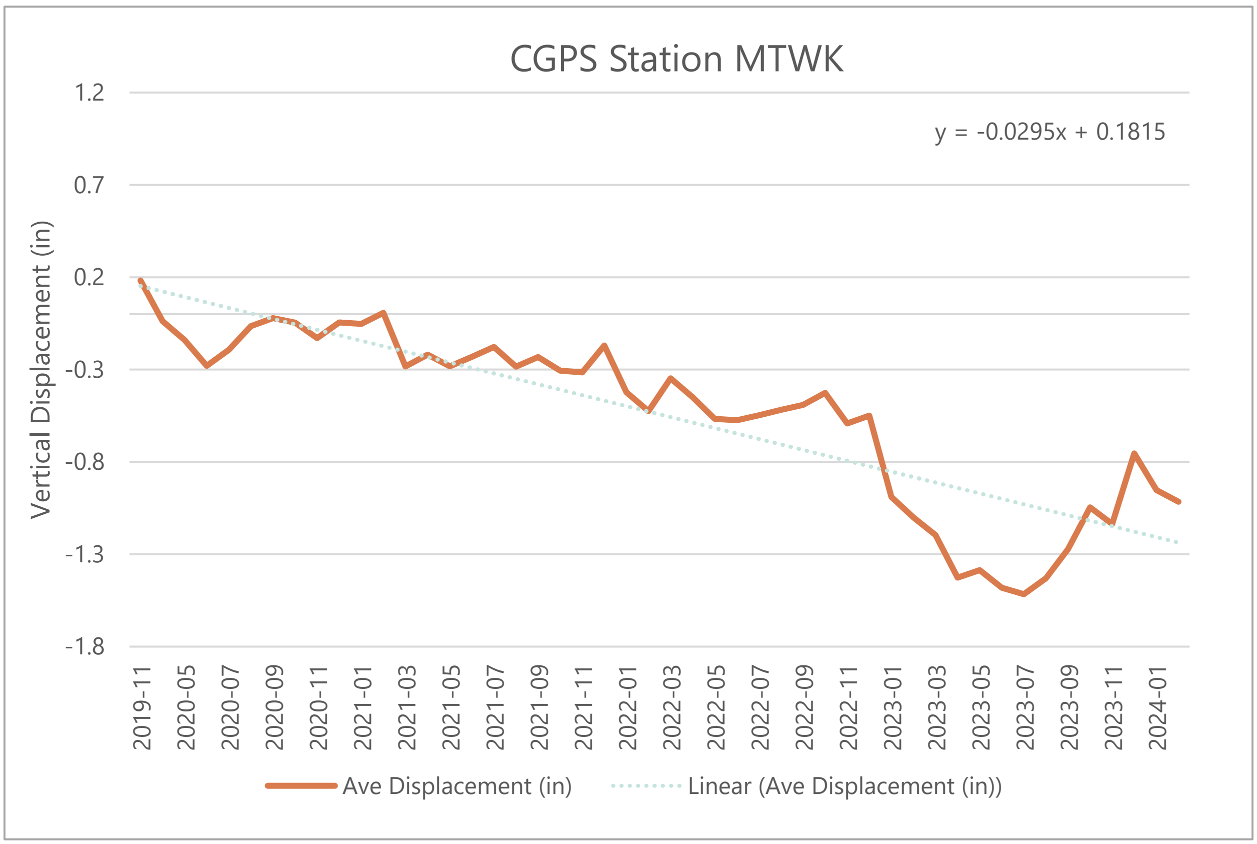


Figure 2 shows a time series graph of subsidence for CGPS Station P309. The graph indicates a very slight downward trend, reflecting a small increase in subsidence in the Subbasin. However, the displacement data varies to a great degree, increasing and decreasing throughout 2006 to current conditions. From June 2015 to June 2016, subsidence increased slightly more with an overall subsidence of approximately 0.7 inches. This data point represents the largest observed subsidence across the four CGPS stations, but still shows no inelastic subsidence. The trend line's slope of -0.0004 inches per month (-0.005 inches per year) confirms that subsidence occurring in this region is elastic and negligible.

Figure 2: CGPS Station P309 – Subsidence Time Series

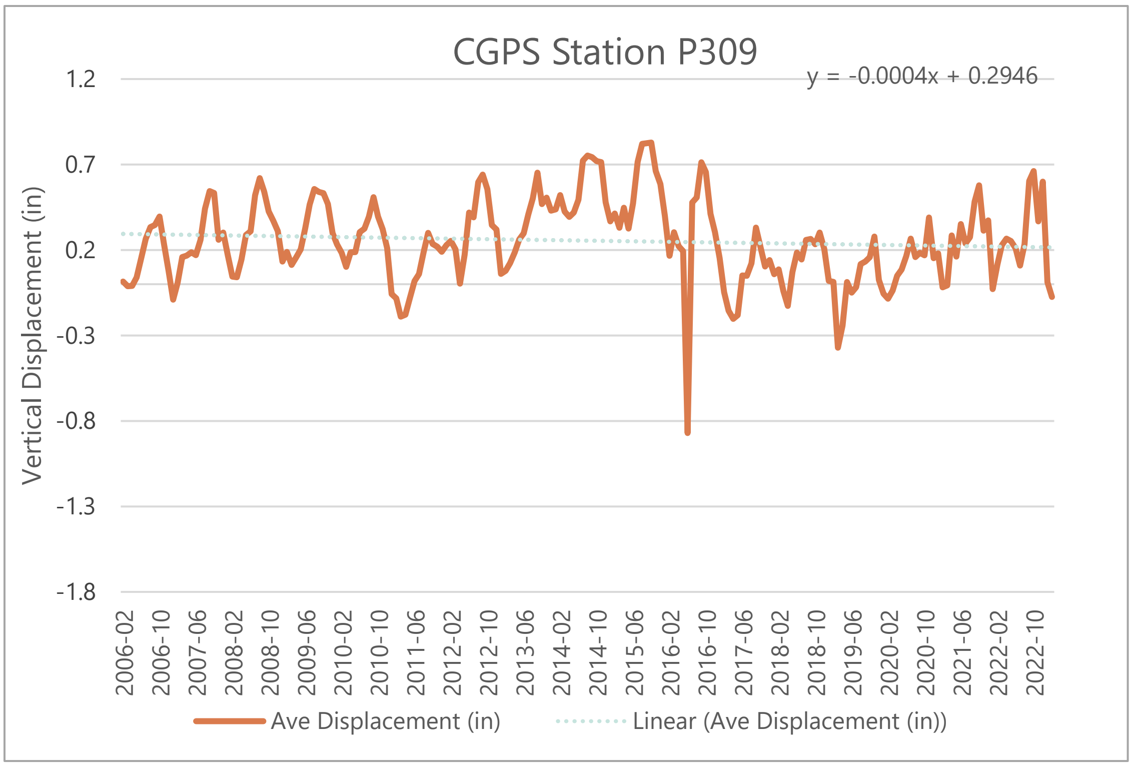


Figure 3 shows a time series graph of subsidence for CGPS Station CMNC, located in the northeastern region of the Subbasin along the southern edge of the Camanche Reservoir. Overall, there is a very slight rise in ground elevation that could be due to several factors, such as swelling of clay soils in wet winters. There is no inelastic subsidence occurring at this CGPS station. As previously mentioned, CPGS Station CMNC is being monitored by UNGL and its data are subject to data gaps and discontinuous monitoring due to its academic nature. While the dataset does not have a long period of record, it supports the observation that subsidence has not historically been an issue in the Subbasin.

Figure 3: CGPS Station CMNC – Subsidence Time Series

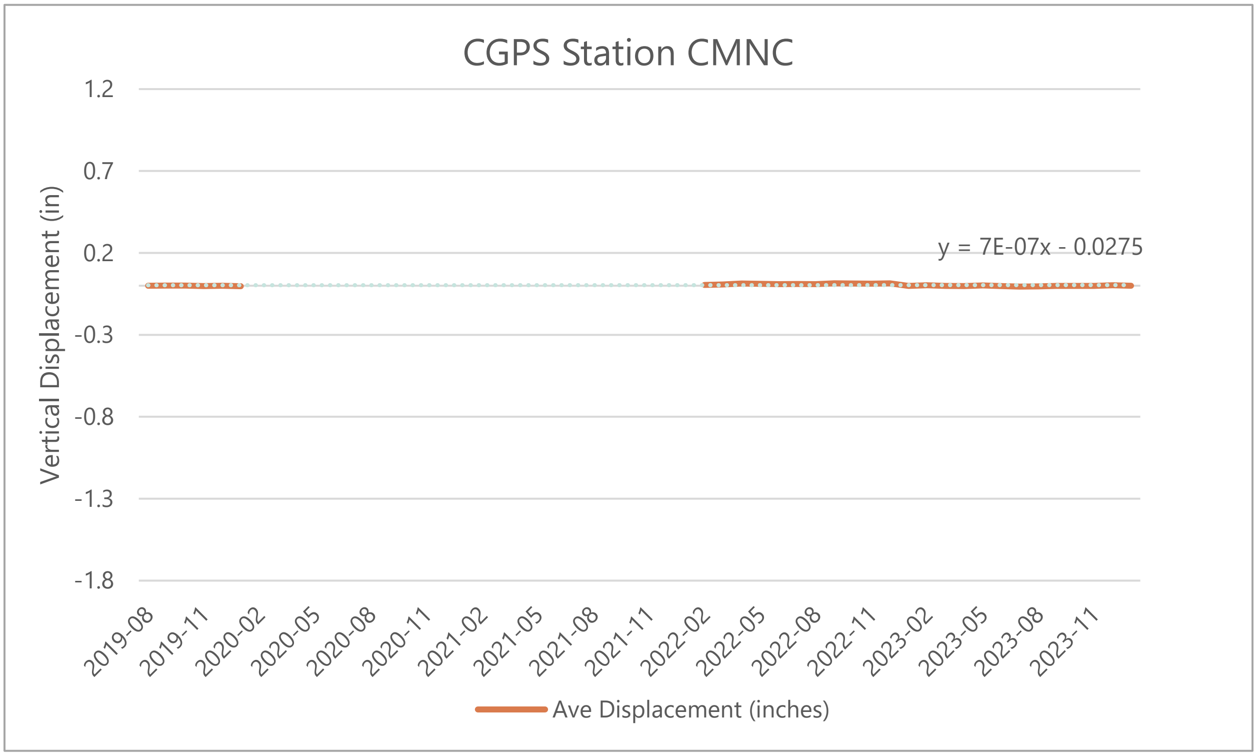
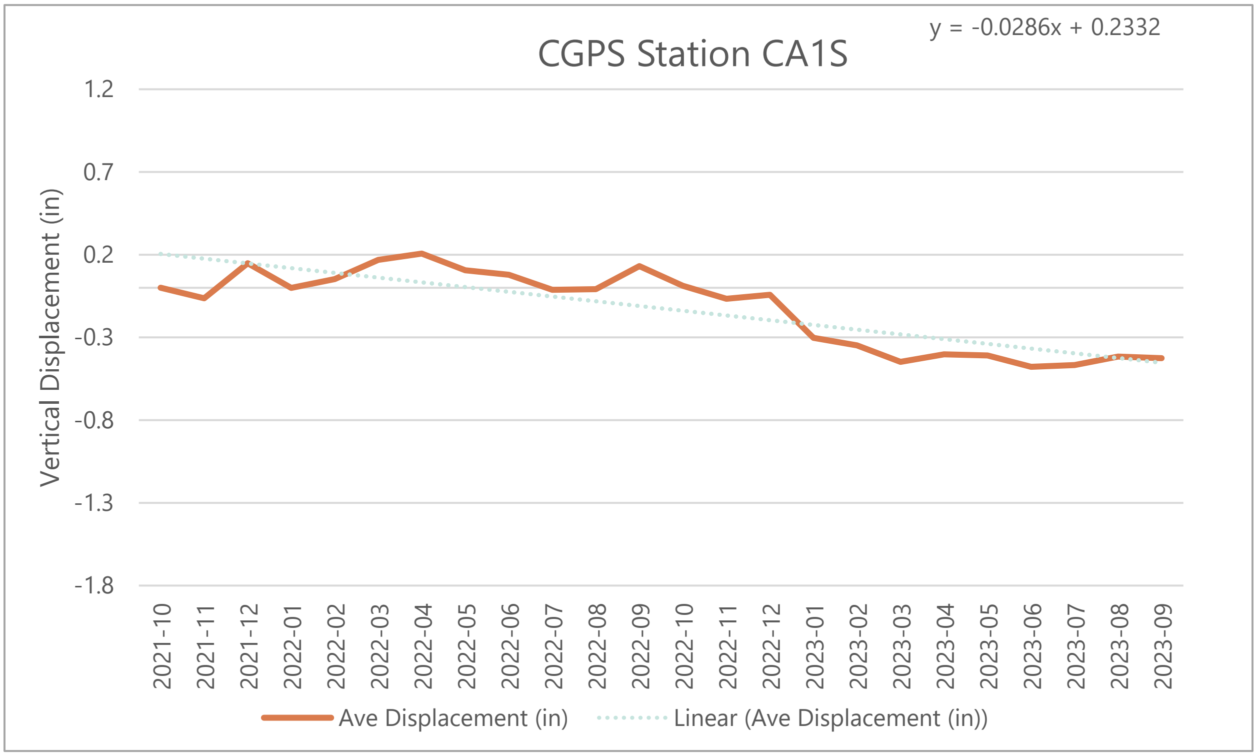


Figure 4 shows a time series graph of subsidence for CGPS Station CA1S, located in the western region of the Subbasin, north of the city of Stockton. The graph indicates a downward trend, reflecting a small increase in subsidence in the Subbasin. The subsidence observed for CGPS Station CA1S shows that subsidence was generally increasing in the Subbasin, and this is reflected in the slope of the trendline. The trend line's slope of -0.0286 inches per month (-0.34 inches per year) shows that the rate of subsidence at this region of the Subbasin is relatively greater than that of the other three CGPS stations, but is still relatively minimal as compared to the overall accuracy of the data. The largest observed vertical displacement in this period of record was -0.261 inches, from December 2022 to January 2023, which is a small degree of subsidence. It is important to note that, like CGPS Station CMNC, this dataset is obtained by UNGL and subject to data gaps and discontinuous monitoring.

Figure 4: CGPS Station CA1S – Subsidence Time Series

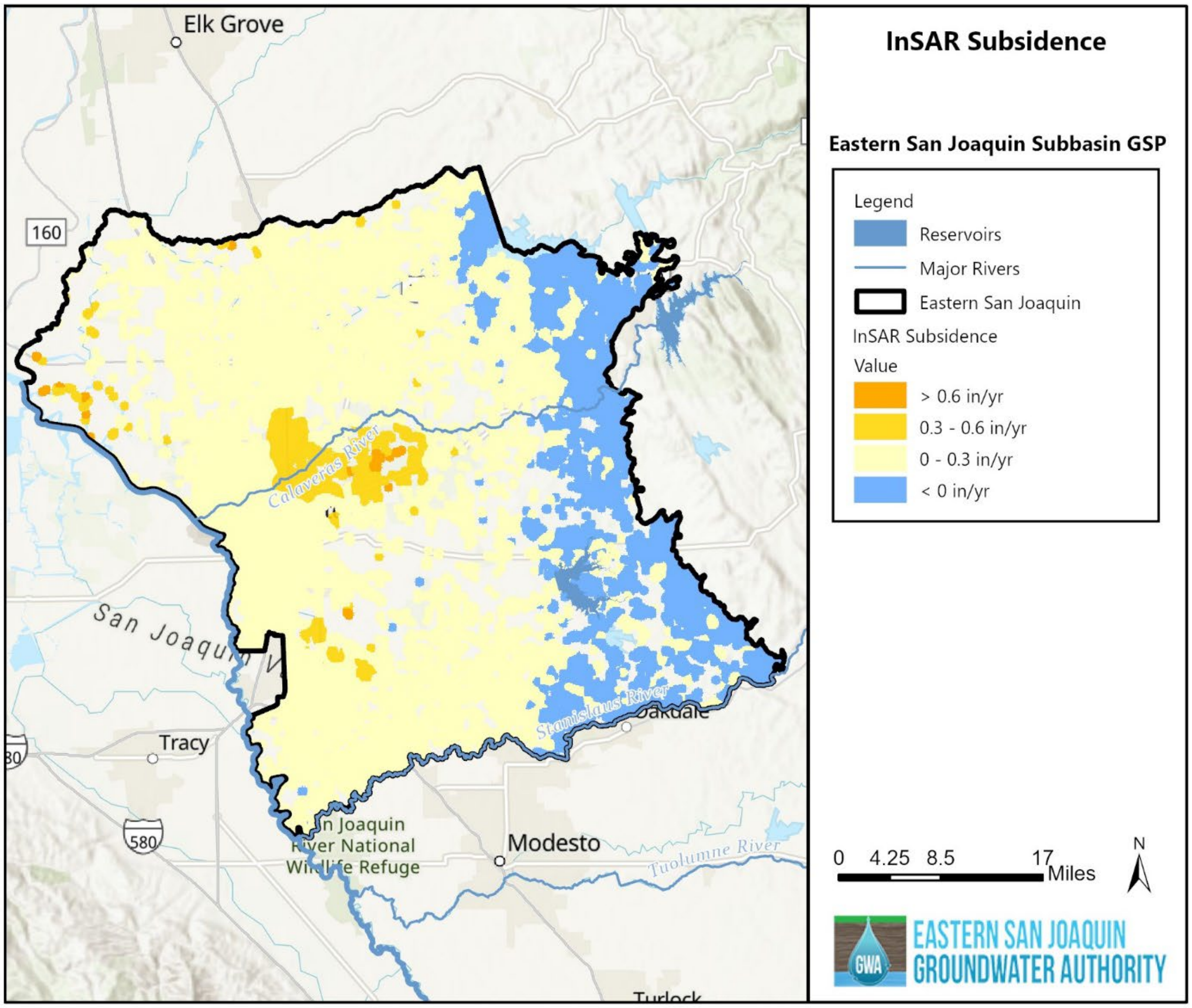


3.2 InSAR

InSAR data were collected from the SGMA Data Viewer sourced from the California Natural Resources Agency (CNRA). Included in this dataset are point data that represent average vertical displacement values for raster data for total and annual vertical displacement rates in monthly time steps. The longest period of record, at the time of this analysis, was from June 13, 2015, to October 1, 2023.

The subsidence analysis using InSAR data revealed minimal subsidence rates across the Subbasin. The highest observed subsidence rate was in the central portion of the Subbasin, averaging 0.92 inches per year between 2015 and 2023. In contrast, subsidence is not occurring in the eastern region of the Subbasin; instead, the ground elevation has increased due to the swelling of clayey soil in the foothills. This observation is supported by the subsidence analysis for CGPS Station CMNC in the eastern Subbasin which showed positive vertical displacement, indicating a rise in ground elevation. The western region of the Subbasin, adjacent to the Delta, is likely experiencing land subsidence due to peat oxidation rather than groundwater extraction. **Figure 5** illustrates that the central portion of the Subbasin in the cone of depression area is more prone to land subsidence and likely related to the lower groundwater levels. Despite this, overall subsidence in the Subbasin remains minimal and is not expected to cause undesirable effects.

Figure 5: Subsidence Rates (inches per year) throughout the Subbasin



Note: InSAR period of the record displayed in the figure above is June 13, 2015, to October 1, 2023

While CGPS data are more accurate than InSAR vertical displacement measurements, InSAR can estimate subsidence rates over a large land area. Compared to CGPS stations, InSAR has a 16 mm vertical accuracy at a 95% confidence level and an estimated 12 mm (0.47 inches) accuracy near Eastern San Joaquin (Towill, 2020).

3.3 Survey Benchmarks

Survey benchmarks were also considered for this analysis. Survey benchmark data were collected from USGS, ACOE, CalTrans, the San Joaquin County Department of Public Works (DPW), and local agencies. While there is a high density of benchmarks in the Subbasin, they are not surveyed regularly.

The USGS is installing extensometers and conducting GPS survey campaigns in other Subbasins, but these efforts require a large budget and predominantly focuses on high-subsidence regions; thus, the USGS is not expected to construct subsidence monitoring networks in Eastern San Joaquin Subbasin. The ACOE conducts surveys of benchmarks along the San Joaquin River; however, the survey frequency is inconsistent and unknown. Similarly, CalTrans and the San Joaquin County DPW do have survey benchmarks in the Subbasin, but they are also not surveyed regularly and are used primarily on a project-by-project basis.

In March 2024, Stockton East Water District (SEWD) conducted benchmark surveys for subsidence monitoring. The aim was to verify claims by the DWR that approximately seven inches of subsidence had occurred in the area over the past seven years. SEWD surveyed the current elevations of six National Geodetic Survey (NGS) benchmarks with published elevations to compare the historical data with current measurements. These benchmarks, all established in 1962, are located along Comstock Road. The survey results indicated that the average subsidence from the published elevations (1962) to current conditions (March 2024) is approximately 9.3 inches, with a range of subsidence spanning 12.72 inches. The greatest subsidence observed was at NGS Survey Benchmark H-956, which showed a subsidence of 16.56 inches over the 62-year period, or an average subsidence rate of 0.27 inches per year. Due to the temporal differences in subsidence observations, this 62-year period does not provide a precise measurement to directly compare with DWR's InSAR 8-year subsidence data from 2015 to 2023 with an average subsidence rate of 0.92 inches per year.

It is also noteworthy that the six surveyed benchmarks surveyed in 2024 are all located in the central region of the Subbasin, where InSAR data indicated the highest subsidence rate of 0.92 inches per year had occurred. While the subsidence of 16.56 inches at NGS Survey Benchmark H-956 is significant, it must be considered within the context of the 62-year period. The benchmark survey results suggest that subsidence in the Subbasin is not occurring at significant levels and is not expected to cause undesirable effects.

3.4 Subsidence Rates and Groundwater Levels

Historically, the Subbasin has not had significant or undesirable effects caused by inelastic land subsidence. Examining recent CGPS vertical displacement data, less than one foot of subsidence was observed throughout the Subbasin between 2015 and 2023. While the 2020 GSP originally considered groundwater levels as a proxy for subsidence, a strong correlation was not observed. Undesirable impacts are not expected to occur if groundwater levels drop below the minimum thresholds. Even when groundwater levels have historically dropped below the minimum thresholds, subsidence has not been observed.

Figure 6 shows a time series graph of subsidence (vertical displacement of land surface) and groundwater elevation for CGPS Station MTWK, with Manteca 18 as the respective groundwater level representative monitoring well (RMW). The graph indicates a slight downward trend in land surface elevation, reflecting a small increase in subsidence rates in the Subbasin. From January 2023 to July 2023, land surface elevations increased slightly more when groundwater levels declined, though overall subsidence remains minimal. It is important to note that, while there was a significant drop in groundwater elevations during September 2023, when groundwater levels recovered in the winter of 2024, subsidence reversed. This shows elastic subsidence that can recover with sustainable groundwater levels. Note that the historical groundwater levels in this example did not decline below MT for that RMW.

Figure 6: CGPS Station MTWK: Subsidence Time Series

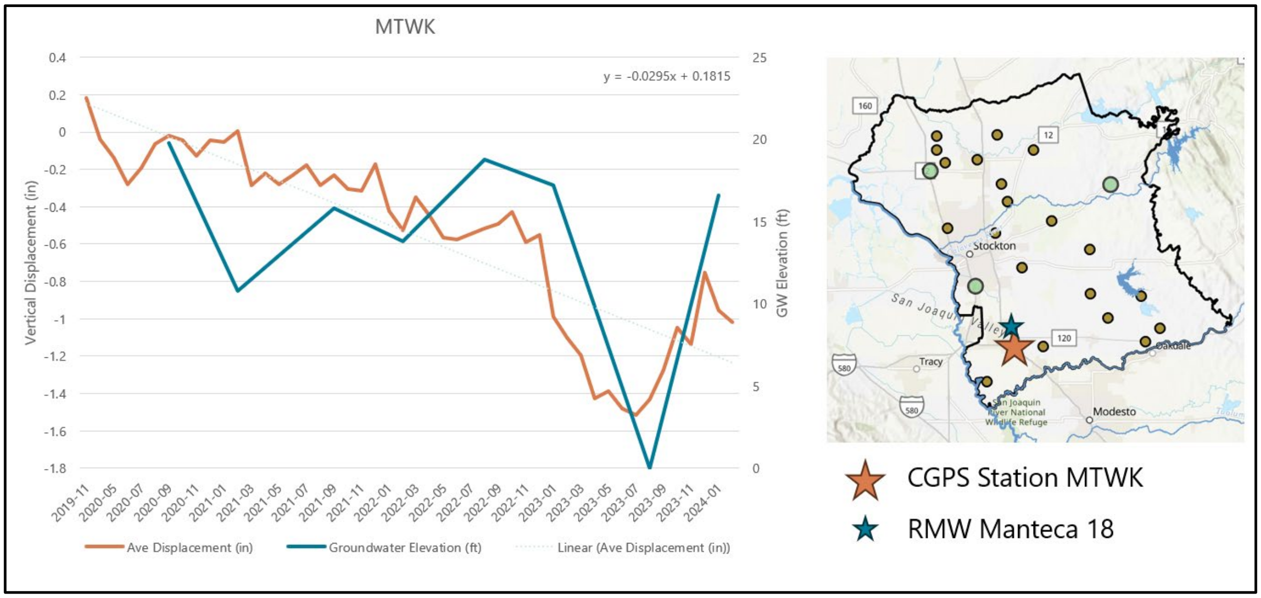
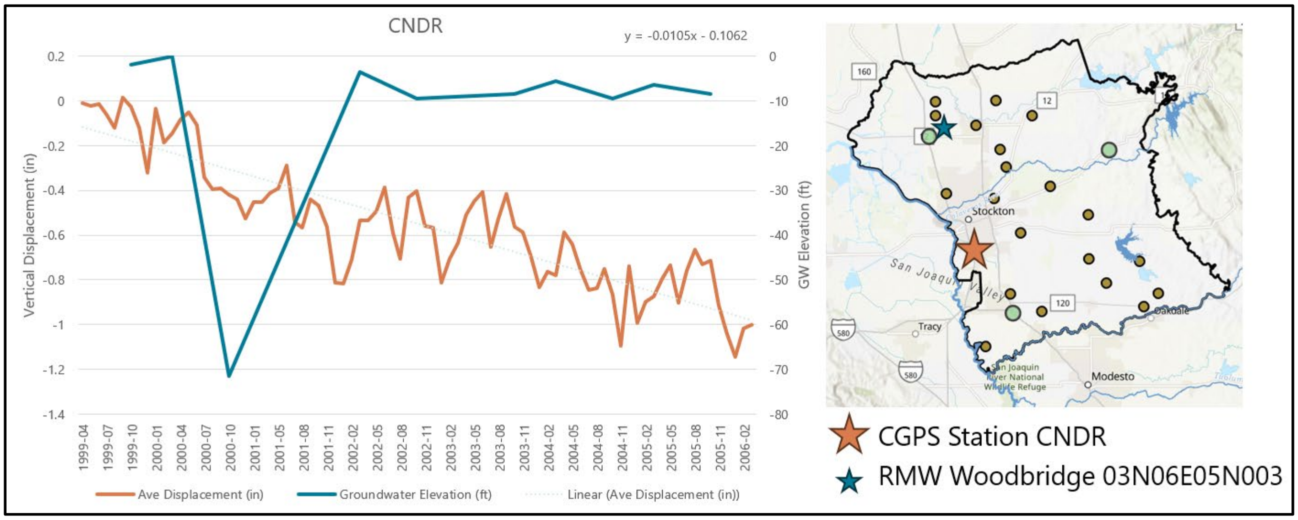


Figure 7 shows a time series graph of subsidence (vertical displacement of land surface) and groundwater elevations for CGPS Station CNDR, with Woodbridge 03N06E05N003 as the respective RMW. The graph indicates a slight downward trend in land surface elevations, reflecting a small increase in subsidence in the Subbasin. The trend line's slope of -0.0105 inches per month confirms that subsidence is occurring at this location in the Subbasin, but at very low levels. There was a significant decrease of 70 feet in groundwater elevation between March 1, 2000 and November 1, 2000 at this groundwater level RMW. Important to note that while there was a sharp decline in groundwater elevation during October 2000, subsidence rates appear to be unaffected. Woodbridge 03N06E05N003 groundwater level RMW was selected for analysis because it is the only RMW that has historically declined below its respective minimum threshold. CNDR CGPS station was selected because it is the only CGPS station with historical observations during the period when the groundwater levels were below the RMW's minimum threshold.

Figure 7: CGPS Station CNDR – Time Series of Subsidence and Groundwater Levels



4. REPRESENTATIVE MONITORING NETWORK

Four CGPS stations were selected for the Subbasin's Representative Monitoring Network (RMN) for inelastic land subsidence based on data availability, location, and monitoring status. The first station, P309 (SOPAC), is located in the eastern region of the Subbasin, north of the Calaveras River, and provides a comprehensive data record from March 4, 2006, to January 19, 2024. This station was chosen due to its extensive data period and its spatial coverage in the eastern portion of the Subbasin. The second station, MTWK (UNAVCO), is situated in the southern region of the Subbasin, south of the city of Manteca, with data available from December 12, 2019, to January 19, 2024. It is the closest station to the Corcoran clay, an important area to monitor due to the potential for inelastic subsidence near clay-rich areas.

Additionally, two stations from the University of Nevada Geodetic Laboratory (UNGL) were included in the RMN to provide further spatial coverage and address data gaps. The CMNC station, located along the southern edge of the Camanche Reservoir, has data in 2020 and between February 2022 and January 2024. The CA1S station, north of the city of Stockton, offers a continuous record from October 2021 to September 2023. These stations were selected to enhance the spatial distribution of monitoring locations and continuity of subsidence data in the Subbasin.

Six survey benchmarks from San Joaquin County and NGS were selected to supplement the CGPS data. Survey benchmarks were also selected to expand the spatial coverage of the subsidence monitoring network in the Subbasin and verify to InSAR data. From San Joaquin County, survey benchmarks M-20 and O-29 were selected. Benchmark M-20 was chosen for the RMN due to its location in the Subbasin, situated in the area with the highest subsidence rate. Benchmark O-29 was selected for its position near a localized, unverified point location of increased subsidence according to InSAR data.

From the NGS, benchmarks Q-833, J-956, G-965, and J-957 were selected. Benchmark Q-833 was chosen due to its proximity to the LODI CGPS Station, its good condition, and elevation observations in 1947 and

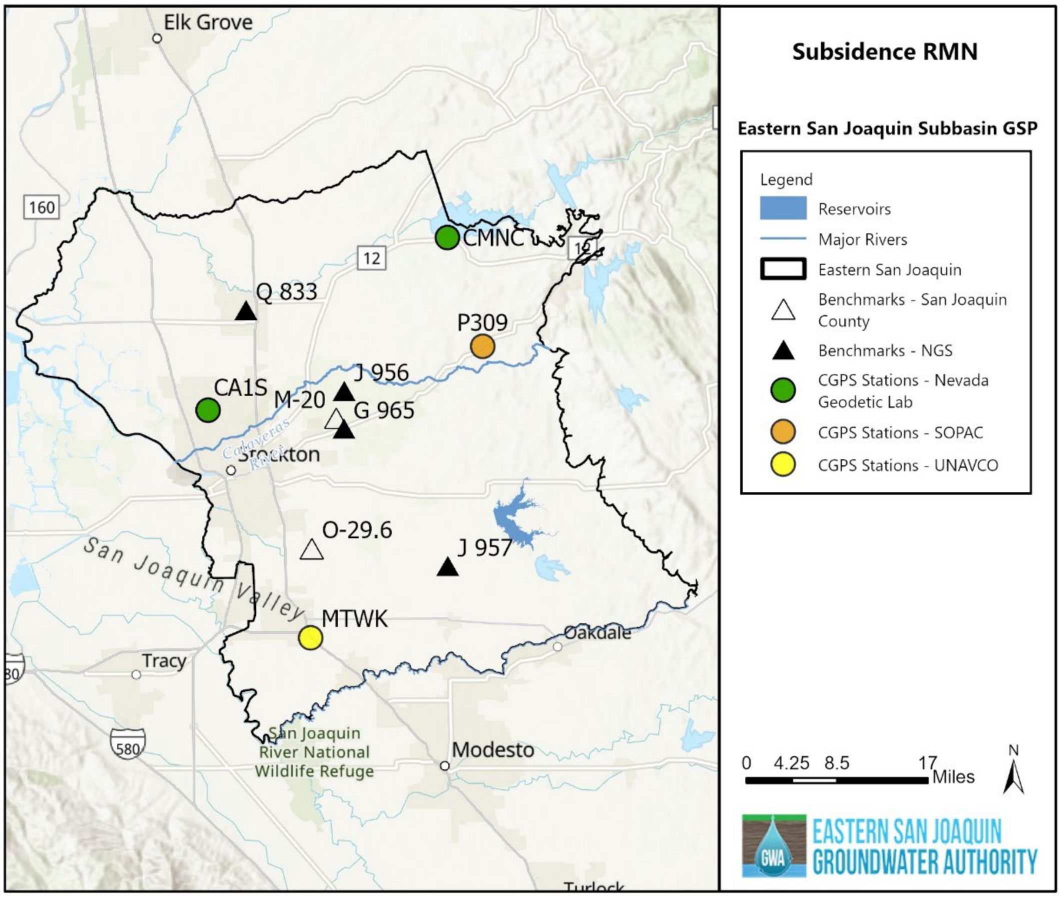
1987. Benchmark J-956 is an important survey benchmark because it was recently surveyed in 2024, is in good condition, and is located in the cone of depression area with higher subsidence rates. Benchmark G-965 was selected for the RMN because of its good condition, long period of record dating back to 1962, and its location in the cone of depression area, with the latest survey in 1987. Benchmark J-957 was chosen for its observations in 1962 and 1987, its good condition, and its location in the southeast corner of the Subbasin. InSAR will serve as a supplementary data source for the rest of the Subbasin, and its accuracy will be validated using CGPS and benchmark data.

Table 1 describes monitoring site type, location, and data source for the four CGPS Stations and six survey benchmarks that will make up the Subbasin's RMN. **Figure 8** shows the selected representative monitoring locations across the Subbasin.

Table 1: Subsidence Representative Monitoring Network

Name	Type	Location (dd)	Source
CA1S	CGPS	Lat: 38.022 N Long: 121.324 W	UNGL
CMNC	CGPS	Lat: 38.206 N Long: 120.999 W	UNGL
MTWK	CGPS	Lat: 37.778 N Long: 121.185 W	UNAVCO
P309	CGPS	Lat: 38.089 N Long: 120.951 W	SOPAC
Q-833	Survey Benchmark	Lat: 38.130 N Long: 121.272 W	NGS
J-956	Survey Benchmark	Lat: 38.043 N Long: 121.139 W	NGS
G-965	Survey Benchmark	Lat: 38.003 N Long: 121.139 W	NGS
M-20	Survey Benchmark	Lat: 38.014 N Long: 121.139 W	San Joaquin County
O-29.6	Survey Benchmark	Lat: 37.875 N Long: 121.183 W	San Joaquin County
J-957	Survey Benchmark	Lat: 37.856 N Long: 120.998 W	NGS

Figure 8: Subsidence Representative Monitoring Network

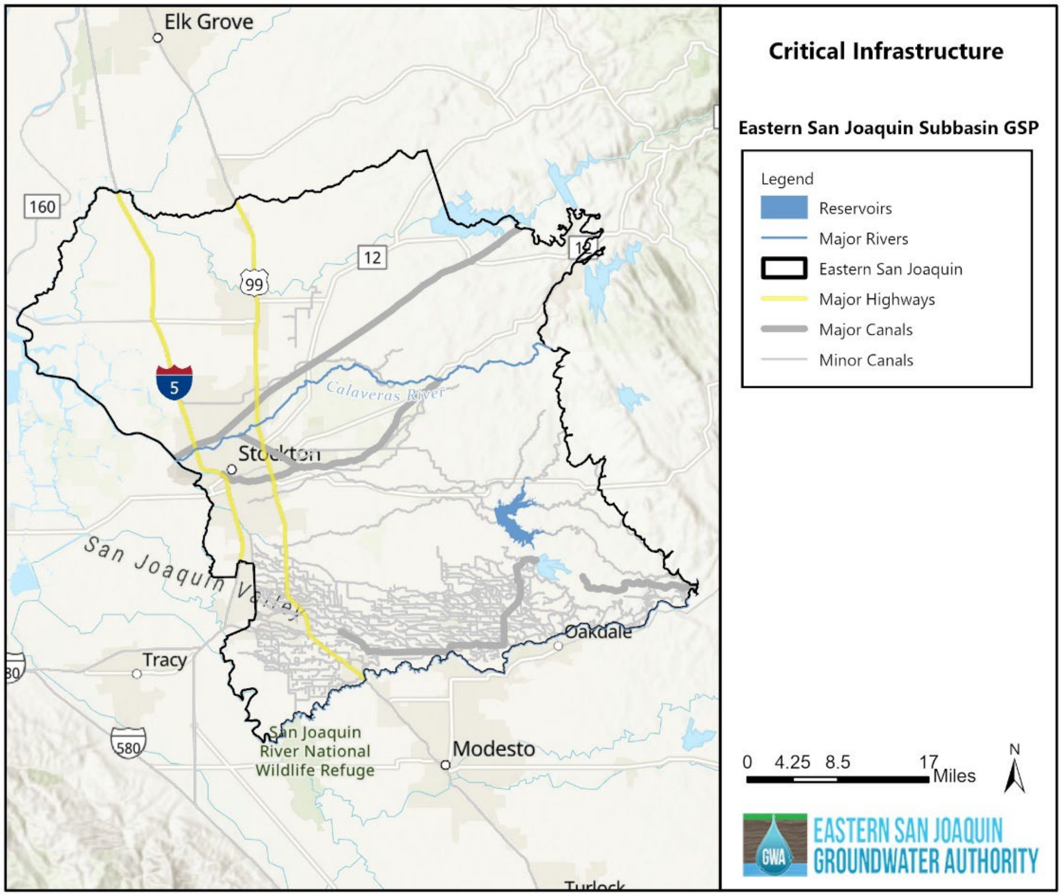


5. SUSTAINABILITY GOAL

5.1 Critical Infrastructure

Critical infrastructure identified in the Subbasin includes conveyance infrastructure, canals, and pipelines, as well as major roads. The major pipelines selected for this analysis are the East Bay Municipal Utility District's Mokelumne Aqueduct, stretching from the northeast to the western region of the Subbasin; Stockton East Water District's major canals and pipelines in the central region; South San Joaquin Irrigation District's Main District Canal in the southcentral region, and Oakdale Irrigation District's North Main Canal in the southeastern corner of the Subbasin. The major roadways included are Highway 5 and Highway 99. **Figure 9** illustrates all the critical infrastructure, including conveyance systems and major roads, across the Subbasin. Most of the minor canals are concentrated in the southern region of the Subbasin and are displayed for reference purposes only.

Figure 9: Critical Infrastructure



5.2 Undesirable Results

Undesirable results from inelastic land subsidence are defined as those causing significant and unreasonable impacts to the critical infrastructure identified in **Section 5.1**, specifically conveyance infrastructure and major roads. Inelastic land subsidence related to groundwater pumping occurs due to the dewatering of fine-grained geologic materials, such as clay, leading to structural collapse and loss of void spaces. Although there is no significant historical evidence of subsidence in the Subbasin, SGMA requires that the GSP considers the potential consequences of undesirable results.

Per input from the Subbasin GSAs, local infrastructure can typically withstand subsidence ranging between 24 and 36 inches. Based on InSAR data currently, available, 2015-2016 maximum subsidence rates in the Eastern San Joaquin Subbasin ranged from -1.2 inches per year to -2.4 inches per year, and there has been a maximum average subsidence rate of 0.93 inches per year over the last approximately eight years (2015-2023). Given that approximately 10 years have elapsed since the implementation of SGMA commenced in 2015, and assuming an additional 10 years for achieving significant progress towards the Subbasin's sustainability goal, it has been assumed that an additional 24 inches of subsidence (-1.2 inches per year times 20 years) can occur until 2040 without experiencing undesirable results relating to inelastic land subsidence. Potential effects of inelastic land subsidence in excess of 24 inches include damage to water conveyance facilities and major roads, reduced capacity of surface water delivery systems leading to increased groundwater demand, negative impacts on property values, and economic burdens associated with mitigating the damage.

6. SUSTAINABLE MANAGEMENT CRITERIA

The identified undesirable results described in **Section 5.2** and historical subsidence measurements were used as a basis to establish sustainable management criteria for the Subbasin for inelastic land subsidence. From this basis, new minimum thresholds, measurable objectives, and interim milestones were developed for the Subbasin identifying the total amount (inches) of subsidence and 5-year rolling average rate of subsidence per five-year time period for each SMC.

The subsidence minimum thresholds are established to prevent inelastic subsidence that could affect critical infrastructure. At present, there is no significant inelastic subsidence in the Subbasin affecting any beneficial user, and the minimum threshold is conservatively set to prevent subsidence impacts and allow for adaptive mitigation measures if necessary. The measurable objectives (MOs) and interim milestones are intended to prevent any further subsidence after 2040. **Table 2** summarizes the SMCs for the subsidence in the Subbasin to be applied to each representative monitoring location in the Subbasin's revised RMN for inelastic land subsidence.

Table 2: Subsidence Sustainable Management Criteria

Criteria	Time Interval	Total Extent (inches)	5-Year Average Rate (inches/year)
Minimum Threshold	2020-2040	24	2.4
Measurable Objective	After 2040	0	0
Interim Milestones	2020-2025	12	2.4
	2025-2030	6	1.2
	2030-2035	3	0.6
	2035-2040	3	0.6
	After 2040	0	0

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TECHNICAL MEMORANDUM NO. 3 – Groundwater Quality

TO: Paul Gosselin, California Department of Water Resources Deputy Director

CC: Ashley Couch, on behalf of the Eastern San Joaquin Groundwater Authority

PREPARED BY: Liz DaBramo, Emily Honn, and Astrid Guerrero/Woodard & Curran

DATE: November 2024

RE: Eastern San Joaquin Groundwater Authority Response to DWR's July 6, 2023 Approved Determination Letter for the 2022 Revised GSP - Technical Memorandum No. 3, Response to DWR Recommended Corrective Actions Nos. 5, 7, and 8

On July 27, 2022, the Groundwater Sustainability Agencies (GSAs) submitted the Eastern San Joaquin Groundwater Subbasin Revised 2022 Groundwater Sustainability Plan (GSP or Plan) for the San Joaquin Valley – Eastern San Joaquin Subbasin (Subbasin) to the California Department of Water Resources (DWR) in response to DWR's incomplete determination letter dated January 28, 2022. In a July 6, 2023 letter, DWR staff concluded that the GSAs had taken sufficient actions to correct deficiencies identified by DWR and approved the 2022 Revised Plan (see **Appendix 3-B of the GSP**). In Section 6 of the letter, DWR staff also identified recommended corrective actions (RCAs) for the GSAs to address by the Plan's first periodic evaluation. This technical memorandum (TM) is in response to RCA Nos. 5, 7, and 8 related to groundwater quality and seawater intrusion.

Seawater intrusion and groundwater quality are closely linked, particularly in coastal regions where freshwater and saltwater meet. Excessive groundwater extraction may disrupt the natural hydraulic gradient, allowing seawater to move inland and degrade groundwater. This intrusion increases groundwater salinity, potentially rendering it unsuitable for drinking, irrigation, and industrial use without treatment. Effective management and mitigation strategies are crucial to protect groundwater quality from seawater intrusion. Regular monitoring of groundwater levels and salinity can help maintain the balance between freshwater and seawater. While the Eastern San Joaquin Subbasin is not on the coast, it abuts the San Joaquin-Sacramento Delta (Delta) which was a brackish water body before large-scale water management and infrastructure was incorporated.

Given the interconnection of seawater intrusion and groundwater quality, along with the approach described below to DWR's RCAs, this document includes the response to both the seawater intrusion-related RCAs (#5 and #8) and groundwater quality RCA (#7) in a single TM. This TM is organized into the following sections:

1) Seawater Intrusion
    a. Overview of Recommended Corrective Action #5 and #8
    b. 2020 Approach
    c. 2025 Approach
    d. Supporting Analysis

e. Response to RCA #5 and #8

2) Groundwater Quality

   a. Overview of Recommended Corrective Action #7
   b. 2020 Approach
   c. 2025 Approach
   d. New Groundwater Quality Representative Monitoring Wells (RMW)
   e. Sustainable Management Criteria (SMC)

1. SEAWATER INTRUSION

1.1 Overview of Recommended Corrective Actions #5 and #8

The following is the text included in Section 6 of DWR's 2023 Determination Letter:

Corrective Action #5

- *Department staff recommend the GSP provide additional explanation for how the 2,000 mg/L chloride isocontour line will prevent significant and unreasonable impacts to beneficial uses and users of groundwater. Additionally, the Plan should provide the current chloride conditions and interim milestones for seawater intrusion.*

Corrective Action #8

- *The GSP currently states that only groundwater quality wells from the representative monitoring network will be utilized to create the chloride isocontour line that will be used to evaluate seawater intrusion sustainable management criteria. As currently depicted, very few representative monitoring wells are on the western side of the isocontour line. Department staff recommend that development of the chloride isocontour line utilize all groundwater quality wells in the western portion of the Subbasin, as appropriate considering well construction information.*

1.2 2020 Approach

The northwest corner of the Eastern San Joaquin (ESJ) Subbasin overlies a portion of the Delta. The Delta originally experienced groundwater fluctuations closely tied to tidal cycles, with a mix of brackish, saline ocean water, and fresh streamflow typical of an inland river delta and estuary. However, after decades of land reclamation and the implementation of managed operations as a result of the State Water Project and Central Valley Project, the Delta is now managed as a freshwater body. Saline water is no longer able to migrate eastward beyond the extensive network of levees and engineering alterations to the original natural channels. As a result, seawater intrusion has not historically been observed within the Subbasin nor is it likely to occur in the future.

The 2020 GSP addressed the potential for seawater intrusion in the Subbasin. As such, a Representative Monitoring Network (RMN) was established, and Sustainable Management Criteria (SMCs) were developed. A 2,000 mg/L chloride concentration isocontour line, based on the location of monitoring wells, was used as a benchmark for evaluating potential impacts from seawater intrusion. This isocontour line was not based on existing or historical chloride concentrations; rather, it was delineated to indicate where undesirable results from seawater intrusion could potentially occur in the future. The isocontour line was delineated along the west side of the RMN to ensure that a line of "sentinel" monitoring wells would be able to observe elevated chloride levels before reaching other parts of the Subbasin. A high minimum threshold (MT) of 2,000 mg/L chloride was set to distinguish elevated concentrations derived from seawater intrusion from those derived from naturally occurring high chloride groundwater. Figure 1 shows the delineated chloride isocontour line for the original GSP's seawater intrusion MT.

Figure 1: 2020 GSP – Seawater Intrusion MT Chloride Isocontour Line

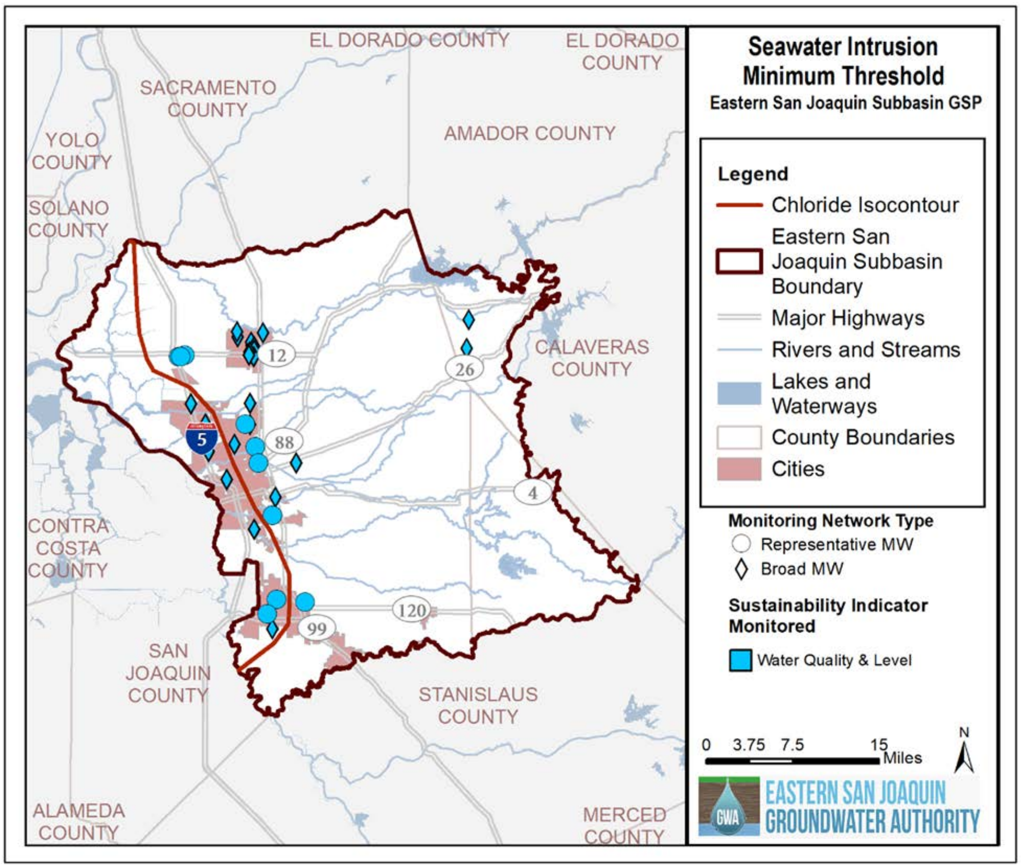


Table 1 gives an overview of the 2020 GSP's SMC for seawater intrusion. Undesirable results were considered to occur when chloride concentrations reached 2,000 mg/L at the established isocontour line, and the source of the elevated concentrations is demonstrated to be a result of groundwater management activities that have induced the intrusion of seawater. This undesirable result was designed to be protective of future changes in Delta tidal patterns as a result of climate change and associated sea level rise or significant changes in Delta management practices. Increased salinity from seawater intrusion could reduce the usable water supply for groundwater users, with domestic wells being most vulnerable due to the high cost of treatment or limited access to alternative supplies. This degradation in water quality could lead to changes in irrigation practices, alterations in crops grown, decreased property values, and other economic

impacts. Municipal uses could also be affected, necessitating the installation of treatment systems or the search for alternate water supplies.

Table 1: 2020 GSP – Sustainable Management Criteria for Seawater Intrusion

Criteria	Narrative Description
Proposed Minimum Threshold (MT)	2,000 mg/L chloride at select wells
Proposed Measurable Objective (MO)	500 mg/L chloride
Proposed Interim Milestones (IMs)	5-yr milestones along linear trend between current conditions and MO
Definition of Unreasonable Result	Considered to occur when all representative monitoring wells (RMWs) exceed the MT for seawater intrusion for two consecutive years and where these concentrations are caused by changes in the hydrologic gradient as it relates to the Delta

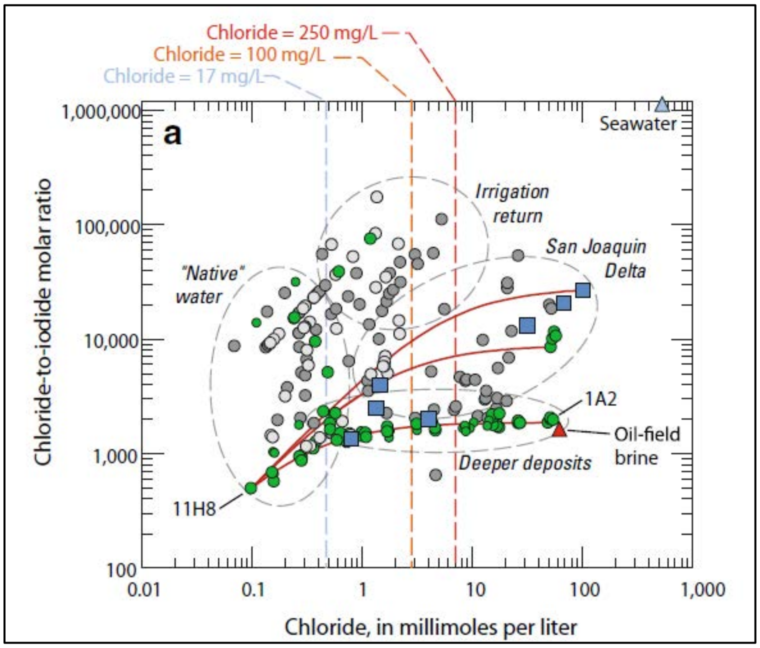
A USGS study conducted by O'Leary *et. al.* (2015) investigated the factors contributing to high chloride concentrations in the Subbasin. The study used major-ion analysis and stable isotope concentrations to determine water types and evaluate groundwater salinity sources in the Subbasin. **Figure 2** was presented in the study and illustrates the chloride-to-iodide ratios of water samples from various sources within the Subbasin. It shows that different water sources have distinct chloride-to-iodide ratios and chloride concentrations, allowing for the identification of the origins of high-chloride water. There are three primary sources of high-chloride water in the Subbasin:

- Irrigation return water
- Naturally occurring connate water from deeper deposits
- Saline water intrusion from the Delta

Connate water refers to groundwater that has been trapped in the pores of sedimentary rocks since their formation. Often highly saline, connate water typically originates from ancient seawater that was trapped during aquifer formation. Connate water can play a significant role in the hydrogeology and geochemistry of an area, influencing the salinity and chemical composition of aquifers.

The study results mean that high chloride concentrations do not necessarily indicate seawater intrusion. Connate water can reach concentrations as high as 2,050 mg/L, which exceeds the USEPA Secondary Maximum Contaminant Level (SMCL) of 250 mg/L for chloride. The high chloride concentrations from non-Delta sources resultantly contributed to the high MT established for chloride in the 2020 GSP. Conducting major-ion analysis to determine the source of chloride during semi-annual sampling is economically prohibitive; therefore, no further analyses were conducted to determine the origin of chlorides in the Subbasin.

Figure 2: Chloride-to-Iodide Ratio as a Function of Chloride Concentration (O'Leary, *et. al.*, 2015)



1.3 2025 Approach

To address DWR's Recommended Corrective Action #5, this document aims to demonstrate that seawater intrusion is not an applicable sustainability criterion for the Eastern San Joaquin Subbasin. As outlined in the 2020 approach and the USGS study (O'Leary *et. al*., 2015), it is challenging to distinguish increased chloride concentrations caused by seawater intrusion from other groundwater quality issues. And given the lack of proximity to the coast and the presence of connate groundwater in the San Joaquin Valley, the seawater intrusion sustainability criterion was reexamined.

The 2025 Periodic Evaluation considered the approach of neighboring subbasins, such as the Tracy and Solano Subbasins which are closer to the saline zone of the Delta, in addressing the seawater intrusion criterion. Both the Tracy and Solano Subbasin GSPs state that seawater intrusion has not and is unlikely to occur in the future, so sustainability criteria were not established in the GSPs. Like the Tracy and Solano Subbasins, the Eastern San Joaquin Subbasin is located in the Delta and is unlikely to experience seawater intrusion in the future with the continued management of the X2 barrier and upstream reservoir releases. Therefore, this Periodic Evaluation and 2024 Amended GSP addresses DWR's recommended corrective actions for seawater intrusion by considering the sustainability criterion to not be applicable for the Subbasin for reasons stated below, to eliminate associated SMC for seawater intrusion from the GSP and, instead, incorporate chloride as part of the groundwater quality sustainability criterion, including establishing SMC for chloride under the groundwater quality sustainability criterion.

1.4 Supporting Analysis

The following section provides supporting analysis for this approach by showing:

1. The Delta is managed as a freshwater body in the Subbasin
2. There is minimal pumping in the Eastern San Joaquin Subbasin near the Delta
3. There are relatively low chloride concentrations in the Subbasin
4. Higher salinity water will be addressed through groundwater quality SMCs
5. The Subbasin is committed to monitoring and changing management strategies if conditions worsen

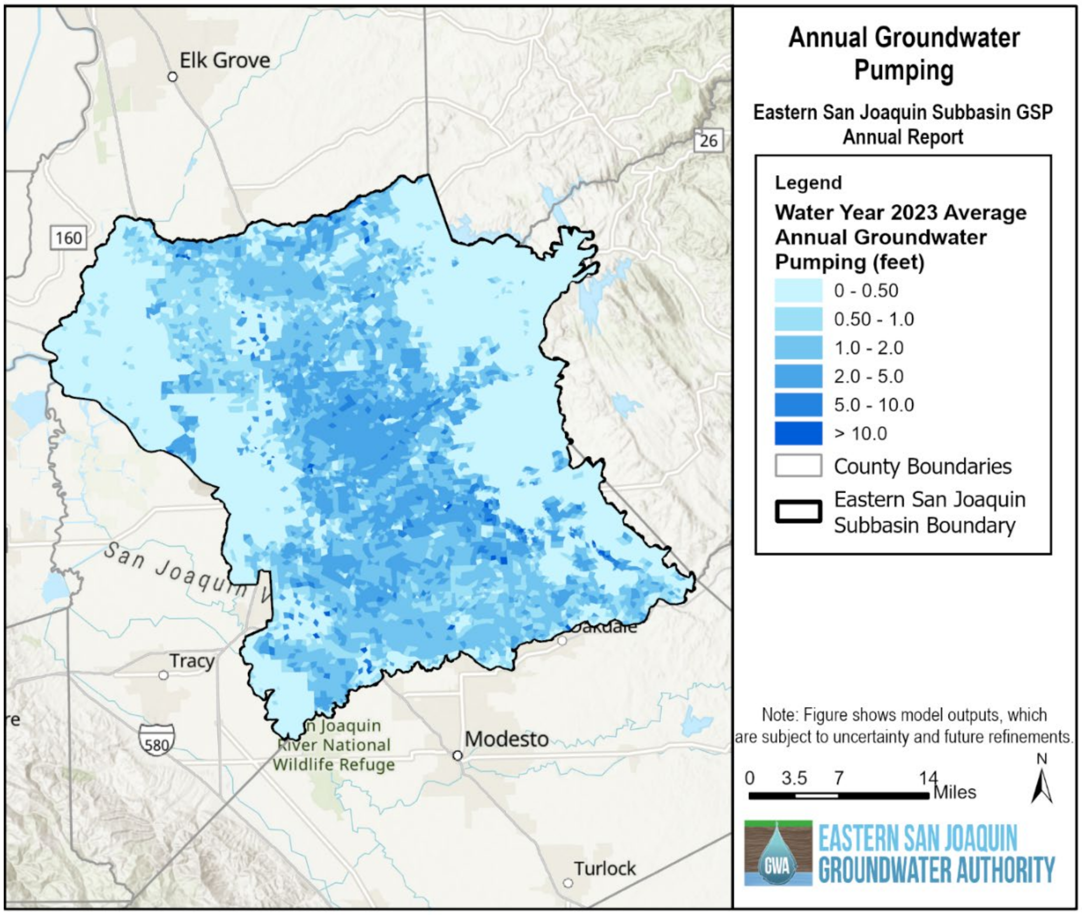
1.4.1 Delta is Managed to Maintain Freshwater Flows

The Subbasin is located adjacent to the Delta region. Prior to the construction of the Shasta Dam in 1943, brackish water had entered the surface waterways throughout the Delta. The Delta ecosystem naturally adapted to a salinity cycle that brought brackish tidal water from the San Francisco Bay. However, the construction of levees for agricultural development, followed by the development and operation of the Central Valley Project and the State Water Project, has changed the pattern of seawater movement into the Delta (Water Education Foundation 2019). Historically, some saltwater may have infiltrated the aquifers, locally affecting groundwater quality. Current management practices aim to maintain freshwater flows in the Delta through a combination of hydraulic and physical barriers and modifications to existing channels (Water Education Foundation 2019). The "X2" barrier, where the salinity is approximately 2 parts per thousand (ppt), is located well outside of the Subbasin boundary, further downstream in the Delta (Cloern, 2012). (For reference purposes, the salinity of the ocean is about 35 ppt.) Various agencies and regulations, such as the Delta Protection Commission (DPC), Delta Stewardship Council, San Joaquin County & Delta Water Quality Coalition, and State Water Board Resolution No. 2009-011, contribute to managing and maintaining salinity conditions in the Delta region.

1.4.2 Minimal Groundwater Pumping Near the Delta

Figure 3 presents the Subbasin's 2023 average groundwater pumping in feet across the Subbasin. The majority of pumping is in the northwest portion of Subbasin; areas adjacent to the Delta pump less than half a foot of groundwater per year.

Figure 3: 2023 Annual Groundwater Pumping



This figure reflects groundwater pumping from the 2023 Eastern San Joaquin Annual Report. Results may vary with the updated 2024 Eastern San Joaquin Water Resources Model Version 3.0.

1.4.3 Low Chloride Concentrations

Historical and current chloride concentrations were analyzed in the Subbasin. A variety of groundwater quality data were collected and examined. The datasets used for this analysis include (1) the Groundwater Ambient Monitoring and Assessment (GAMA) database, (2) The National Water (NWQMC) database, (3) the region's Opti Data Management System (DMS), and (4) SGMA Data Viewer (DWR). From these datasets, 4,000 unique wells were utilized with approximately 19,500 chloride observations.

Most wells had chloride concentrations well below the secondary maximum contaminant level (SMCL) of 250 mg/L for chloride. (Secondary MCLs are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. Contaminants with SMCLs are not considered to present a risk to human health and are not enforced.) Chloride concentrations throughout the Subbasin have remained relatively low. **Table 2** shows the percentage of chloride measurements after 2015 that exceed thresholds of 250 mg/L, 500 mg/L, and 2,000 mg/L. Notably, the majority of measurements (80%) fell within the 0–250 mg/L range, indicating low chloride levels throughout the Subbasin. Additionally, 14% of chloride observations were in the 250–500 mg/L range. Overall, 94% of measurements are below the 500 mg/L threshold. This analysis demonstrates that chloride concentrations in the Subbasin are generally low.

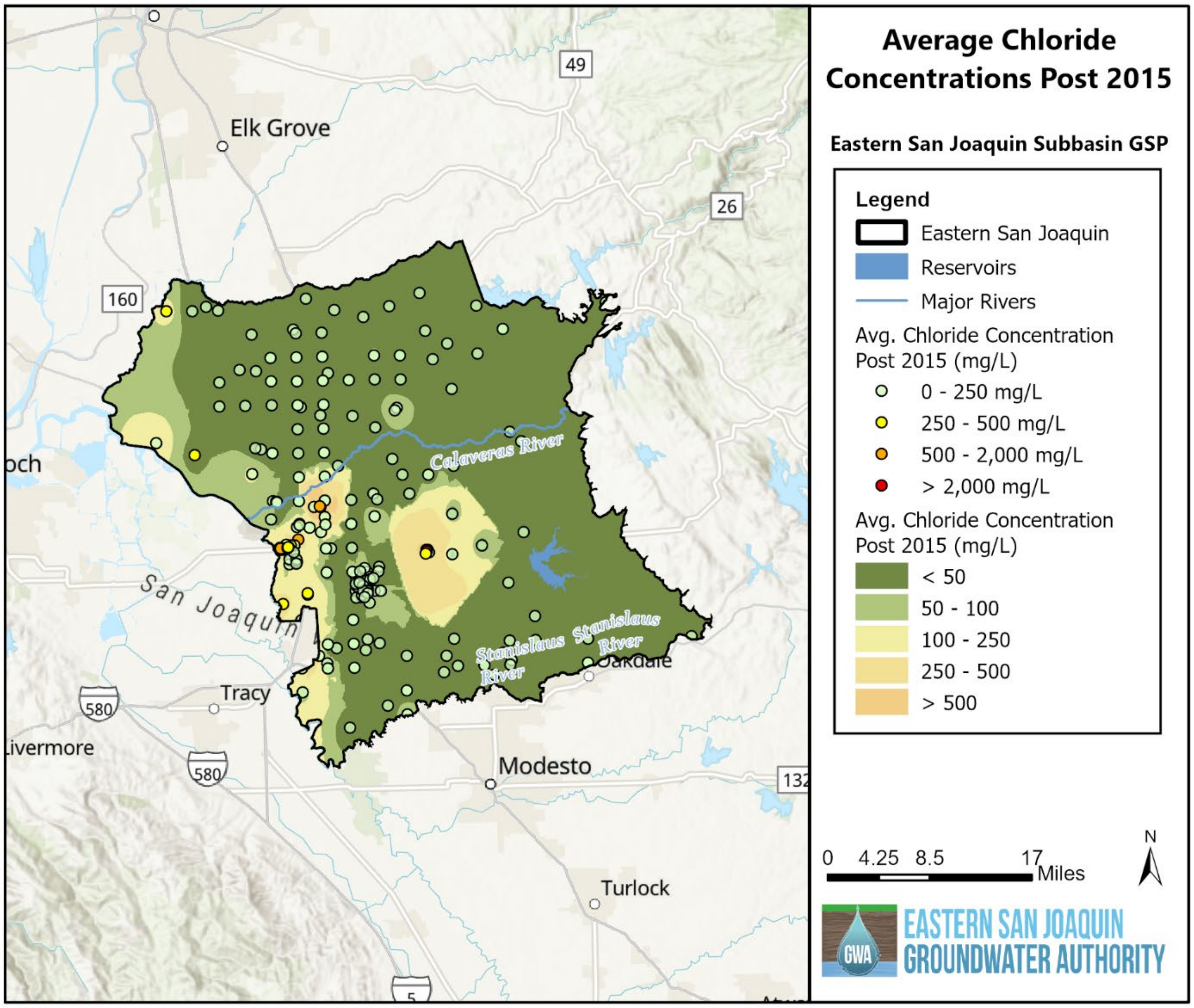
Table 2: Chloride Concentrations after 2015

Threshold Concentration	Percentage of Measurements after 2015 above Threshold
250 mg/L	14%
500 mg/L	5%
2,000 mg/L	1%

Chloride measurements in Table 2 are based on approximately 19,500 observations from 4,000 unique wells.

Figure 4 shows the average chloride concentration in the Subbasin since January 2015. These results are in line with those of **Table 2**. As shown in **Figure 4**, the majority of chloride concentrations in the Subbasin are within the 0 to 250 mg/L range. There are instances of higher concentrations in the 250 to 500 mg/L range, localized within the central and western regions of the Subbasin. Notably, these areas of relatively higher chloride concentrations are not located only in the Delta area and do not form a seawater intrusion front pattern. Overall, concentrations of chloride in the Subbasin are minimal and seawater intrusion is not occurring in the Subbasin or expected to occur in the future.

Figure 4: Average Chloride Concentrations Post 2015



1.4.4 Groundwater Quality Monitoring will incorporate Chloride

As previously mentioned, high salinity water in the Subbasin is likely not attributed to seawater intrusion, but most likely from other sources of chloride such as irrigation return flows. As demonstrated in the USGS study by O'Leary (O'Leary *et. al.*, 2015), the determination of degraded water quality sources is very complex and infeasible on a regular basis. As such, chloride will be included as a constituent of concern in the groundwater quality sustainability criteria in the 2024 Amended GSP. The RMWs and SMCs for this sustainability criterion are discussed in **Section 2**.

1.4.5 Commitment to Monitoring and Adaptive Management

The Subbasin is dedicated to monitoring chloride concentrations semi-annually. If salinity conditions were to worsen and deviate from current trends, the Subbasin will adjust management strategies accordingly to manage both chloride and total dissolved solids (TDS) as indicators of degraded groundwater quality. However, concentrations of chloride in the Subbasin are currently minimal and not expected to change in the future.

1.5 Response to RCA #5 and #8

To address DWR's Recommended Corrective Action #5 and #8, this Periodic Evaluation (and associated GSP amendment) will conclude that seawater intrusion is not an applicable sustainability criterion for the Subbasin and will not set SMCs for seawater intrusion. The approach to respond to RCA #5 and #8 is to remove the associated seawater intrusion SMC (2020 GSP) and add chloride to the groundwater quality SMC. This approach has been confirmed with DWR at a meeting on March 19, 2024.

2. GROUNDWATER QUALITY

2.1 Overview of Recommended Corrective Action #7

The following is the text included in Section 6 of DWR's 2023 Determination Letter:

Corrective Action #7

- *Department staff recommend that existing wells be evaluated to be included as part of the groundwater quality monitoring network to fill data gaps in the eastern portion of the Subbasin, until newly proposed monitoring wells are constructed. Additionally, Department staff recommend the final groundwater quality network identify a monitoring location in the central portion of the Subbasin where the existing groundwater depression was identified.*

2.2 2020 Approach

Two monitoring networks were created in the 2020 GSP to track the degraded water quality indicator: the representative monitoring network (RMN) and the broad monitoring network. SMCs were developed for the 10 RMN wells for total dissolved solids. Data collected at these wells have been reported annually through the annual report process. The broad monitoring network included an additional 21 wells intended to add additional monitoring to track the degradation of water quality throughout the Subbasin; however, these wells are not used for compliance with SMCs for groundwater quality. The broad network includes both single-completion wells and nested and/or clustered wells.

Most of the Subbasin's RMWs for groundwater quality are concentrated mostly on the western portion of the Subbasin where historically water quality has been of lower quality than the eastern side of the Subbasin. TDS was the only constituent for which SMCs were developed for groundwater quality in the 2020 GSP. The SMCs listed in **Table 3** were developed for TDS.

Table 3: 2020 GSP – Sustainable Management Criteria for Groundwater Quality

Criteria	Narrative Description
Minimum Threshold	Set at 1,000 mg/L TDS at all RMW locations. The MT is set to protect the beneficial uses of groundwater as a drinking water and agricultural supply. 1,000 mg/L represents the Upper Limit of the SMCL for TDS.
Measurable Objective	Set at 600 mg/L for TDS at all RMW locations. The MO is also set to ensure the protection of beneficial uses of groundwater as a drinking water and agricultural supply. The SMCL Recommended level of TDS is 500 mg/L. A 100 mg/L buffer was added to the SMCL recommended level to set the MO.
Definition of Unreasonable Result	Occurs when more than 25% of the RMWs (3 of 10 sites) exceed the MTs for water quality for two consecutive years, as a result of groundwater management activities.

2.3 2025 Approach

The Subbasin's approach to addressing DWR's RCA #7 involves streamlining and combining representative and broad network wells into a unified set of RMWs. This new set of wells will cover the spatial extent of the Subbasin and follow the recommendations outlined in the DWR *Monitoring Network Best Management Practices* (BMPs) (DWR 2016).

As part of this approach, the Subbasin analyzed available wells with recent TDS data from the Groundwater Ambient Monitoring and Assessment (GAMA) Program. The locations, observations, and concentrations of the new set of monitoring wells were examined, as shown in **Figure 5** through **Figure 7**. The chloride data collected to respond to RCA #5 and #8, described in Section 1, were also analyzed. The well characteristics and groundwater quality observations were used to inform the selection of a new RMN with updated SMCs.

Figure 5 illustrates the count of TDS groundwater quality observations for each well between January 2015 and January 2024. The majority of wells have 10 or fewer observations, indicating that most wells were not sampled on an annual basis. Several wells closer to the city of Stockton have up to 50 groundwater quality observations. The wells with the highest sample count appear to be located near groundwater cleanup sites. Ideally, wells in the RMN would have been sampled regularly; however, wells that were located in the specific areas requested in RCA #7 were not sampled frequently (greater than 10 times) in recent years.

Figure 6 displays wells with TDS observations in recent years (2015 through early 2024) by well depth. The threshold between shallow and deep wells was set at 200 feet for consistency with the 2020 GSP. There were several wells without perforation or depth information. Between shallow, deep, and unknown well depths, there is a similar distribution of high- and low-quality groundwater. In other words, TDS was not observed in just the shallow or deep aquifer. The expanded groundwater quality RMN includes wells perforated at varying well depths to capture vertical differences in groundwater quality, as described in Section 2.4.

Figure 7 illustrates the maximum TDS concentrations since January 2015. The majority of wells have TDS concentrations below the measurable objective of 600 mg/L. However, some wells have recent TDS concentrations above minimum threshold of 1,000 mg/L. These wells are primarily located near the city of Stockton. Public water purveyors closely monitor groundwater quality and source and treat their water accordingly. The expanded RMN is intended to monitor groundwater quality concentrations and trends to avoid undesirable impacts and worsening of groundwater conditions as a result of groundwater pumping and management.

Figure 5: Monitoring Frequency for Wells Measuring Total Dissolved Solids

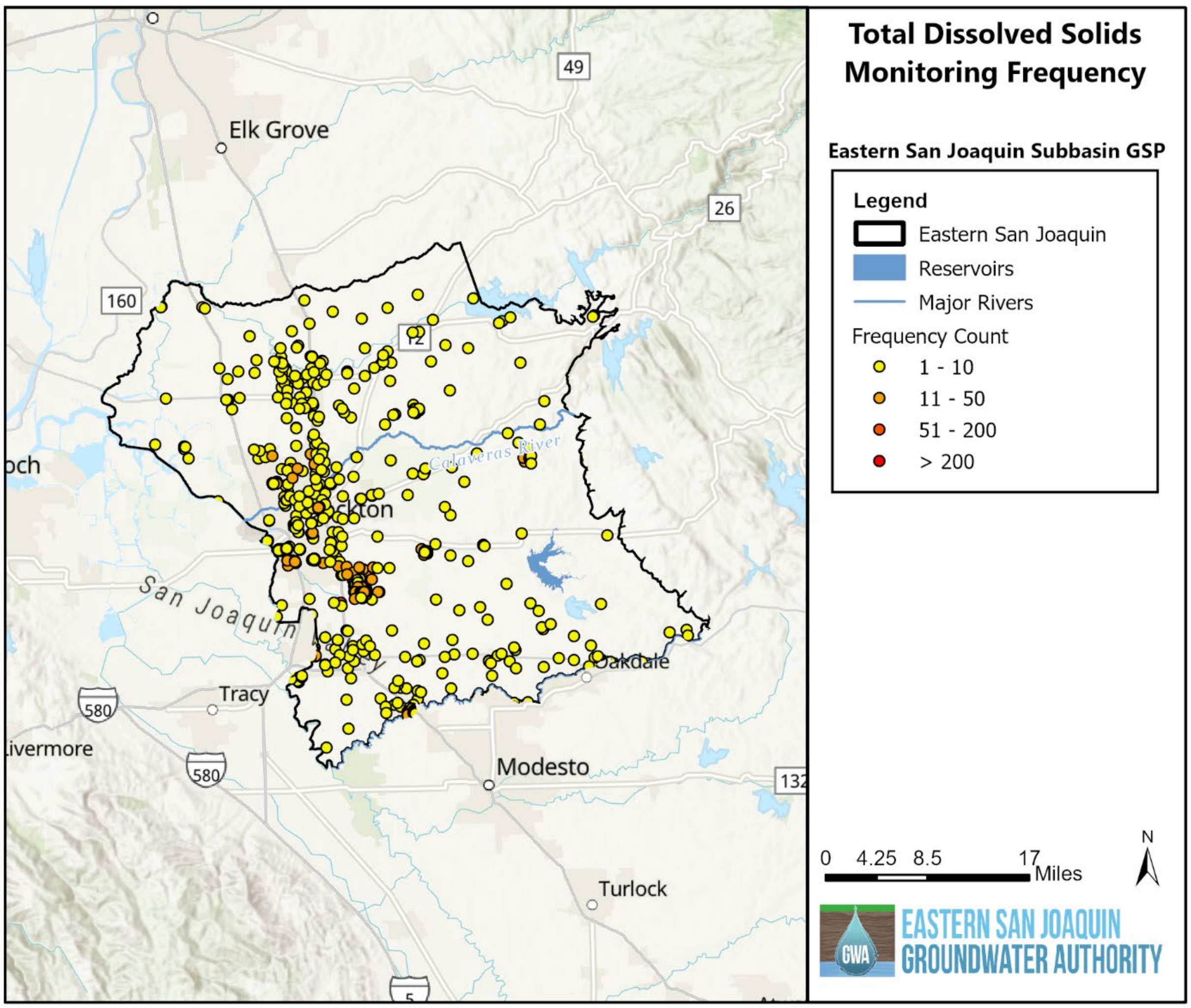


Figure 6: Wells with Recent TDS Observations by Well Depth

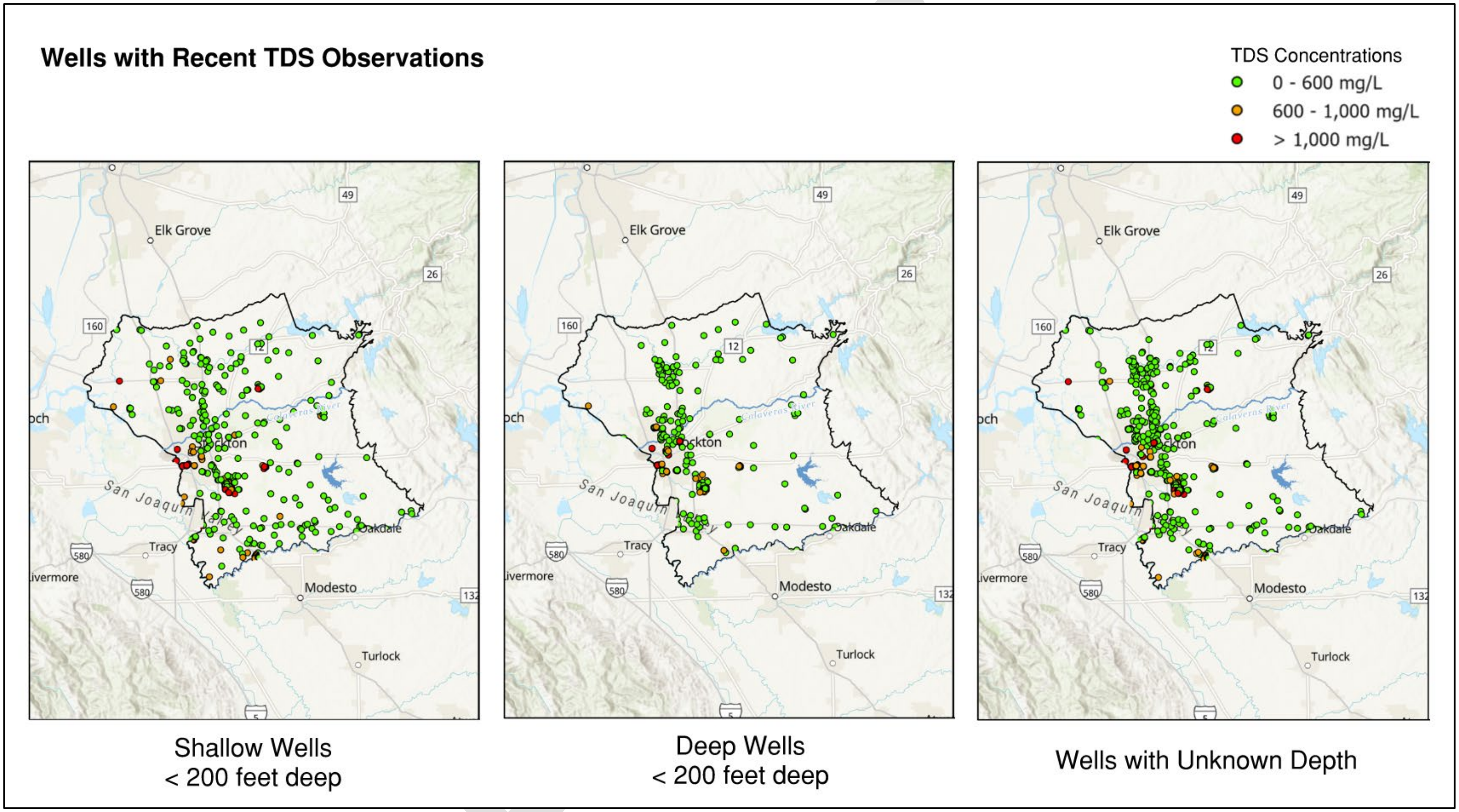
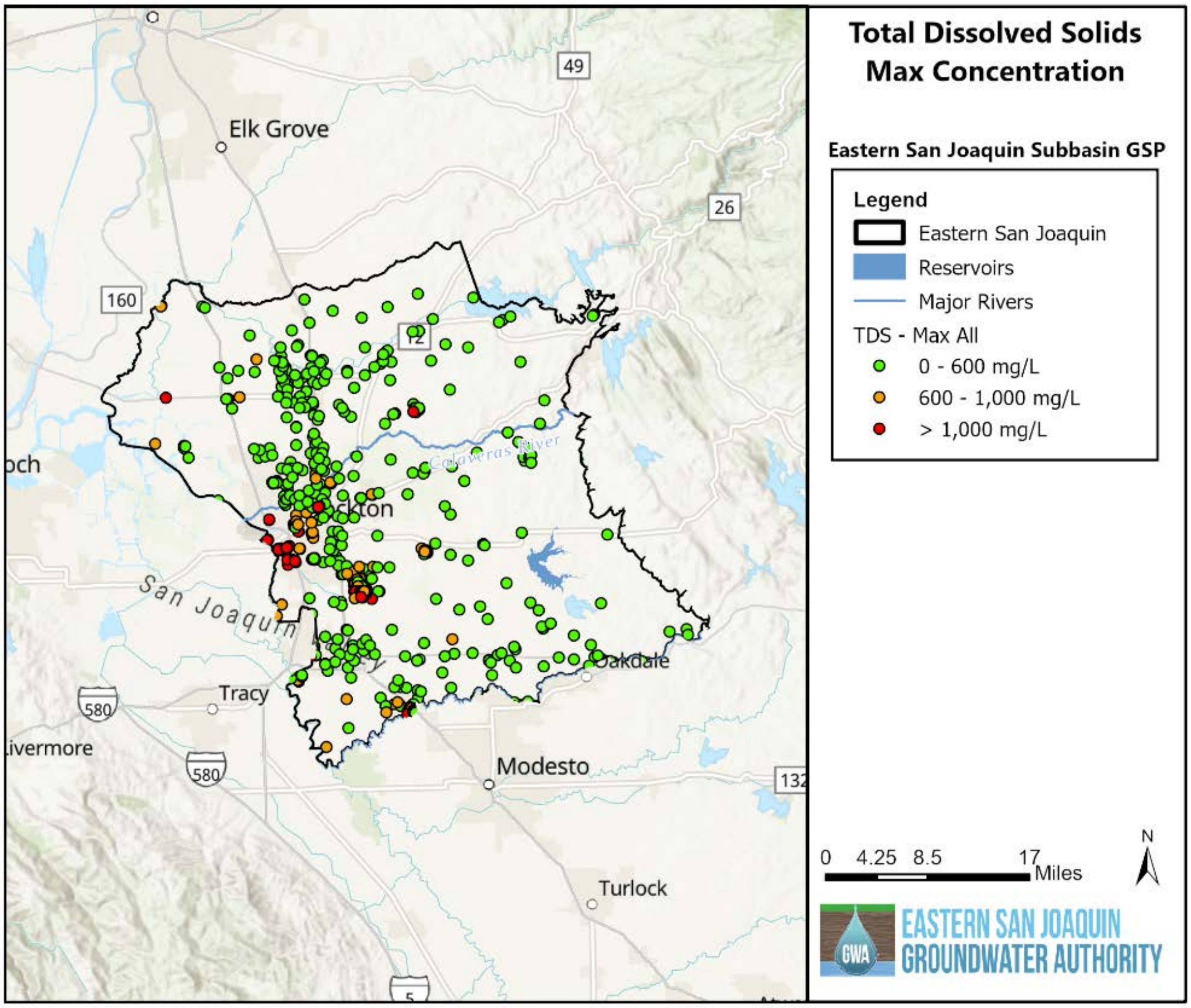


Figure 7: Maximum Concentrations for Wells Measuring Total Dissolved Solids



2.4 New Groundwater Quality RMWs

In response to DWR's 2023 Determination Letter, the RMN for water quality was improved in the 2024 Amended GSP. The original 10 wells from the 2020 RMN were retained, and 11 wells were added. New wells were included to improve coverage in the eastern side of the Subbasin and within the groundwater depression in the north-central portion. Wells were selected in accordance with DWR's *Monitoring Networks and Identification of Data Gaps Best Management Practice* (DWR 2016). **Figure 9** shows the final updated 2024 Amended RMN for groundwater quality. Information on these wells is detailed in **Table 4**. For each well, the table includes appropriate well IDs, a description of the wells, monitoring agency, location, and the screen internal and well depth.

The following summarizes the 11 new wells that were added to the representative network in further detail. **Figure 9** displays the groundwater quality RMN by source.

- New Stockton Wells: Stockton 26 in the original representative monitoring network has been decommissioned since the 2020 GSP. Therefore, Stockton 26 was removed, and as part of the 2024 Amended RMN, Stockton 27 and 31 have been added to the representative network. These two new wells will be monitored in addition to the remaining two Stockton wells in the existing network, for a total of four RMWs in the city of Stockon.
- Representative Network for Groundwater Levels: Swenson-3, Lodi City Well #2, and OID-8 are groundwater level RMWs that have been added to the network for groundwater quality. These wells expand coverage within data gap areas. Additionally, these wells also serve to support the Subbasin's response to Recommended Corrective Action #1, where the Subbasin is committing to tracking trends in groundwater quality with trends in groundwater levels at these three wells. While there is not evidence of a strong connection between declining water levels and degraded water quality, these wells will be used to track trends in both annually going forward.
- Existing Broad Monitoring Network Well: One well from the 2020 GSP's broad monitoring network, CCWD 010/011/012, was included in the updated network in the 2024 Amended RMN. This well provides beneficial spatial coverage in the northeast part of the Subbasin as well as valuable coverage at various depths.
- Additional Wells: Five wells, new to the 2024 Amended GSP, were added to the RMN. These wells include Well No. 05 monitored by Lockeford CSD, Well No. 07 monitored by Linden County WD, Well #2 at Shady Rest Trailer County, and Well No. 11 and 16 monitored by the city of Ripon. Each of these wells fill remaining data gaps on the eastern side and southern portion of the Subbasin. Several of these wells are already being monitored for California Water Watch through the State Water Resources Control Board every three years. Permission was obtained by each of these monitoring entities and a commitment to monitor for SGMA compliance has been made going forward.

The updated groundwater quality RMN has a diverse vertical extent and spans both shallow and deep aquifers. Several wells have multiple completions. This allows for a three-dimensional mapping of degraded water quality, as recommended by DWR's Monitoring Network BMPs. **Figure 9** shows the source of each well in the groundwater quality RMN, and **Figure 10** shows the well depth of each groundwater quality RMW. **Table 4** lists the well ID, monitoring agency, location, and perforation data for each groundwater quality RMW.

Figure 8: Updated Groundwater Quality Representative Monitoring Network

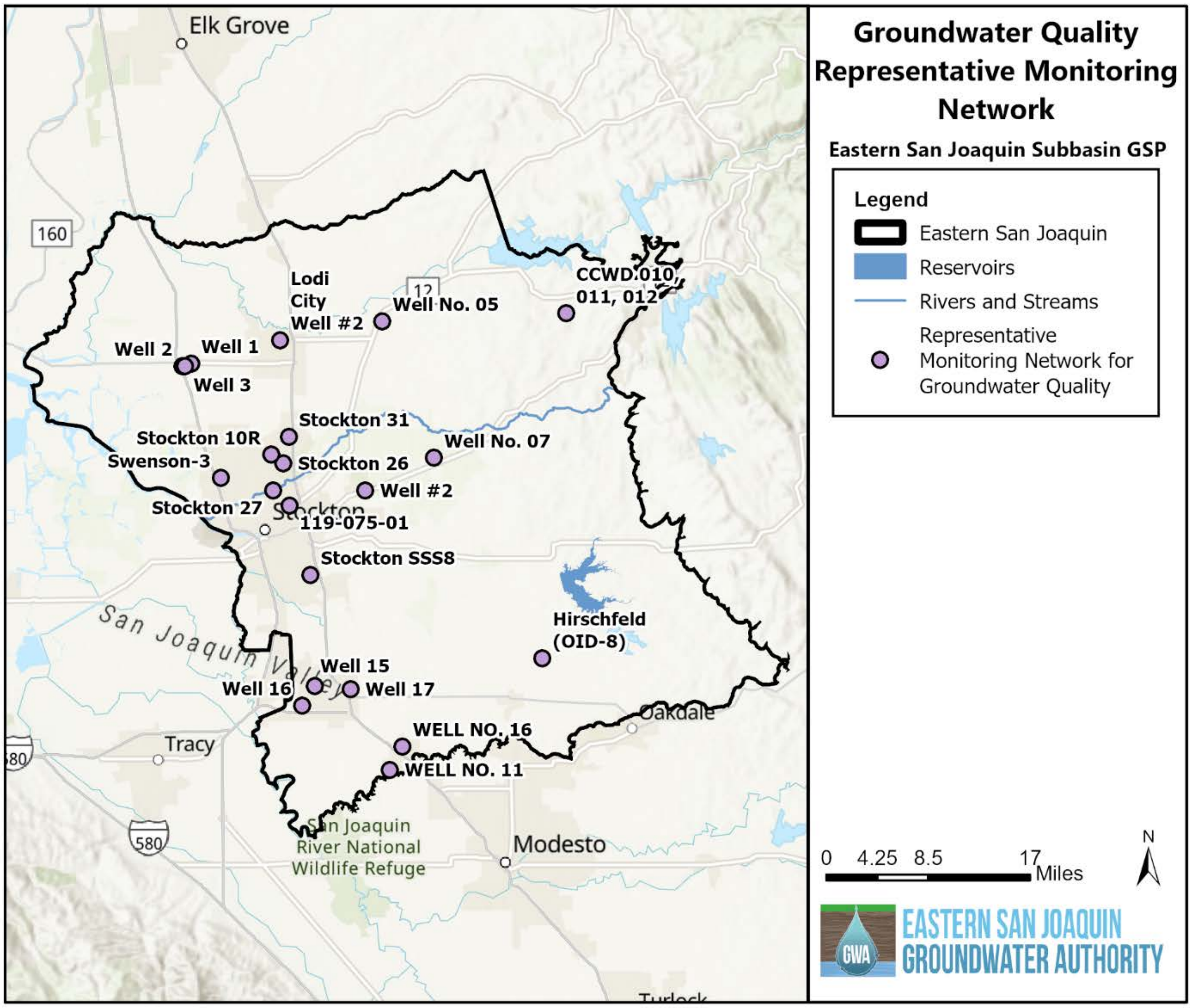


Figure 9: Updated Groundwater Quality RMN by Source

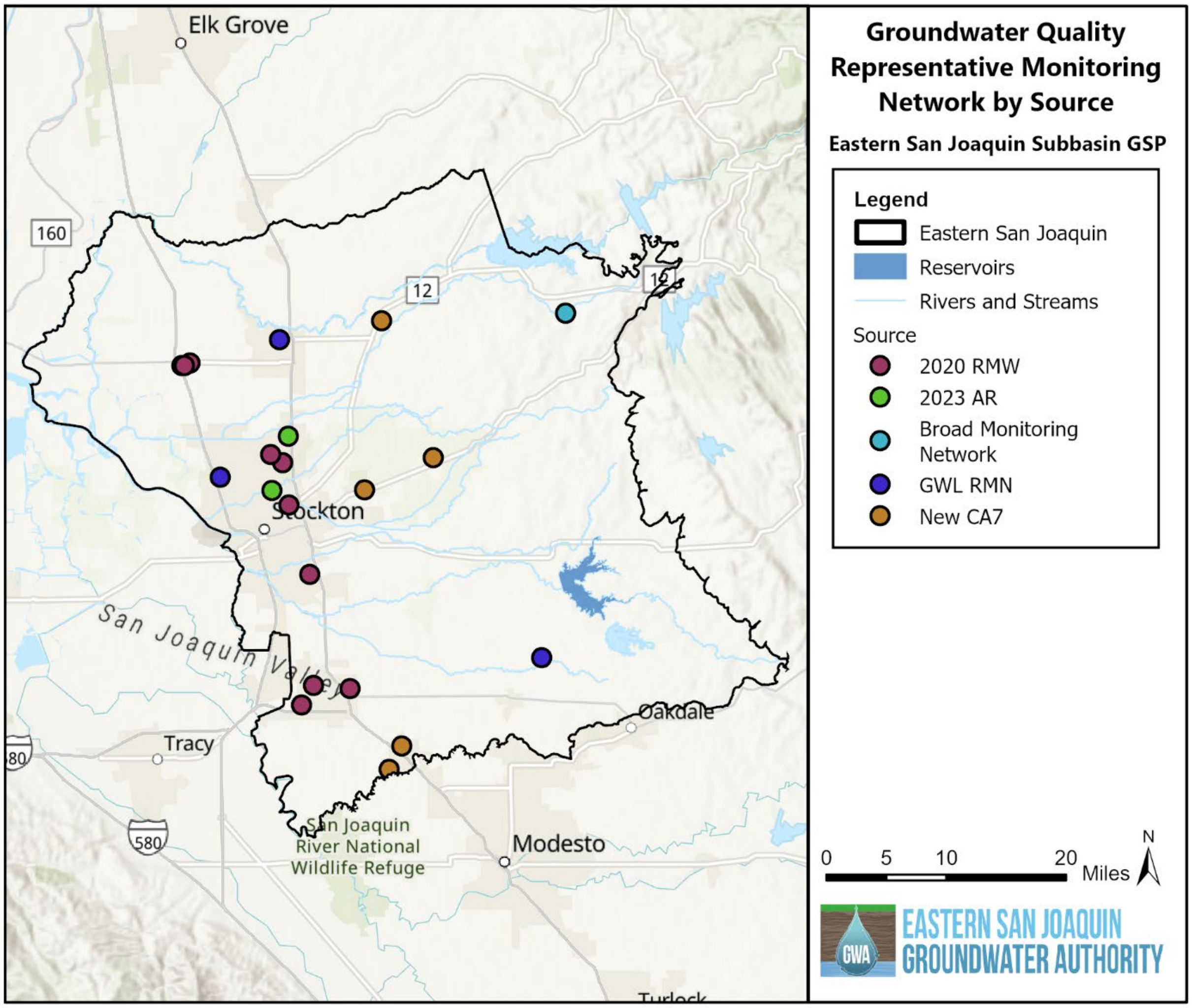


Figure 10: Updated Groundwater Quality RMN by Well Depth

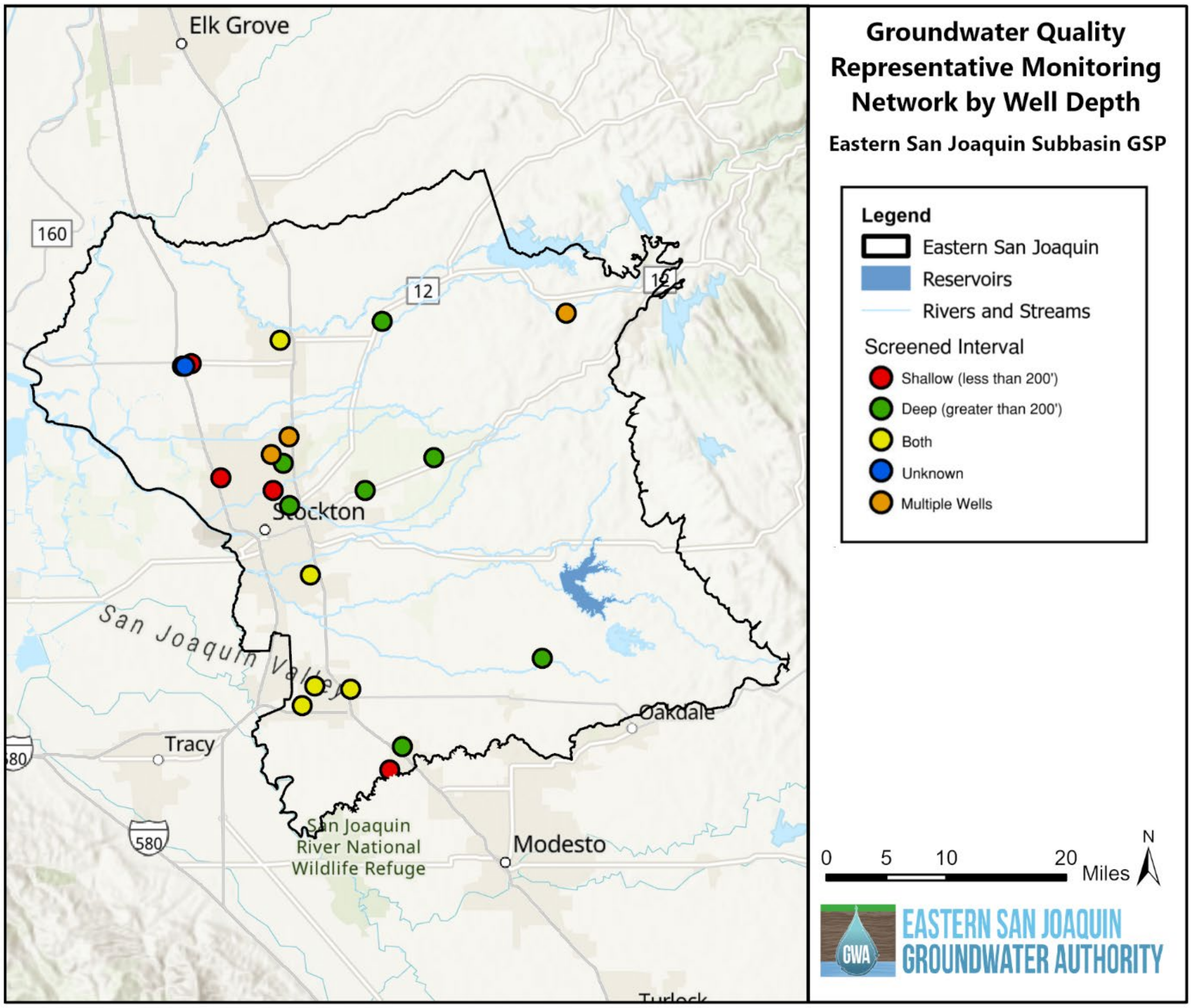


Table 4: 2024 Amended Representative Monitoring Network for Groundwater Quality – Well List

GSP Well ID	CASGEM ID	GM Well ID	Monitoring Agency	LATITUDE	LONGITUDE	Source	Screen Group	Screen Top	Screen Bottom	Well Depth
Well 1	381154N1213818W001	CA3901248_001_001	San Joaquin County (Flag City)	38.115366	-121.381755	2020 RMW	Shallow (less than 200')	110	170	-
Well 2	381131N1213920W001	CA3901248_002_002	San Joaquin County (Flag City)	38.113064	-121.391997	2020 RMW	Shallow (less than 200')	110	170	-
Well 3	381130N1213887W001		San Joaquin County (Flag City)	38.11299	-121.388682	2020 RMW	Unknown	-	-	-
119-075-01	01N/07E-18D01M	CA3910001_063_063	Cal Water	37.980357	-121.263022	2020 RMW	Deep (greater than 200')	200	560	-
Well 15	378089N1212325W001	CA3910005_015_015	City of Manteca	37.808954	-121.232674	2020 RMW	Both	140	240	-
Well 16	377904N1212476W001	CA3910005_016_016	City of Manteca	37.790339	-121.247724	2020 RMW	Both	137	274	-
Well 17	378059N1211878W001	CA3910005_028_028	City of Manteca	37.805695	-121.18896	2020 RMW	Both	110	230	-
Stockton 27			City of Stockton	37.994542	-121.282878	2023 AR	Shallow (less than 200')	0	200	-
Stockton SSS8	379146N1212401W001	CA3910012_089_089	City of Stockton	37.91465	-121.237343	2020 RMW	Both	158	256	-
Stockton 31		CA3910012_094_094	City of Stockton	38.045846	-121.263778	2023 AR	Multiple Wells[1]	157	362	380
Stockton 10R	380292N1212843W001	CA3910012_100_100	City of Stockton	38.028706	-121.285004	2020 RMW	Multiple Wells[2]	164	488	498
Well No. 05		CA3910008_005_005	Lockeford CSD	38.155478	-121.150908	New CA7	Deep (greater than 200')	250	310	-
Well No. 07		CA3910019_007_007	Linden County WD	38.025715	-121.088695	New CA7	Deep (greater than 200')	480	600	-
Well #2		CA3900755_002_002	Shady Rest Trailer Court	37.994757	-121.171349	New CA7	Deep (greater than 200')	200	210	-
WELL NO. 11		CA3910007_012_012	City of Ripon	37.729054	-121.141496	New CA7	Shallow (less than 200')	125	155	163
WELL NO. 16		CA3910007_026_026	City of Ripon	37.7510854	-121.1264178	New CA7	Deep (greater than 200')	232	356	366
Swenson-3	380067N1213458W003			38.0067	-121.3458	GWL RMN	Multiple Wells[3]	194	502	
Lodi City Well #2		CA3910004_003_003	City of Lodi	38.1376	-121.274	GWL RMN	Both	110	309	-
Hirschfeld (OID-8)			Oakdale ID	37.8352	-120.957	GWL RMN	Deep (greater than 200')	-	-	408
CCWD 010, 011, 012			Calaveras County WD	38.16278308	-120.92918	Broad Monitoring Network	Multiple Wells[4]	115	390	

[1] *Screened: 157-172, 183-207, 308-328, 337-362 feet deep*
[2] *Screened: 164-172, 180-194, 208-266, 294-306, 358-412, 452-466, 474-488 feet deep*
[3] *Screened 1: 482-502, 2: 294-314; 3:194-204 feet deep*
[4] *Screened 010: 370-390; 011: 250-270; 012: 115-135 feet deep*

2.5 Sustainable Management Criteria

SMCs were established for each RMW for TDS and Chloride.

The TDS SMCs remained unchanged from the 2020 GSP and were applied to the new RMWs. The ESJ Groundwater Authority Board selected an MT of 1,000 mg/L based on stakeholder concerns for drinking water and agricultural beneficial uses. The MO was set to 600 mg/L based on the TDS recommended SMCL for drinking water of 500 mg/L and adding a 100 mg/L buffer. The 600 mg/L TDS measurable objective is close to the recommended SMCL of 500 mg/L and significantly below the upper limit SMCL of 1,000 mg/L and is considered adequate for drinking water and agricultural uses. More information about the establishment of TDS SMC is described in Section 3.3.3 of the 2020 GSP.

The chloride SMCs aimed to avoid worsening groundwater quality from 2015 conditions. The MT for chloride was set at the maximum of the chloride SMCL (250 mg/L) or 2015 conditions, whichever is greater. All RMWs had chloride concentrations below the SMCL; therefore, the MT for all groundwater-quality RMWs is 250 mg/L. The chloride MO is equal to current conditions, established at the maximum of recent historical conditions between 2015 and 2023.

For both TDS and chloride, the interim milestones are the MO (if current concentrations are currently at the MO), or along an allowable linear increase in concentrations in groundwater until the MO is reached. Concentrations at the MO would subsequently be maintained after 2040. Increases in TDS and chloride in concentrations are considered to be allowable up to the MO because:

- For chloride, the largest difference between average current conditions and the MO for chloride is 24 mg/L with an average difference of 3 mg/L. Based on limited historical data, the average variation in chloride concentrations in the Subbasin is approximately 8 mg/L. For TDS, the largest difference between average current conditions and the MO for TDS is 358 mg/L with an average difference of 51 mg/L. Based on limited historical data, the average variation in TDS concentrations in the Subbasin is approximately 82 mg/L. Therefore, the average variation in concentrations is on par with the average existing differences in concentration between current conditions and the respective constituent MOs.

- Proximity to the Delta is one possible reason for increased TDS and/or chloride concentrations in groundwater. Delta salinity concentrations are managed by the State, and the portion of the Delta in the Eastern San Joaquin Subbasin is managed as a freshwater body. The GSAs can manage groundwater pumping in the Subbasin, which is relatively low in the Delta area, to reduce the potential of chloride intrusion. However, the salinity of the Delta from changing reservoir operations upstream and outside of the Subbasin is outside of the management scope of the GSAs.

- Irrigation return flows are another possible reason for increased concentrations of TDS and/or chloride in groundwater. The Subbasin depends heavily on agriculture for its local economies, and limiting agricultural uses would impact the basin. Agricultural sources of salinity are managed through existing management and regulatory programs within the Subbasin, such as the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) and the Irrigated Lands Regulatory Program (ILRP).

Table 5 summarizes the approach to establishing the groundwater quality SMCs for TDS and chloride. **Table 6** details the recent groundwater quality observations and MOs/MTs for each RMN. Each RMW will be monitored semi-annually, once in spring and once in fall, and reported in the Annual Reports.

Table 5: Summary of Groundwater Quality SMC Approach

Criteria	Chloride	TDS
Measurable Objective	Maximum recent historical conditions (2015-2023)	600 mg/L
Interim Milestones	Current concentration or linear increase to MO	Current concentration or linear increase to MO
Minimum Threshold	250 mg/L (SMCL), or chloride concentrations as measured in 2015 (whichever is greater)	1,000 mg/L (SMCL), or TDS concentrations as measured in 2015 (whichever is greater)

Table 6: Groundwater Quality RMN and Recent Groundwater Quality Observations and SMCs

GSP Well ID	Average Chloride (2015-Present)	Max Chloride (2015-Present)	Average TDS (2015-Present)	Max TDS (2015-Present)	Chloride MO	Chloride MT	TDS MO	TDS MT
Well 1	34.6	36	445	470	36	250	600	1,000
Well 2	73	73	568	590	73	250	600	1,000
Well 3	34.6	36	520	570	36	250	600	1,000
119-075-01	26.6	30	360	380	30	250	600	1,000
Well 15	15.8	17	310	310	17	250	600	1,000
Well 16	12.83	16	250	260	16	250	600	1,000
Well 17	15.2	17	305	320	17	250	600	1,000
Stockton 27	10.34	26	65	65.3	26	250	600	1,000
Stockton SSS8	38.5	41	330	330	41	250	600	1,000
Stockton 31	27.4	51	301	480	51	250	600	1,000
Stockton 10R	18	20	390	390	20	250	600	1,000
Well No. 05	14.7	17	227	240	17	250	600	1,000
Well No. 07	3.5	3.8	173	180	3.8	250	600	1,000
Well #2	16.3	33	323	520	33	250	600	1,000
WELL NO. 11[1]	75.5	83	610	610	83	250	600	1,000
WELL NO. 16[1]	75.5	83	580	580	83	250	600	1,000
Swenson-3[2]		100			100	250	600	1,000
Lodi City Well #2	6.2	6.2	190	190	6.2	250	600	1,000
Hirschfeld (OID-8)	12	12	200	200	12	250	600	1,000
CCWD 010, 011, 012[3]						250	600	1,000

Note: all concentrations in mg/L

[1]No recent chloride observations. Reported chloride concentrations from nearby WELL NO. 3. (CA3910007_003_003) from January 2015, January 2018, and January 2021.

[2]Swenson-3 is currently not accessible, but since it is originally a GWL RMN, it is expected to be accessible going forward. If not, then another well will be selected to replace it. There are no recent groundwater quality observations and the reported data is from nearby well ID CA3910012_030_030 in October 1991.

[3]No recent or nearby groundwater quality observations.

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ATTACHMENT 2

TECHNICAL MEMORANDUM NO. 4 – Water Budgets and Groundwater Storage

TO: Paul Gosselin, California Department of Water Resources Deputy Director

CC: Ashley Couch, on behalf of the Eastern San Joaquin Groundwater Authority

PREPARED BY: Emily Honn, Woodard & Curran

DATE: November 2024

RE: Eastern San Joaquin Groundwater Authority Response to DWR's July 6, 2023 Approved Determination Letter for the 2022 Revised GSP - Technical Memorandum No. 4, Response to DWR Recommended Corrective Actions Nos. 3 and 4

On July 27, 2022, the Groundwater Sustainability Agencies (GSAs) submitted the Eastern San Joaquin Groundwater Subbasin Revised 2022 Groundwater Sustainability Plan (GSP or Plan) for the San Joaquin Valley – Eastern San Joaquin Subbasin (Subbasin) to the California Department of Water Resources (DWR) in response to DWR's incomplete determination letter dated January 28, 2022. In a July 6, 2023 letter, DWR staff concluded that the GSAs had taken sufficient actions to correct deficiencies identified by DWR and approved the 2022 Revised Plan (see **Appendix 3-B in the GSP**). In Section 6 of the letter, DWR staff also identified recommended corrective actions (RCAs) for the GSAs to address by the Plan's first periodic evaluation.

This technical memorandum (TM) is in response to RCAs #3 and #4 related to clarifying water budget assumptions and revising the sustainable management criteria (SMC) for groundwater storage. As part of the GSP implementation and in response to RCAs #3 and #4, the Eastern San Joaquin Water Resources Model (ESJWRM) was updated in 2024 to reflect the latest data and groundwater conditions, as documented in the 2024 Model Documentation Update (Woodard & Curran, 2024). Groundwater storage in the Subbasin is estimated using ESJWRM Version 3.0 and therefore, total Subbasin storage was revised with this significant model update. For this reason, the Subbasin's response to RCAs #3 and #4 are combined into this single TM.

This TM is organized into the following sections:

1) Water Budget Updates
    a. Overview of Recommended Corrective Action #3
    b. Development of ESJWRM Version 3.0
    c. Updated ESJWRM Version 3.0 Water Budget Tables
2) Groundwater Storage
    a. Overview of Recommended Corrective Action #4

b. 2020 Approach

c. 2024 Updated Approach

1. WATER BUDGET UPDATES

1.1 Overview of Recommended Corrective Action #3

The following is the text included in Section 6 of DWR's 2023 Determination Letter:

Department staff recommend that in the first periodic evaluation of the GSP, only water budgets developed from the most recent or best available data be included. As currently presented, it is unclear whether the sustainable yield estimate and estimated groundwater offset required to achieve sustainability are based on the updated modeling results (based on ESJWRM Version 2.0) or are from the modeling scenarios presented in the original GSP submitted in 2020 (based on ESJWRM Version 1.0).

1.2 Development of ESJWRM Version 3.0

In response to RCA #3 and in conjunction with the development of the first periodic evaluation of the ESJ GSP, ESJWRM underwent a significant update in 2024. ESJWRM Version 3.0 now represents the latest working version of the model. The historical conditions, current conditions, projected conditions baseline, and projected conditions scenarios have been re-developed using ESJWRM Version 3.0. The results of these scenarios are included in this TM as well as in the first GSP Periodic Evaluation and 2024 GSP Amendment.

ESJWRM Version 3.0 includes the following major modeling updates:

- Updated historical model
- Calibrated historical model (Historical ESJWRM Version 3.0)
- Updated model scenarios
    - Current Conditions (methodology change in estimating current conditions from 2020 ESJ GSP)
    - Projected Conditions Baseline or PCBL Version 3.0 (no major changes from Version 2.0)
    - Projected Conditions Baseline with Climate Change or PCBL-CC Version 3.0 (no major changes from Version 2.0)
    - Projected Conditions Baseline with Demand Reduction or PCBL-DR Version 3.0 and Projected Conditions Baseline with Climate Change and Demand Reduction or PCBL-CC-DR Version 3.0 (no major changes in approach from Version 2.0)
    - Projected Conditions Baseline with Projects & Management Actions or PCBL-PMA Version 3.0 and Projected Conditions Baseline with Climate Change and Projects & Management Actions or PCBL-CC-PMA Version 3.0 (no major changes in approach from Version 2.0)

- Updated water budgets based on ESJWRM Version 3.0

Major changes to the ESJWRM model are described in the 2024 Model Documentation Update (Woodard & Curran, 2024). ESJWRM Version 3.0 will be used going forward as the latest version of the model. It was used to address RCA #4 and #6 in response to DWR's 2023 Determination Letter. A review of how it was used to address RCA #4 is included in Section 2 of this TM; how it was used to address RCA #6 is described in detail in Technical Memorandum No. 5 (ISW TM).

1.2.1 Summary of Significant Historical Model Updates in ESJWRM Version 3.0

A more comprehensive summary is included in the 2024 Model Documentation TM (Woodard & Curran, 2024), but a summary of the major model changes that were made is included below in **Table 1**.

Table 1: Historical Model Data and Feature Updates

Model Element	2024 Update
Layering	Refined based on AEM and added shallow alluvium layer
Streams	Removed Bear Creek from simulated streams
Land Use	Incorporated most recent DWR Statewide Crop Mapping (5 years: 2018, 2019, 2020, 2021, 2022) and removed previous data used for WY 2007-2015
Urban Water Demand	Updated rural residential population estimate using Census Tract data
Surface Water Supply	Added estimate of Farmington seepage and revised carriage/canal losses for SEWD. Made slight adjustments to diversions for NSJWCD, OID, and SSJID.
SW and GW Delivery Groups	Small updates based on local information received and to limit area overlaps

1.2.2 Summary of Current Conditions Scenario Updates using ESJWRM Version 3.0

The methodology used to develop the estimate of current conditions in the Subbasin was updated in ESJWRM Version 3.0. The 2020 GSP used a separate baseline model to estimate current conditions in the Subbasin over 50 years of historical hydrology. The methodology was updated in 2024 to remove reliance on a separate model run and instead focus on the recent years in the Historical ESJWRM Version 3.0. Current conditions in Version 3.0 are represented as an average of the last five water years (2019-2023) in Historical ESJWRM Version 3.0. This includes three (3) dry years and two (2) wet years. Current conditions are continuously changing by nature of what the scenario represents and are summarized in the Subbasin Annual Reports. Under this iteration of current conditions, an increased change in storage can be observed, which is consistent with recent trends in groundwater levels. There is an increased agricultural demand relative to the longer historical period but decreased urban demand due to conservation policies despite urban expansion.

1.2.3 Summary of Projected Conditions Scenario Updates using ESJWRM Version 3.0

The Projected Conditions Baseline (PCBL) Version 3.0 and Projected Conditions Baseline with Climate Change (PCBL-CC) Version 3.0 were revised based on updates made to the Historical ESJWRM Version 3.0 model. The simulation period was extended to 55 years; otherwise, assumptions of projected conditions remained the same as in PCBL Version 2.0.

Though not required by the SGMA regulations, updates to the Projected Conditions Baseline with Demand Reduction (PCBL-DR) Version 3.0 and Projected Conditions Baseline with Projects & Management Actions (PCBL-PMA) Version 3.0 scenarios, both with and without climate change, were also updated using PCBL Version 3.0 and PCBL-CC Version 3.0. These scenarios are important tools used within the ESJ Subbasin to better understand the relative benefits of supply and demand side solutions on the path toward subbasin sustainability. The approach used to develop these scenarios remained the same as is included in the 2022 Revised GSP, however, a few assumptions were updated based on input from the Eastern San Joaquin Groundwater Authority (ESJGWA) Project Management Committee (PMC). The following two sections detail some of the updates to these scenarios.

PCBL with Demand Reduction and PCBL with Climate Change and Demand Reduction

The demand reduction scenario models the impact of decreasing urban and agricultural demand across the Subbasin in order to understand what groundwater pumping reduction may be necessary to achieve a long-term groundwater storage deficit of approximately zero. An additional demand reduction scenario that includes the possible impacts of climate change was also rerun as part of the 2024 update.

The same approach used in 2022 was applied to the 2024 update. However, with the updated version of the model, a few modifications to the assumptions were made in order to achieve an annual average change in storage of zero. Both the PCBL scenario with climate change (PCBL-CC-DR Version 3.0) and without climate change (PCBL-DR Version 3.0) were developed.

- Urban Demand: Urban per capita water use was reduced by 15% under both PCBL-DR Version 3.0 and PCBL-CC-DR Version 3.0. This reduction is not indicative of how potential future urban demand cutbacks may be implemented.
- Agricultural Demand: Agricultural groundwater pumping was reduced in areas further than one (1) mile from streams by reducing agricultural acreage. Larger users of agricultural groundwater in ESJWRM were reduced at higher percents compared to smaller users. This reduction is not indicative of how potential future agricultural demand cutbacks may be implemented.

Table 2 shows how these percent reductions varied by type of user for each scenario. Further detail can be found in the 2024 Model Documentation TM (Woodard & Curran, 2024).

Table 2: Percent Demand Reduction Applied by Type of User

Percent Reduction	PCBL-DR Version 3.0	PCBL-CC-DR Version 3.0
Ag GW Pumping <2 AF/acre	0%	0%
Ag GW Pumping 2-3 AF/acre	15%	25%
Ag GW Pumping >=3 AF/acre	28%	38%
Urban Demand	15%	15%

PCBL with Projects & Management Actions and PCBL with Climate Change and Projects & Management Actions

The 2022 Revised GSP categorized projects and management actions into two categories: Category A and Category B projects. Category A projects are likely to advance in the next five years and have existing water rights or agreements in place. Category B projects are not anticipated to advance in the next five years but could be leveraged in the future. Category B projects may be elevated the Category A list should the appropriate project specifications be met.

A formal call for projects was initiated on April 26, 2024, so that GSAs could either provide updates on existing Category A and B projects or add new projects. Project status, timeline, benefits, and description were updated. Two new projects were added to the Category A list: NSJWCD Private Pumping Partnerships and OID In-Lieu and Direct Recharge. **Table 3** show the updated Category A list of projects. **Table 4**Table 3 show the updated Category B list of projects. Four new additional Category B projects were approved by the ESJGWA Board at their September 11, 2024 meeting and are not included in Table 4. More information on these projects is included in Appendix 6-A.

There are a total of 13 Category A projects. Seven are in-lieu recharge projects, three are direct recharge projects, and three are a combination of in-lieu recharge and direct recharge. Overall, the total additional surface water provided by Category A projects (either by in lieu or direct recharge) varies by water year type and ranges from 36,000 to 96,000 acre-feet per year (AFY) and is a mixture of deliveries to agricultural customers (including assumptions on evaporation and delivery losses), deliveries to urban customers, and direct recharge projects. A summary of the total additional water supply (excluding assumed losses) anticipated from Category A projects is included in **Table 3**.

Category A projects are simulated in ESJWRM to show the impact of these likely projects on the Subbasin under both the with climate change (PCBL-PMA-CC Version 3.0) and without climate change (PCBL-PMA Version 3.0) scenarios. Both scenarios reduce the reliance on groundwater by increasing in-lieu recharge in the Subbasin and directly reduce the change in groundwater storage via increased groundwater recharge projects. Though both scenarios do still indicate some additional projects or demand reductions may be needed, the Category A projects that are planned and being actively undertaken by the GSAs will improve sustainability in the Subbasin. Further detail, including results, can be found in the 2024 Model Documentation TM (Woodard & Curran, 2024).

Table 3: List of Category A Projects (2024)

Activity	Project Type	Project Proponent	Schedule (initiation and completion)	Baseline Water Year Type	Annual Volume (AFY) in PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0
SEWD Lake Grupe In-lieu Recharge	In-Lieu Recharge	SEWD	2020-2023	Drought	2,000
				Dry	4,900
				Normal	4,900
				Wet	4,900
SEWD Surface Water Implementation Expansion	In-Lieu Recharge	SEWD	2019-2029	Drought	4,000
				Dry	8,000
				Normal	19,000
				Wet	19,000
SEWD West Groundwater Recharge Basin	Direct Recharge	SEWD	2032	Drought	1,500
				Dry	4,000
				Normal	16,000
				Wet	16,000
CSJWCD Capital Improvement Program	In-Lieu Recharge	CSJWCD	2020-2027, on-going with 7-year completion cycles	Drought	-
				Dry	12,000
				Normal	24,000
				Wet	24,000
Long-term Water Transfer to SEWD and CSJWCD	Transfers/In-Lieu Recharge	SSJ GSA and OID	2019-2021	Drought	20,000
				Dry	5,000
				Normal	-
				Wet	-
City of Lodi White Slough Water Pollution Control Facility Expansion	Recycled Water/In-Lieu Recharge	City of Lodi	2019-2020	Drought	3,729
				Dry	3,729
				Normal	3,729
				Wet	3,729
NSJWCD South System Modernization	In-Lieu Recharge/Direct Recharge	NSJWCD	2018-2024	Drought	-
				Dry	1,200
				Normal	8,000
				Wet	10,000
	Direct Recharge	NSJWCD	2022-2024	Drought	-

Activity	Project Type	Project Proponent	Schedule (initiation and completion)	Baseline Water Year Type	Annual Volume (AFY) in PCBL-PMA Version 3.0 and PCBL-CC-PMA Version 3.0
NSJWCD Tecklenburg Recharge Project				Dry	300
				Normal	1,000
				Wet	2,000
NSJWCD South System Groundwater Banking with East Bay Municipal Utilities District (EBMUD)	In-Lieu Recharge	NSJWCD	2020-2025	Drought	-
				Dry	750
				Normal	3,200
				Wet	4,000
NSJWCD North System Modernization/Lakso Recharge	In-Lieu Recharge/Direct Recharge	NSJWCD	2021-2026	Drought	-
				Dry	1,000
				Normal	3,000
				Wet	4,000
City of Stockton Delta Water Treatment Plant Groundwater Recharge Improvements Project	Direct Recharge	City of Stockton	2022-2026	Drought	5,040
				Dry	5,040
				Normal	5,040
				Wet	5,040
NSJWCD Private Pump Partnerships	In-Lieu/Direct Recharge	NSJWCD	2024	Drought	-
				Dry	-
				Normal	1,500
				Wet	3,000
OID In-Lieu and Direct Recharge Project	In-Lieu/Direct Recharge	OID	2023-2032	Drought	0
				Dry	0
				Normal	3,000
				Wet	3,000

Table 4: List of Category B Projects (2024)

Project Name	Project Type	Project Proponent	Schedule (initiation and completion)	Annual Volume (AFY)
Perfecting Mokelumne River Water Right	In-Lieu Recharge	San Joaquin County	2024-2025	158,000
City of Manteca Metering Infrastructure	Conservation	City of Manteca	Not determined	272
City of Lodi Surface Water Facility Expansion & Delivery Pipeline	In-Lieu Recharge	City of Lodi	2030-2033	4,750
BNSF Railway Company Intermodal Facility Recharge Pond	Direct Recharge	CSJWCD	2020-2025	1,000
City of Stockton Advanced Metering Infrastructure	Conservation	City of Stockton	2023-2028	2,000
Manaserro Recharge Project	Direct Recharge	NSJWCD	2023-2025	8,000
City of Escalon Wastewater Reuse	Recycling/ In-Lieu Recharge/ Transfers	SSJ GSA	2020-2028	672
City of Ripon Surface Water Supply	In-Lieu Recharge	SSJ GSA	2028-2030	6,000
City of Escalon Connection to Nick DeGroot Water Treatment Plant	In-Lieu Recharge	SSJ GSA	2028-2030	2,015
Farmington Dam Repurpose Project	Direct Recharge	SEWD	2030-2050	60,000
Mobilizing Recharge Opportunities (also known as the "MICUP" Project)	Direct Recharge	San Joaquin County	2024-2040	158,000
NSJWCD Winery Recycled Water	Recycling/ In-Lieu Recharge/ Direct Recharge	NSJWCD	2025-2027	750

Project Name	Project Type	Project Proponent	Schedule (initiation and completion)	Annual Volume (AFY)
SSJID Storm Water Reuse	Storm Water/ In-Lieu Recharge/ Direct Recharge	SSJ GSA	2027-2030	1,100
North System Groundwater Recharge Project - Phase 2	Direct Recharge	NSJWCD	2026-2029	3,000
Threfall Ranch Reservoir, In-Lieu and Direct Recharge Project	In-Lieu Recharge/ Direct Recharge	ESJ GSA	2025	2,000
Wallace-Burson Conjunctive Use Program	Conjunctive Use/Direct Recharge	ESJ GSA	2030-2040	3,000
Calaveras River Wholesale Water Service Expansion	In-Lieu Recharge	ESJ GSA	2020-2040	600
Recycled Water to Manteca Golf Course	Recycling	City of Manteca	Not determined	406
Stormwater Collection, Treatment, and Infiltration	Direct Recharge/ Stormwater	City of Manteca	Not determined	Not determined
Off-Stream Regulating Reservoir	Direct Recharge	SEWD	2026-2050	Not determined
On-Farm Recharge Project	Direct Recharge	SEWD	2024-2030	108,300
Bellota Weir Modifications Project	Direct Recharge/Storm water	SEWD	2023-2030	5,000
City of Stockton DWTP Groundwater Recharge - Design and Construction	Direct Recharge	City of Stockton	2024-2026	11,000
Water Supply Enhancement Project - Distribution Pipelines	In-Lieu Recharge/Direct Recharge	SEWD	2024-2040	17,000
Water Treatment Plant Aquifer Storage Recovery Well - 7401	Direct Recharge	SEWD	2024-2026	2,420
Beckman Well	Direct Recharge	SEWD	2024-2028	Not determined

Project Name	Project Type	Project Proponent	Schedule (initiation and completion)	Annual Volume (AFY)
West Linden Project	In-Lieu Recharge/Direct Recharge	SEWD	2024-2035	60,000
Water Supply Enhancement Project - Direct Recharge	Direct Recharge	SEWD	2024-2030	Not determined
SSJID Water Master Plan - System Improvements	In-Lieu Recharge	SSJ GSA	2023-2040	15,000

1.3 Updated ESJWRM Version 3.0 Water Budget Tables

Table 5, **Table 6**, and **Table 7** provide the updated ESJWRM Version 3.0 Water Budget Tables for the Stream System, Land Surface System and Groundwater System, respectively, for the Historical Conditions, Current Conditions, Projected Conditions Baseline (PCBL) and Projected Conditions Baseline with Climate Change.

Table 5: Average Annual Water Budget in ESJWRM Version 3.0 – Stream System (AF/year)

Component	Historical Conditions (AF/year)	Current Conditions (AF/year)	Projected Conditions Baseline (AF/year)	Projected Conditions Baseline With Climate Change (AF/year)
Hydrologic Period	**WY 1996 - 2023**	**WY 2019 - 2023**	**55 Years (WY 1969-2023)**	**55 Years (WY 1969-2023) with 2070 CT**
Model Version	**Historical ESJWRM Version 3.0**	**Historical ESJWRM Version 3.0**	**ESJWRM PCBL Version 3.0**	**ESJWRM PCBL-CC Version 3.0**
Inflows				
Stream Inflows[1]	4,221,000	4,224,000	4,519,000	4,929,000
Cosumnes River	385,000	432,000	463,000	501,000
Dry Creek	26,000	27,000	33,000	40,000
Mokelumne River	531,000	539,000	600,000	650,000
Calaveras River	163,000	186,000	184,000	207,000
Stanislaus River	613,000	665,000	664,000	809,000
San Joaquin River	2,427,000	2,315,000	2,500,000	2,635,000
Local Tributaries[3]	76,000	59,000	74,000	87,000
Stream Gain from Groundwater[2]	145,000	130,000	121,000	115,000
Eastern San Joaquin Subbasin	75,000	63,000	57,000	53,000
Dry Creek[11]	-	-	-	-

Component	Historical Conditions (AF/year)	Current Conditions (AF/year)	Projected Conditions Baseline (AF/year)	Projected Conditions Baseline With Climate Change (AF/year)
Mokelumne River	14,000	13,000	10,000	8,000
Calaveras River	1,000	1,000	1,000	1,000
Stanislaus River	28,000	18,000	17,000	16,000
San Joaquin River	31,000	31,000	29,000	27,000
Other Subbasins[4]	70,000	67,000	65,000	62,000
Dry Creek	23,000	29,000	28,000	27,000
Mokelumne River[11]	-	-	-	-
Stanislaus River	27,000	19,000	17,000	16,000
San Joaquin River	20,000	20,000	19,000	18,000
Runoff to the Stream System[5]	629,000	741,000	656,000	753,000
Return Flow to Stream System[6]	96,000	95,000	111,000	112,000
Total Inflow[10]	**5,092,000**	**5,190,000**	**5,407,000**	**5,908,000**
Outflows				
Stream Outflows[7]	4,426,000	4,469,000	4,655,000	5,108,000
Stream Seepage[2]	284,000	331,000	374,000	420,000
Eastern San Joaquin Subbasin	236,000	267,000	298,000	330,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	125,000	135,000	150,000	160,000
Calaveras River	37,000	37,000	39,000	41,000
Stanislaus River	36,000	55,000	67,000	82,000
San Joaquin River	37,000	37,000	40,000	45,000
Other Subbasins[4]	47,000	65,000	76,000	90,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	3,000	3,000	3,000	4,000
Stanislaus River	30,000	47,000	56,000	69,000
San Joaquin River	12,000	12,000	14,000	14,000
Surface Water Diversions[8]	340,000	353,000	340,000	340,000
Riparian Intake from Streams[9]	42,000	37,000	37,000	40,000
Total Outflow[10]	**5,092,000**	**5,190,000**	**5,407,000**	**5,908,000**

Notes:

[1] Stream inflows into Eastern San Joaquin Subbasin include flows from Dry Creek, Mokelumne River, Calaveras River, Stanislaus River, San Joaquin River, and estimated tributary flows. Differences between historical and current/projected flows are due to differing hydrologic periods.

[2]Stream gain from groundwater and stream seepage represent the interaction of surface water and groundwater. Differences between the scenarios are related to differences in streamflows and long-term average groundwater elevations. Projected scenarios and even current condition averages represent lower groundwater levels, causing less stream interaction.
[3]Local tributaries include Bear Creek and related streams, Little Johns Creek, Duck Creek, and Lone Tree Creek.[4]Other subbasins include the Cosumnes, Modesto, South American, Solano, East Contra Costa, and Tracy Subbasins. Stream-aquifer interaction with the other subbasins was included for streams on the boundaries of the Eastern San Joaquin Subbasin.
[5]Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff of precipitation (due to more paved areas), the changes in runoff between the model scenarios are due to differences in the urban areas in the scenarios, as well as the amount of precipitation occurring. The historical calibration, with both less precipitation (due to more dry years than wet in the 28-year period) and smaller urban areas, has a corresponding smaller runoff. The current conditions scenario uses urban areas at the end of the historical calibration, while the projected scenario includes urban buildout to sphere of influence or general plan boundaries and therefore has more runoff.
[6]Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural or municipal purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand and therefore correspondingly higher applied water to meet that demand resulting in greater urban return flows (i.e., discharge of treated wastewater).
[7]Stream outflows occur at the edge of Eastern San Joaquin Subbasin at the confluence of the San Joaquin and Mokelumne Rivers.
[8]Surface water diversions shown in this table are the volumes of water taken directly off the river prior to any losses due to evaporation or canal seepage. These numbers do not include surface water directly diverted from simulated stream nodes (i.e., water taken off Stanislaus River occurs just upstream in the Subbasin). Differences between scenarios are due to differences in historical, current, and planned surface water diversions.
[9]Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by streamflows. Differences between scenarios may be due to availability of streamflows or extent of riparian vegetation, which may be affected by growth in urban areas.
[10]Summations in table may not match the numbers in the table. This is due to the rounding of model results.
[11]Values smaller than 500 AF/year are represented by a dash (-).

Table 6: Average Annual Water Budget in ESJWRM Version 3.0 – Land Surface System (AF/year)

Component	Historical Conditions (AF/year)	Current Conditions (AF/year)	Projected Conditions Baseline (AF/year)	Projected Conditions Baseline With Climate Change (AF/year)
Hydrologic Period	**WY 1996 - 2023**	**WY 2019 - 2023**	**55 Years (WY 1969-2023)**	**55 Years (WY 1969-2023) with 2070 CT**
Model Version	**Historical ESJWRM Version 3.0**	**Historical ESJWRM Version 3.0**	**ESJWRM PCBL Version 3.0**	**ESJWRM PCBL-CC Version 3.0**
Inflows				
Precipitation[1]	988,000	1,063,000	992,000	1,087,000
Total Surface Water Supply[2]	568,000	562,000	525,000	525,000
Agricultural	512,000	497,000	452,000	452,000
Urban and Industrial	56,000	65,000	73,000	73,000
Total Groundwater Supply[3]	732,000	830,000	799,000	879,000
Agricultural	666,000	777,000	732,000	812,000
Urban and Industrial	66,000	53,000	67,000	67,000
Riparian Intake from Streams[4]	30,000	26,000	26,000	29,000
Total Inflow[10]	**2,318,000**	**2,481,000**	**2,342,000**	**2,521,000**
Outflows				
Evapotranspiration[5]	1,309,000	1,352,000	1,302,000	1,384,000
Agricultural	1,006,000	1,080,000	999,000	1,089,000
Municipal and Domestic	59,000	58,000	80,000	81,000
Refuge, Native, and Riparian	243,000	213,000	214,000	214,000
Runoff to the Stream System[6]	629,000	741,000	656,000	753,000
Return Flow to the Stream System[7]	96,000	95,000	111,000	112,000
Agricultural	22,000	22,000	25,000	26,000
Municipal and Domestic	75,000	73,000	86,000	86,000
Deep Percolation[8]	275,000	284,000	270,000	268,000
Precipitation	60,000	53,000	55,000	52,000
Applied Surface Water - Agricultural	85,000	82,000	73,000	70,000
Applied Surface Water - Urban and Industrial	9,000	11,000	12,000	11,000
Applied Groundwater - Agricultural	111,000	129,000	119,000	125,000
Applied Groundwater - Urban and Industrial	11,000	9,000	11,000	10,000
Other Flows[9]	8,000	9,000	4,000	5,000
Total Outflow[10]	**2,318,000**	**2,481,000**	**2,342,000**	**2,521,000**

Notes:

[1]The projected conditions scenarios utilize the same 55 years of hydrology (water years 1969-2023) with perturbations in the climate change scenario causing more precipitation. The historical calibration has a shorter hydrologic period (28 years from 1996-2023) with slightly less precipitation on average. Current conditions represent recent years with 2 wet years (2019 and 2023) and 3 dry or critical years (2020, 2021, and 2022).[2]Total surface water supply shown in this table is the volume of surface water diverted or transported to meet agricultural and urban demands minus estimated losses due to evaporation or canal seepage. Differences between scenarios are due to differences in current and planned surface water deliveries.

[3]Total groundwater supply in the scenarios is calculated based on meeting remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.

[4]Riparian intake from streams is the portion of the riparian vegetation evapotranspiration met by streamflows. Differences between scenarios may be due to availability of streamflows or extent of riparian vegetation, which may be affected by growth in urban areas.

[5]Evapotranspiration is the demand required by agricultural land (i.e., crops); municipal and domestic areas (i.e., industrial and urban demands); and refuge, native and riparian areas. Differences in evapotranspiration are largely related to differences in urban areas between the scenarios and the loss of agricultural or native/riparian land as urban growth occurs.

[6]Runoff to the stream system is due to precipitation. As urban areas are assumed to have greater runoff (e.g., more paved areas), the changes in runoff between the model scenarios are due to differences in the urban areas in the scenarios, as well as the amount of precipitation occurring. The historical calibration, with both less precipitation and smaller urban areas, has a corresponding smaller runoff. The current conditions scenario uses urban areas at the end of the historical calibration, while the projected scenario includes urban buildout to sphere of influence or general plan boundaries and therefore has more runoff.

[7]Return flow to the stream system is due to applied water, either surface water or groundwater used for agricultural or municipal purposes. Differences between the scenarios is primarily related to the urban growth in the projected conditions scenario causing higher urban demand and therefore correspondingly higher applied water to meet that demand.

[8]Deep percolation is the amount of infiltrated water ultimately reaching the groundwater aquifer. The source of the water may be from precipitation or either applied surface water or groundwater used for agricultural or urban and industrial purposes. Differences between scenarios are related to differences between these sources of water and differences in the infiltration parameters related to land use.

[9]Other Flows captures the gains and losses due to land expansion and temporary storage in the root-zone and unsaturated (vadose) zones.

[10]Summations in table may not match the numbers in the table. This is due to the rounding of model results.

Table 7: Annual Average Water Budget in ESJWRM Version 3.0 – Groundwater System (AF/year)

Component	Historical Conditions (AF/year)	Current Conditions (AF/year)	Projected Conditions Baseline (AF/year)	Projected Conditions Baseline With Climate Change (AF/year)
Hydrologic Period	**WY 1996 - 2023**	**WY 2019 - 2023**	**55 Years (WY 1969-2023)**	**55 Years (WY 1969-2023) with 2070 CT**
Model Version	**Historical ESJWRM Version 3.0**	**Historical ESJWRM Version 3.0**	**ESJWRM PCBL Version 3.0**	**ESJWRM PCBL-CC Version 3.0**
Inflows				
Deep Percolation[1]	275,000	284,000	270,000	268,000
Precipitation	60,000	53,000	55,000	52,000
Applied Surface Water - Agricultural	85,000	82,000	73,000	70,000
Applied Surface Water - Urban and Industrial	9,000	11,000	12,000	11,000
Applied Groundwater - Agricultural	111,000	129,000	119,000	125,000
Applied Groundwater - Urban and Industrial	11,000	9,000	11,000	10,000
Stream Seepage[2]	236,000	267,000	298,000	330,000
Dry Creek	2,000	2,000	2,000	2,000
Mokelumne River	125,000	135,000	150,000	160,000
Calaveras River	37,000	37,000	39,000	41,000
Stanislaus River	36,000	55,000	67,000	82,000
San Joaquin River	37,000	37,000	40,000	45,000
Other Recharge	170,000	174,000	165,000	168,000
Carriage/Canal Recharge	103,000	109,000	98,000	98,000
Managed Aquifer Recharge	5,000	9,000	11,000	11,000
Reservoir Seepage	17,000	14,000	14,000	14,000
Ungauged Watershed Drainage	45,000	42,000	45,000	48,000
Subsurface Inflow[3]	176,000	188,000	204,000	222,000
Cosumnes Subbasin	28,000	34,000	35,000	35,000
Sierra Nevada Mountains	55,000	54,000	57,000	55,000
Modesto Subbasin	30,000	32,000	37,000	41,000
South American Subbasin	3,000	4,000	5,000	6,000
Solano Subbasin	19,000	19,000	22,000	27,000
East Contra Costa Subbasin	9,000	10,000	11,000	13,000
Tracy Subbasin	31,000	34,000	37,000	44,000
Total Inflow[5]	**857,000**	**912,000**	**937,000**	**988,000**

Component	Historical Conditions (AF/year)	Current Conditions (AF/year)	Projected Conditions Baseline (AF/year)	Projected Conditions Baseline With Climate Change (AF/year)
Outflows				
Groundwater Outflow to Streams[2]	75,000	63,000	57,000	53,000
Dry Creek[6]	-	-	-	-
Mokelumne River	14,000	13,000	10,000	8,000
Calaveras River	1,000	1,000	1,000	1,000
Stanislaus River	28,000	18,000	17,000	16,000
San Joaquin River	31,000	31,000	29,000	27,000
Groundwater Pumping[4]	732,000	830,000	799,000	879,000
Agricultural	666,000	777,000	732,000	812,000
Urban and Industrial	66,000	53,000	67,000	67,000
Subsurface Outflow[3]	96,000	104,000	110,000	111,000
Cosumnes Subbasin	27,000	32,000	36,000	37,000
Modesto Subbasin	40,000	44,000	44,000	46,000
South American Subbasin[6]	1,000	1,000	-	-
Solano Subbasin	11,000	11,000	11,000	10,000
East Contra Costa Subbasin	2,000	2,000	2,000	2,000
Tracy Subbasin	16,000	14,000	17,000	16,000
Total Outflow[5]	**903,000**	**997,000**	**965,000**	**1,043,000**
Change in Groundwater Storage (Inflows Minus Outflows)				
Change in Groundwater Storage[5]	**(48,000)**	**(89,000)**	**(30,000)**	**(56,000)**

Notes:

[1]Deep percolation is the amount of infiltrated water ultimately reaching the groundwater aquifer. The source of the water may be from precipitation, as well as either applied surface water or groundwater used for agricultural or urban and industrial purposes. Differences between scenarios are related to differences between these sources of water and differences in urban versus agricultural land use totals.

[2]Stream gain from groundwater and stream seepage represent the interaction of surface water and groundwater. Differences between the scenarios are related to differences in streamflows and long-term average groundwater elevations.

[3]The goal of projecting inter-basin flows is to maintain a reasonable balance between the neighboring groundwater subbasins. The resulting projected conditions scenario flows are within 10-15% of historical calibration flows, considered a reasonable range given the availability of projected land use, population, surface water delivery, and groundwater production data from areas outside of the Eastern San Joaquin Subbasin. Continuing inter-basin coordination may refine these numbers.

[4]Groundwater pumping is estimated by the ESJWRM based on the need for additional water to meet remaining demands after surface water deliveries occur. Differences in demand largely drive the amount of groundwater pumped.

[5]Summations in table may not match the numbers in the table. This is due to the rounding of model results.

[6]Values smaller than 500 AF/year are represented by a dash (-).

2. GROUNDWATER STORAGE

2.1 Overview of Recommended Corrective Action #4

The following is the text included in Section 6 of DWR's 2023 Determination Letter:

Department staff recommend the GSP provide a revised estimate for the reduction of groundwater storage volume that is considered an undesirable result. Alternatively, the GSP could highlight how the maximum reduction of groundwater storage related to the chronic lowering of groundwater level minimum thresholds would not result in significant and unreasonable impacts related to groundwater storage and omit the 23 MAF estimate.

2.2 2020 Approach

In the original 2020 GSP, the undesirable result for reduction of groundwater storage was defined as the following:

> *The threshold at which sustained groundwater storage volumes are insufficient to satisfy beneficial uses over the planning and implementation horizon of the GSP*.

The undesirable result threshold was then identified by first evaluating how much of the aquifer supports beneficial uses, or pumping. The zone of pumping was estimated to occur within the shallowest 23 million acre-feet (MAF) of the aquifer. Therefore, the undesirable result for reductions in storage was set at 23 MAF.

Modeling in Historical ESJWRM Version 1.1 indicates that over the historical simulation period 1996-2015, total storage does not vary by more than 0.1 percent per year. Therefore, it is assumed that undesirable results for groundwater levels would be expected to occur long before undesirable results for reduction in storage were to occur. Groundwater levels sustainable management criteria were therefore assumed to be protective of undesirable results in groundwater storage, and as a result, the groundwater level sustainable management criteria were used as a proxy for groundwater storage.

2.3 2024 Updated Approach

DWR has asked for a revision to the 23 MAF undesirable result or a better justification for how reductions in storage are related to groundwater levels sustainable management criteria. The 2024 GSP Amendment combined the two suggestions. A new revised undesirable result for reductions in storage was determined based directly on the estimated change in storage that would occur when an undesirable result is occurring for groundwater levels.

2.3.1 Continue Using GWLs as a Proxy

In the 2024 GSP Amendment, updated modeling still indicates that there is still very little variation in total storage over the historical simulation period. Therefore, the same conclusion from the 2020 GSP remains - that the Subbasin is much more likely to experience an undesirable result for groundwater levels long before an undesirable result for groundwater storage is triggered. Chronic lowering of groundwater levels is directly related to overdraft conditions. If an undesirable result for groundwater levels occurs first, then mitigation will be activated to respond to the undesirable result, effectively making groundwater level sustainable management criteria already protective of the beneficial uses of groundwater noted in the original undesirable result definition for reduction in storage. Lastly, groundwater levels are directly measurable and groundwater storage is not. Given these conditions, it is reasonable to continue using groundwater levels as a proxy for reductions in groundwater storage.

2.3.2 Revise Undesirable Result

While groundwater levels will continue to be used as a proxy, the threshold at which an undesirable result occurs for groundwater storage can be revised based both on the 2024 updated modeling and using a more direct connection to the undesirable result for groundwater levels. The following approach was taken to revising the 23 MAF undesirable result for reductions in groundwater storage:

1. Simulate new model scenarios under which an undesirable result occurs for groundwater levels. This involves selecting various groupings of five (5) representative monitoring network (RMN) wells at which to simulate artificially dropping the groundwater levels in the wells to their respective minimum thresholds. The various well groupings were chosen based on the following factors:
    - Proximity to the Subbasin's groundwater depression
    - Historical sustainable management criteria performance
    - Spatial distribution throughout the Subbasin.
2. The Projected Conditions Baseline with Climate Change (PCBL-CC) Version 3.0 scenario was used to simulate the projected undesirable result for groundwater levels scenario. The undesirable result for groundwater levels is defined as 25% of the groundwater level RMN dropping to their minimum threshold for two consecutive years. In the test scenarios for this analysis, pumping was synthetically induced at the five selected wells in order to 'artificially' lower groundwater levels. This approach was iterated across a range of various groupings of selected wells and a range of different pumping rates, until undesirable results for groundwater levels occurred in each scenario.
3. The resulting reduction in groundwater storage from each of these test scenarios was recorded and used to establish the revised undesirable result for reduction in groundwater, based on the estimated reductions in groundwater storage when an undesirable result for groundwater levels is occurring.

Figure 1 and Figure 2 show examples of two different well groups chosen to simulate lowering groundwater levels. Well Group A in Figure 1 includes a mix of wells that are likely and not likely to exceed their minimum threshold. Well Group B in Figure 2 shows a mix of wells that are not likely or unlikely to exceed their minimum threshold. Both well groups include a well that is within the Subbasin's groundwater depression.

Table 8 shows an example of the corresponding storage reductions associated with Well Group A and Well Group B scenarios across different artificial pumping rates at those locations. Artificial pumping rates were determined based on average or maximum known (and modeled) pumping rates of production wells within the Subbasin.

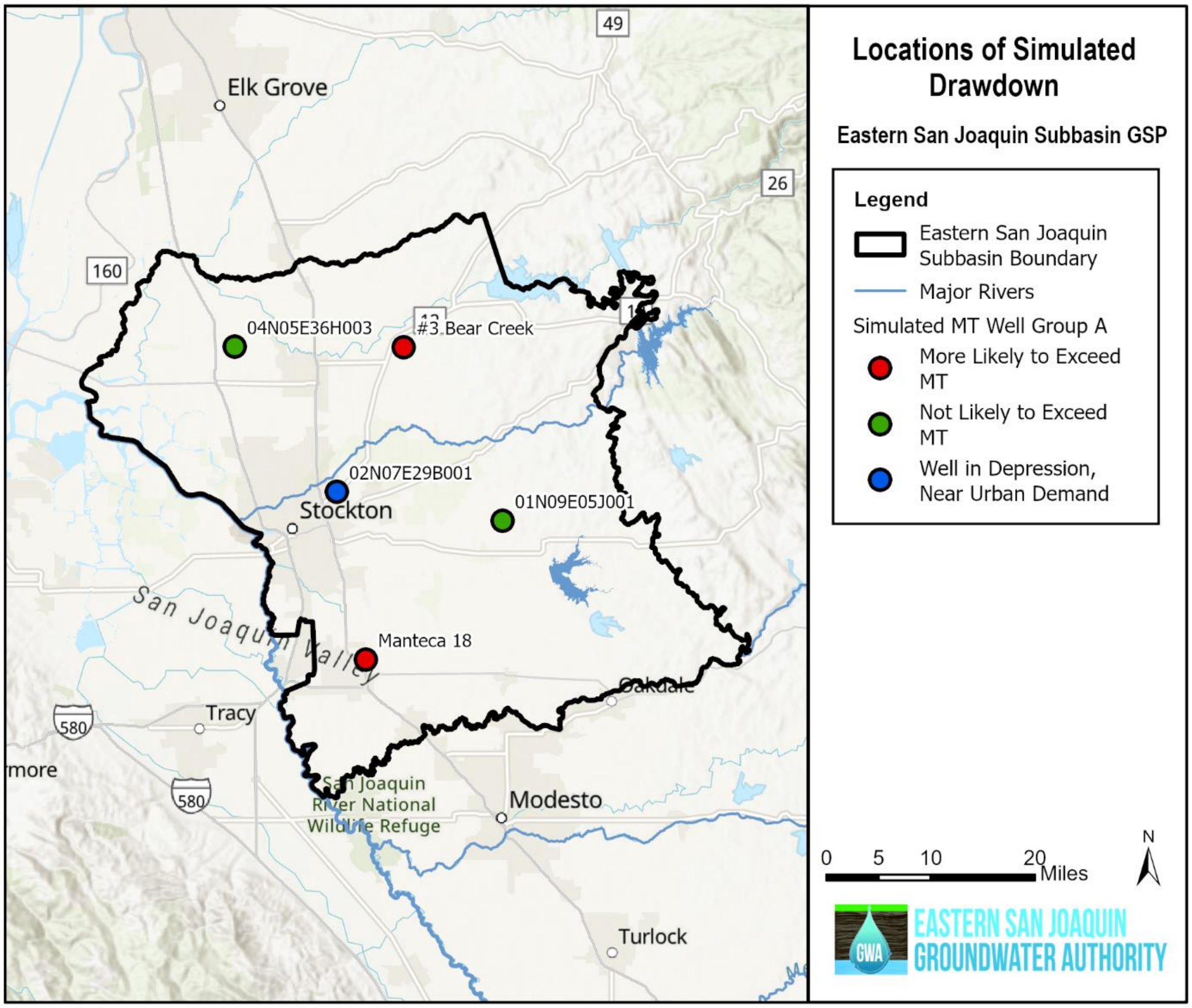


Figure 1: Well Group A Locations of Simulated Drawdown

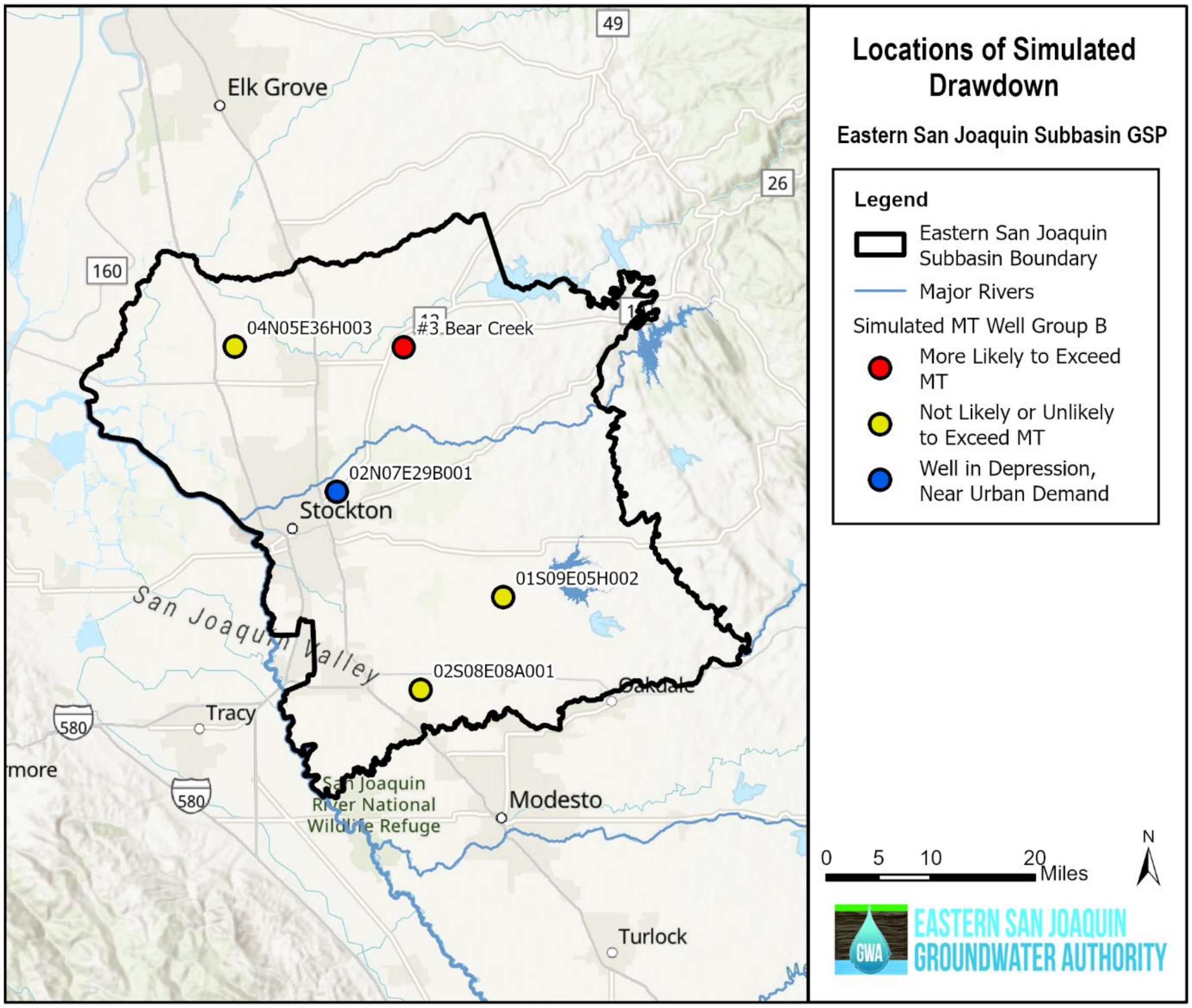


Figure 2: Well Group B Locations of Simulated Drawdown

Table 8: Example Groundwater Storage Reductions Across Test Scenarios

	Average Pumping *(35 AF/month)*	**Maximum Pumping** *(250 AF/month)*
Well Group A	10.6 MAF	13.0 MAF
Well Group B	10.6 MAF	12.9 MAF

The reductions in storage associated with the groundwater level minimum threshold exceedance scenarios varies across the various test scenarios from 10 MAF to 13 MAF. This is consistent with typical results in numerical groundwater modeling where the reductions in storage associated with an undesirable result for groundwater levels varies based on which wells drop experience exceedances and where they are located within in the Subbasin. Therefore, a range in reduction of storage is appropriate to describe an undesirable result, defined by the upper and lower bounds of this groundwater level minimum thresholds analysis.

The revised undesirable result for reductions in groundwater storage is therefore considered to be between 10 to13 MAF. Defining a range in storage for the undesirable result acknowledges the uncertainty associated with the model in terms of storage. Since the climate change scenario was used, it also allows for consideration of the uncertainty associated with how extreme impacts of climate changes may be and where impacts within the Subbasin.

3. REFERENCES

Woodard & Curran. (2024). August 30, 2024. 2024 Model Documentation Update.

ATTACHMENT 2

TECHNICAL MEMORANDUM NO. 5 – Interconnected Surface Waters/ Sustainable Management Criteria

TO: Paul Gosselin, California Department of Water Resources Deputy Director

CC: Ashley Couch, on behalf of the Eastern San Joaquin Groundwater Authority

PREPARED BY: Liz DaBramo, Leslie Dumas/Woodard & Curran

DATE: November 2024

RE: Eastern San Joaquin Groundwater Authority Response to DWR's July 6, 2023 Approved Determination Letter for the 2022 Revised GSP - Technical Memorandum 5, Response to DWR Recommended Corrective Action No. 6

On July 27, 2022, the Groundwater Sustainability Agencies (GSAs) submitted the Eastern San Joaquin Groundwater Subbasin Revised June 2022 Groundwater Sustainability Plan (GSP or Plan) for the San Joaquin Valley – Eastern San Joaquin Subbasin (Subbasin) to the California Department of Water Resources (DWR) in response to DWR's incomplete determination on January 28, 2022. In its July 6, 2023 determination letter, DWR staff concluded that the GSAs had taken sufficient actions to correct deficiencies identified by DWR and approved the 2022 Revised Plan (see **Appendix 3-B in the GSP**). In Section 6 of the determination letter, DWR staff also identified recommended corrective actions (RCAs) for the GSAs to address by the Plan's first periodic evaluation.

This technical memorandum (TM) is in response to RCA #6 related to interconnected surface water. This TM is organized into the following sections:

1) Overview of Recommended Corrective Action #6
2) Quantify Timing, Location, and Volume of Depletions
3) Identify Undesirable Results
4) Update Representative Monitoring Network for ISW
5) Establish Sustainable Management Criteria for ISW
6) Engage with Impacted Parties
7) References

1. OVERVIEW OF RECOMMENDED CORRECTIVE ACTION #6

The following is the text including in Section 6 of DWR's 2023 Determination Letter:

Department staff understand that estimating the location, quantity, and timing of stream depletion due to ongoing, Subbasin-wide pumping is a complex task and that developing suitable tools may take additional time; however, it is critical for the Department's ongoing and future evaluations of whether GSP implementation is on track to achieve sustainable groundwater management. The Department plans to provide guidance on methods and approaches to evaluate the rate, timing, and volume of depletions of interconnected surface water and support for establishing specific sustainable management criteria in the near future. This guidance is intended to assist GSAs to sustainably manage depletions of interconnected surface water. In addition, the GSA should work to address the following items by the first periodic evaluation:

a. Work to establish undesirable results, minimum thresholds, and measurable objectives consistent with the GSP Regulations. Measurable objectives are to use the same metric used for minimum thresholds, including quantifying the location, quantity, and timing of depletions of interconnected surface water due to groundwater extraction. Consider utilizing the interconnected surface water guidance, as appropriate, when issued by the Department.

b. Continue to fill data gaps, collect additional monitoring data, and implement the current strategy to manage depletions of interconnected surface water and define segments of interconnectivity and timing. The monitoring network should be updated to reflect any corresponding changes and approaches.

c. Prioritize collaborating and coordinating with local, state, and federal regulatory agencies as well as interested parties to better understand the full suite of beneficial uses and users that may be impacted by pumping induced surface water depletion within the GSA's jurisdictional area.

2. APPROACH TO RECOMMENDED CORRECTIVE ACTION #6

The 2020 GSP and 2022 Revised GSP both used the chronic lowering of groundwater levels as a proxy for interconnected surface waters. While both GSPs included efforts to map stream connectivity to the groundwater system, new data and associated model updates made to address DWR's Recommended Corrective Actions allowed for the re-evaluation of this mapping using the latest available data. Additionally, efforts were made during the 5-year periodic evaluation process to develop new sustainable management criteria (SMC) and a representative monitoring network (RMN) specific to interconnected surface water systems.

3. QUANTIFY TIMING, LOCATION, AND VOLUME OF DEPLETIONS

3.1 Definitions

Interconnected surface waters (ISWs) are surface water features that are hydraulically connected by a saturated zone to the groundwater system. In these systems, the water table and surface water features intersect at the same elevations and locations. Interconnected surface waters may be either gaining or losing, wherein the surface water feature itself is either gaining water from the aquifer system or losing water to the aquifer system. As described in *Depletions of ISW: An Introduction* (DWR, 2024), the first of three guidance documents on ISWs released by DWR, the consideration and interpretation of ISWs can be based on five example cases of nearby groundwater elevation data (Figure 5 of *Depletions of ISW: An Introduction*). Of the examples provided, Figure 5d is most applicable to Eastern San Joaquin Subbasin due to a lack of shallow monitoring wells and associated historic data near the rivers and creeks in the Subbasin.

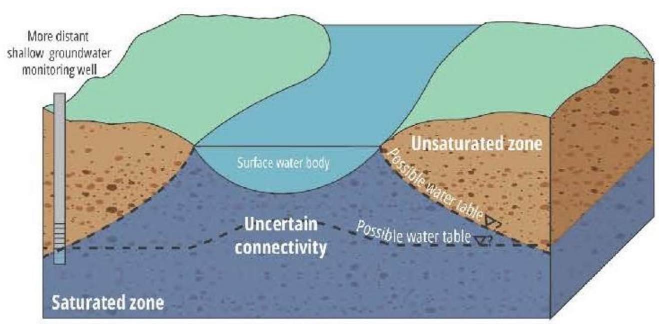


Figure 5d: a stream and a more distant shallow monitoring well with a groundwater elevation below the bottom of the streambed. Without additional data it is difficult to determine if the stream is an ISW.

Source: *Depletions of ISW: An Introduction* (DWR, 2024)

This lack of shallow groundwater level data near surface water courses translates to a low degree of confidence in model calibration around these surface water features and therefore uncertainty around what is or is not a connected reach or model node.

GSP regulations require the identification of ISWs within a basin (and therefore identification of the degree of connectivity) and an estimate of the timing and quantity of depletions of those systems, where depletions are defined as "conditions where groundwater pumping results in reductions in flow or water levels of ISW." However, the DWR guidance document notes that "the definition above differs from how depletions may be defined in other hydrologic contexts, where they can refer to any surface water losses without considering the cause." A good faith effort was conducted to isolate stream depletions in the Eastern San

Joaquin (ESJ) Subbasin due solely to groundwater pumping by comparing (1) pumping and no-pumping scenarios and (2) a pumping "pulse" scenario to examine the delayed impact of pumping on stream depletions, both using the integrated Eastern San Joaquin Water Resources Model Version 3.0 (ESJWRM). However, the analyses resulted in an inconclusive understanding of depletions due to pumping since an equilibrium was not reached within the simulation period and depletions were heavily influenced by initial and boundary conditions. Therefore, the analyses relied on the standard definition of depletions as stream losses to the aquifer system regardless of cause. This allows the GSAs to have more confidence in the results and to be able to manage and report depletions in future Annual Reports without limitations and uncertainties from the existing toolset. At the time of this writing, the additional pending guidance documents from DWR (*Techniques for Estimating Depletions of Interconnected Surface Water* and *Examples of Approaches for Estimating Depletions of Interconnected Surface Water*) had not yet been released. The timing, location, and volume of depletions in the ESJ Subbasin will be revised at a later time in coordination with further guidance from DWR.

3.2 Connectivity

This section details the assumptions and findings about interconnectivity and gains/losses of streams within the Subbasin. As previously mentioned, the updated historical and projected conditions baseline versions of the ESJWRM Version 3.0 were used to analyze stream-aquifer interactions.

Stream connectivity was analyzed by comparing monthly groundwater elevations from the historical calibration of the ESJWRM to streambed elevations along the streams represented in ESJWRM, displayed in **Figure 1**. Layer 1 groundwater levels were used since the new model Layer 1 in ESJWRM represents the shallow, generally unconsolidated sediments where stream-aquifer interaction is occurring. Connected streams were defined as Layer 1 groundwater levels at or above the streambed elevation at least 75 percent of the time. The 75 percent threshold was used for the purpose of comparative analysis only. The definition of ISWs is not limited to surface waters that the ESJGWM indicates are connected to the shallowest modeled groundwater level at least 75 percent of the time. The GSAs understand that an ISW may be seasonally connected and/or connected in only wetter water year types. The GSAs currently do not have sufficient data to determine if or when streams or reaches are connected to the groundwater table with this level of granularity. The GSAs will be collecting more data with the new ISW monitoring wells to help inform this analysis going forward. As described later in the report, in the meantime the GSAs have established MOs and MTs based on maintaining groundwater levels at or above 2015 levels, which should avoid undesirable results to ISW that could occur if groundwater levels dropped below the 2015 levels.

Figure 2 illustrates the simulated, historically 75 percent connected streams in blue. The connected streams are the Mokelumne River, Stanislaus River, and lower San Joaquin River. Streams that are not connected (again, using the 75 percent connectivity comparison point) are Dry Creek, Calaveras River, and Mormon Slough. Other smaller creeks are not represented in ESJWRM due to data limitations and a lack of stream gage data, making it challenging to simulate and calibrate stream-aquifer interactions. As such, these smaller creeks have not been included in this analysis and are noted as a data gap.

To support the understanding of connectivity and the relationship with ISW, the percentage of time that streams are connected by node in ESJWRM is displayed in **Figure 3**. In the historical model, most of the connected streams are connected at least 80 percent of the time, with the not connected streams connected less than 20 percent of the time. These results support the use of 75 percent as the comparison point for connectivity, as most streams would still be classified the same way (connected or disconnected) even if the threshold for connectivity were reduced to below 20 percent. However, many streams or reaches that are connected less than 75 percent of the time, and thus not termed "75% connected," may be connected seasonally and/or only in wetter water year types and may be considered ISW.

Stream connectivity was also analyzed under current conditions (Water Year 2020 through 2024 in the historical ESJWRM model) and for Water Year 2015. As shown in **Figure 4**, there are no significant differences in simulated stream connectivity between historical and current conditions. Water Year 2015, on the other hand, shows that a portion of the Mokelumne River becomes connected less than 75 percent of the time just upstream of the confluence with Dry Creek (**Figure 5**). Water Year 2015 represents dry conditions with low groundwater levels after a multi-year drought. These conditions are later referenced in Section 0 when discussing ISW Sustainable Management Criteria (SMCs).

Figure 1: Stream Reaches in ESJWRM

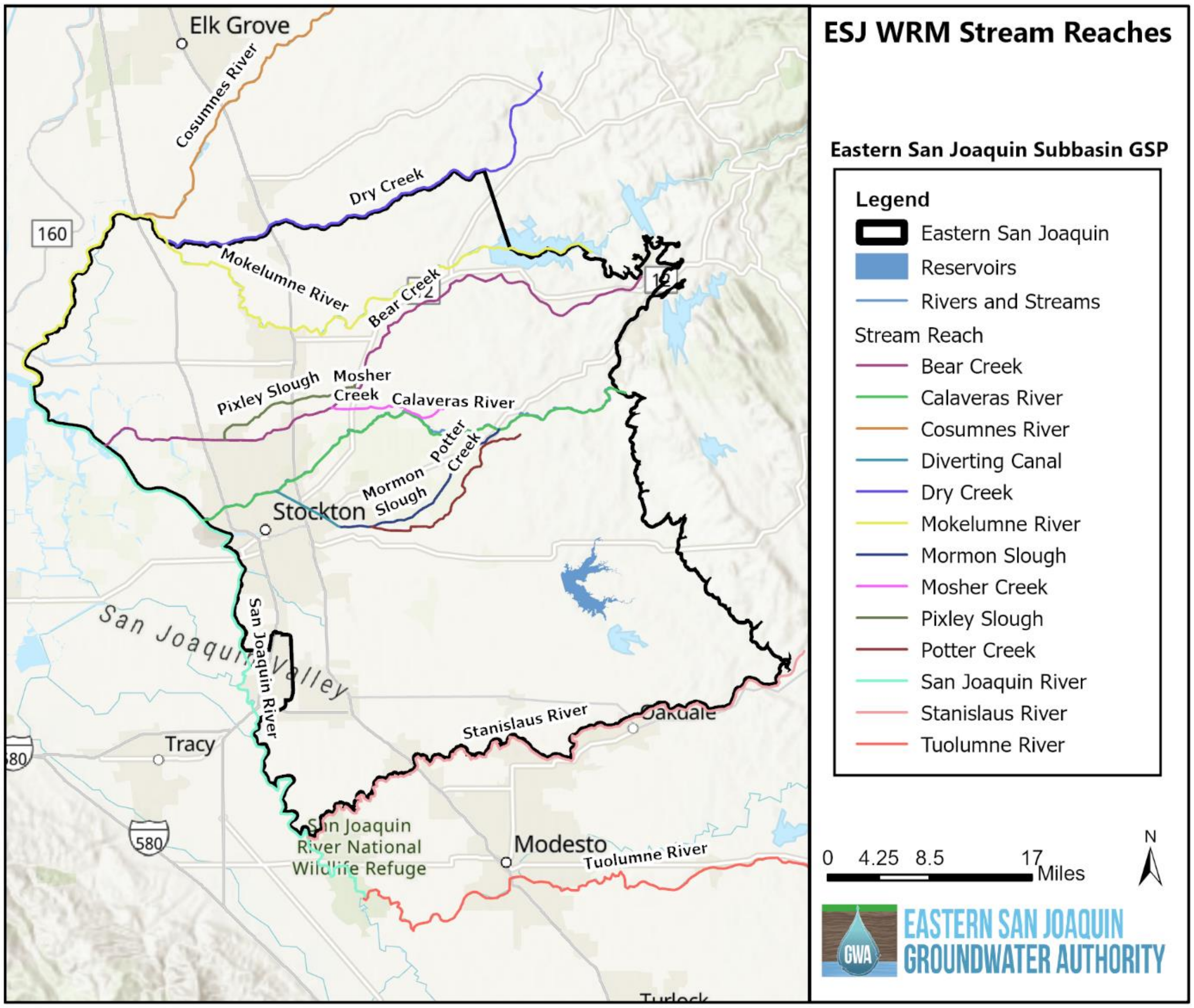


Figure 2: Historical Surface Waters Connected with the Groundwater System at least 75% of All Months in ESJWRM

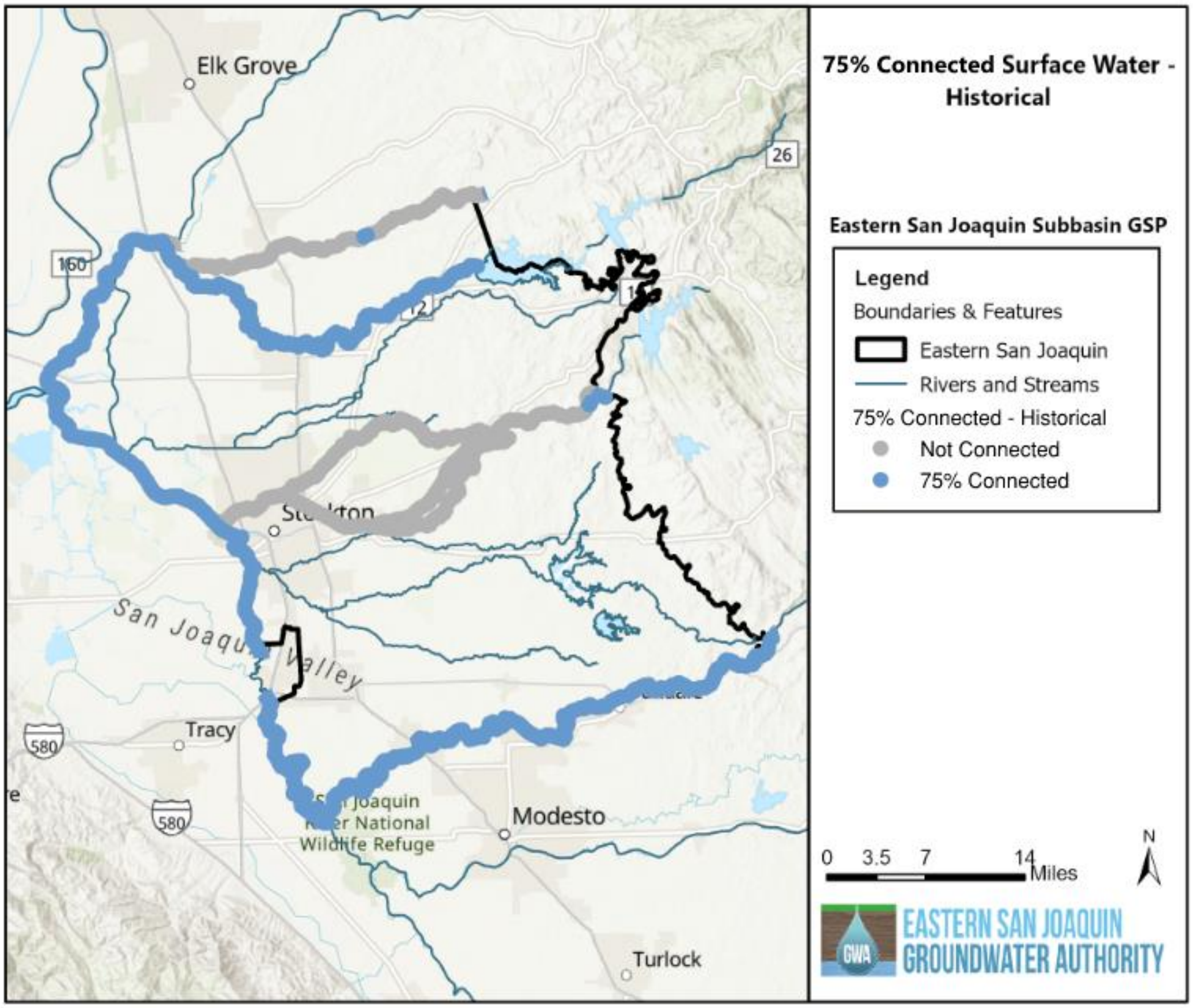


Figure 3: Percentage of Time Stream is Connected – ESJWRM Historical Conditions

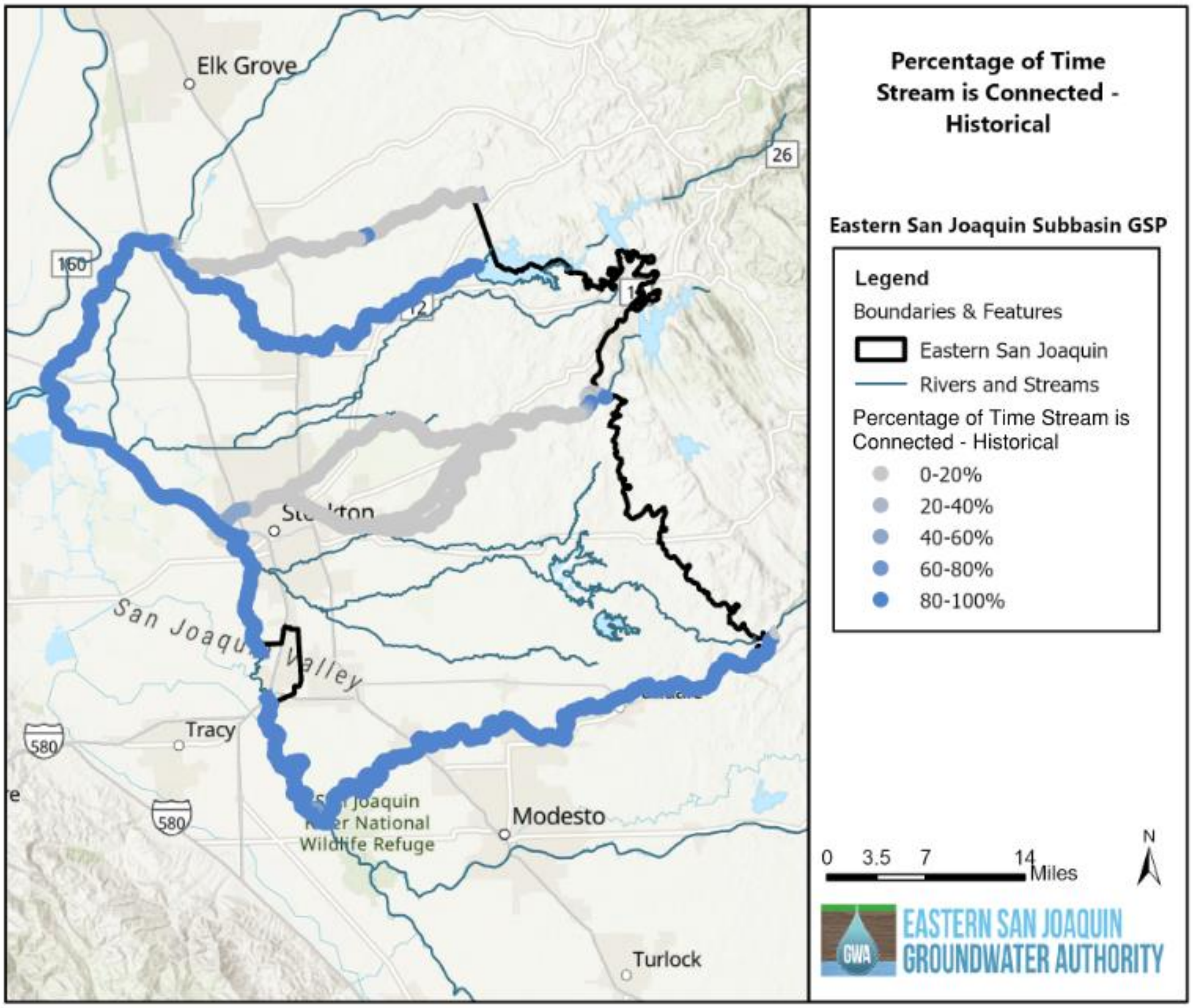


Figure 4: Current Condition Surface Waters Connected with the Groundwater System at least 75% of All Months in ESJWRM

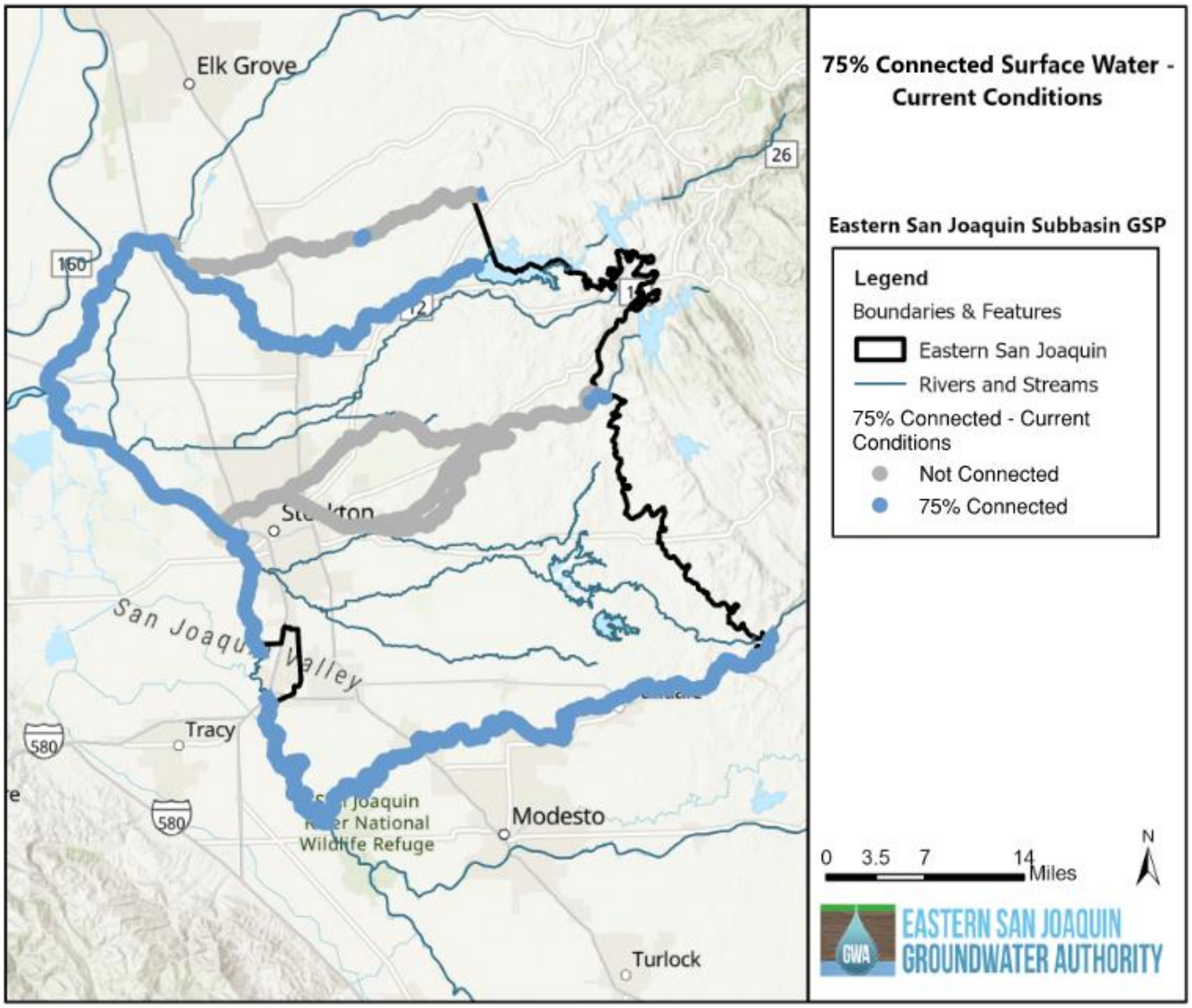
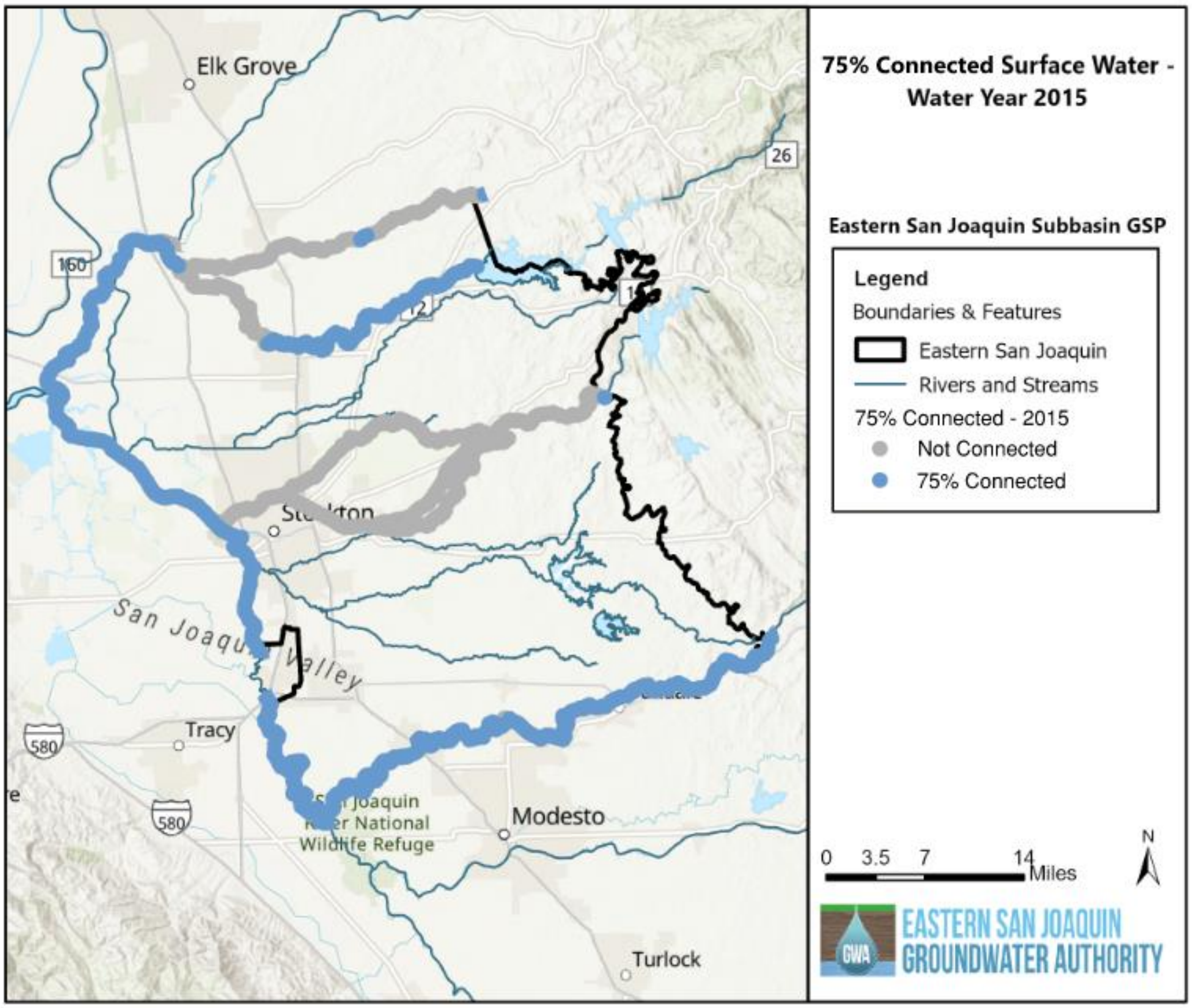


Figure 5: Water Year 2015 Surface Waters Connected with the Groundwater System at least 75% of All Months in ESJWRM



3.3 Stream Gains and Losses

Disconnected streams will always be losing streams, but interconnected streams may be either losing or gaining, depending on the surface water and groundwater conditions. Groundwater discharge from the aquifer is primarily through groundwater pumping; however, groundwater also discharges to streams where groundwater elevations are higher than the streambed elevations and stream levels or stage. **Figure 6**, from DWR's *Depletions of ISW: An Introduction* (DWR, 2024), illustrates connected gaining streams (on the left) where groundwater levels are higher than the stream stage, and losing streams (on the right) where groundwater levels are lower than the stream stage.

Figure 6: Diagram of Gaining and Losing Connected Streams

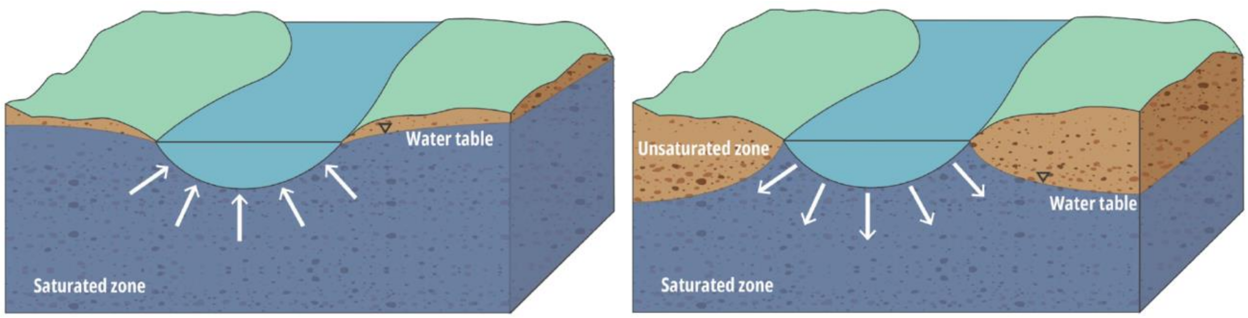


Figure 7 illustrates the historical simulated average annual volume of stream gains and losses by stream node for the period from Water Year 1996 through 2023. While the model shows that the Mokelumne River is a connected river in most years based on the 75 percent comparative point, it is losing water from the stream to the aquifer system upstream of the Cosumnes River, and gaining water from the aquifer system downstream of the Cosumnes River, on average. The model shows that portions of the Stanislaus River are gaining upstream near New Melones Reservoir and downstream near the confluence with the lower San Joaquin River, on average. The lower San Joaquin River is gaining in many sections near the confluence with the Stanislaus River, Calaveras River, and in the Delta region. **Figure 8** shows the simulated average annual volume of stream gains under current conditions (Water Year 2020 through 2023). The trends are very similar to historical gains and losses, with the exception of the Stanislaus River, which has a high number of stream nodes in the center portion of the river that are losing under current conditions.

In addition to the volume of stream gains and losses, the percentage of time that streams are gaining in the model is also displayed in **Figure 9**. Dry Creek, the Calaveras River, and Mormon Slough are rarely gaining because they are not connected reaches. Although the upstream portion of Mokelumne River is connected based on the 75 percent comparative point, the reach is losing water the majority of the time. The lower Mokelumne River, lower San Joaquin River, and upstream and downstream sections of the Stanislaus River are gaining a majority of the time and the central portion of the Stanislaus River gains infrequently in ESJWRM.

The stream gains and losses can also be viewed graphically. **Figure 10** displays the simulated average annual stream gains by river between Water Year 1996 and 2023. Note that these stream gains only reflect the stream-aquifer interactions on the Eastern San Joaquin side of the streams, if a stream is located along a boundary of the Subbasin. Bear Creek is excluded from the figures because there is minimal simulated stream-aquifer interaction. The model shows that the Mokelumne River is losing over 100 thousand acre-feet per year (TAFY) on average. Although the portion of the Mokelumne River downstream of the confluence with the Cosumnes River is gaining on average, the stream losses in the upstream portion of the Mokelumne River significantly outweigh the downstream gains. The San Joaquin and Stanislaus Rivers are losing 5.8 TAFY and 7.8 TAFY, respectively, on average in the ESJ Subbasin. The Calaveras River is not a connected reach and is losing over 30 TAFY.

Figure 11 shows the timeseries of annual stream gains and losses in the Subbasin for each river between Water Year 1996 and 2023 in ESJWRM. It reveals that the San Joaquin River and Stanislaus River can be either net gaining or losing rivers depending on the water year. On the other hand, the Mokelumne River and Calaveras River are always losing, and lose more during wet water years when the stream stage is higher from greater flow in the rivers.

Figure 12 summarizes the simulated average annual stream gains by river in the ESJ Subbasin by water year type. For all rivers except the Stanislaus River, streams lose more in wet years because of higher stream flows. The San Joaquin River is actually net gaining in below normal (BN), dry (D), and critical (C) water year types because it is a connected river, has numerous upstream sources, and groundwater levels are relatively higher than the low stream stage in these year types. The Stanislaus River does not have a clear trend by water year type because it is a connected river that is affected by both changes in stream stage and groundwater levels dynamically from the reservoir to the confluence with the San Joaquin River.

In addition to examining the stream depletions on an annual basis, simulated stream-aquifer interactions can be discerned on a monthly basis. **Figure 13** displays the timeseries of monthly stream gains and losses by river in the Subbasin from ESJWRM. There is a seasonal and annual fluctuation in gains and losses; the simulated average monthly gains are summarized in **Figure 14** by quarter and river. The greatest losses occur during winter months when there is more flow in the river channel. The lower San Joaquin River and Stanislaus River gain during the irrigation season (July through September) since they are connected rivers, and the stream stages drop more quickly during the irrigation season relative to groundwater levels which decline at a slower rate.

Figure 7: Historical Average Annual Stream Gains by Stream Node in ESJWRM

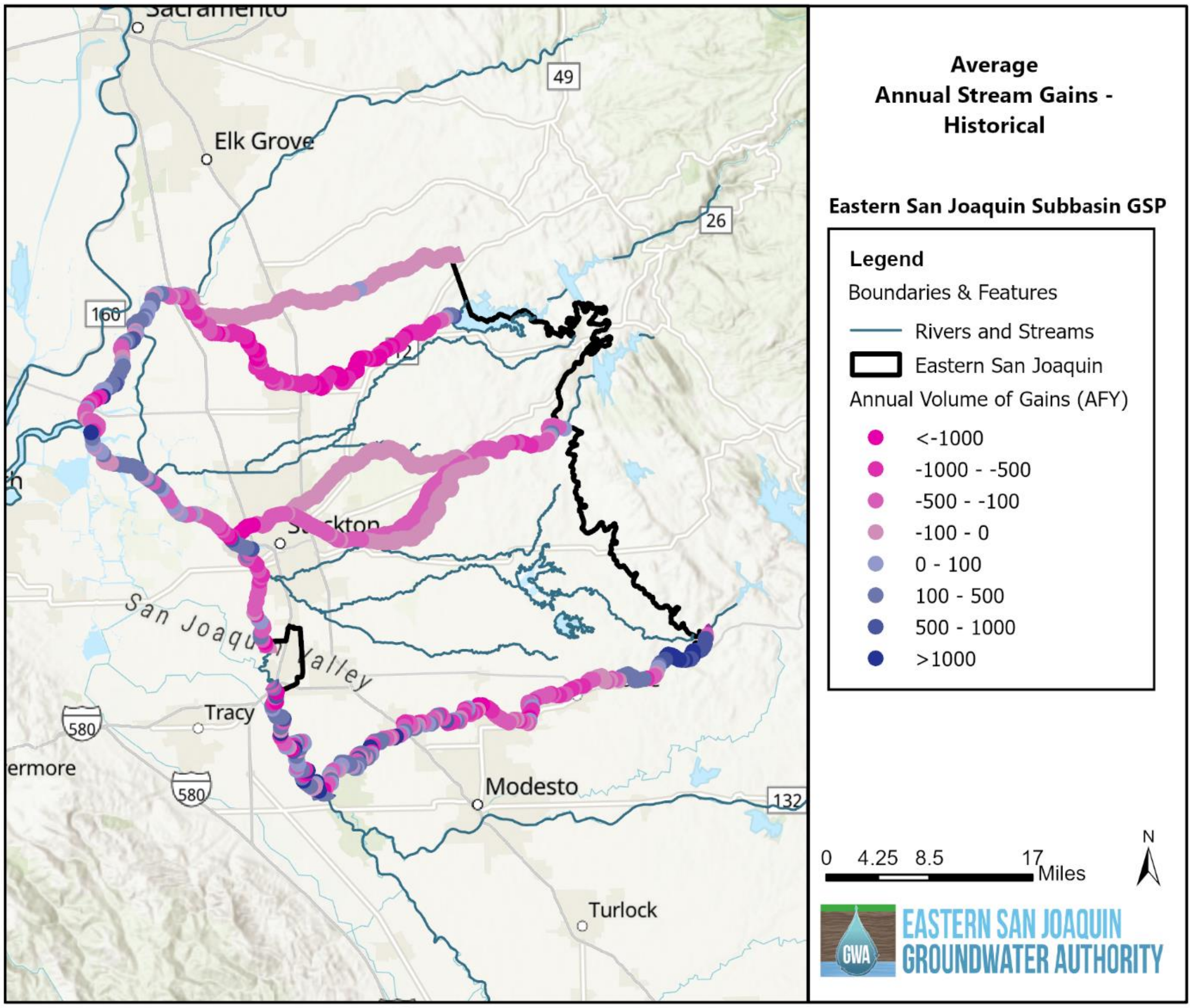


Figure 8: Current Conditions Average Annual Stream Gains by Stream Node in ESJWRM

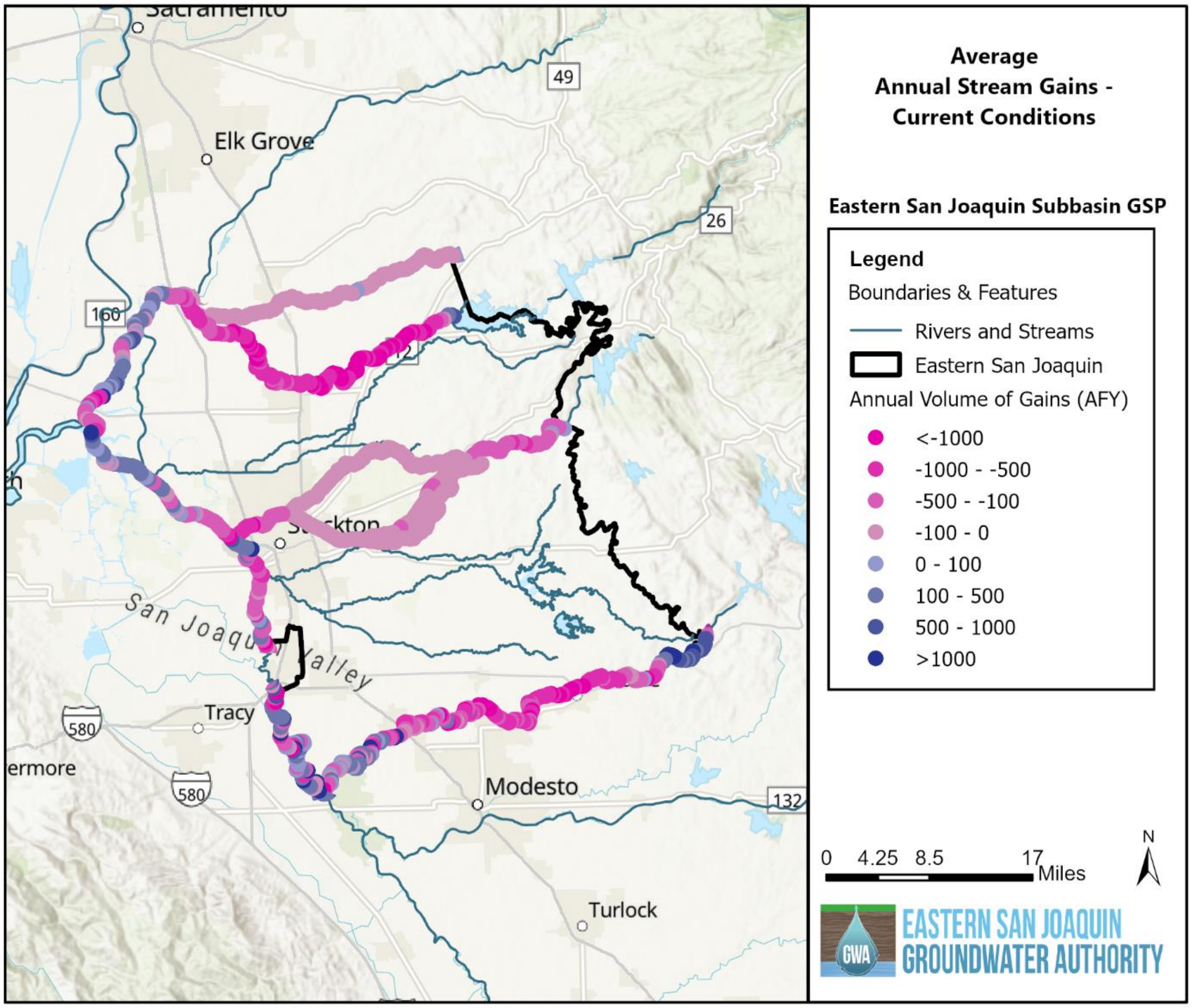


Figure 9: Percentage of Time that Streams are Gaining – ESJ Historical Conditions

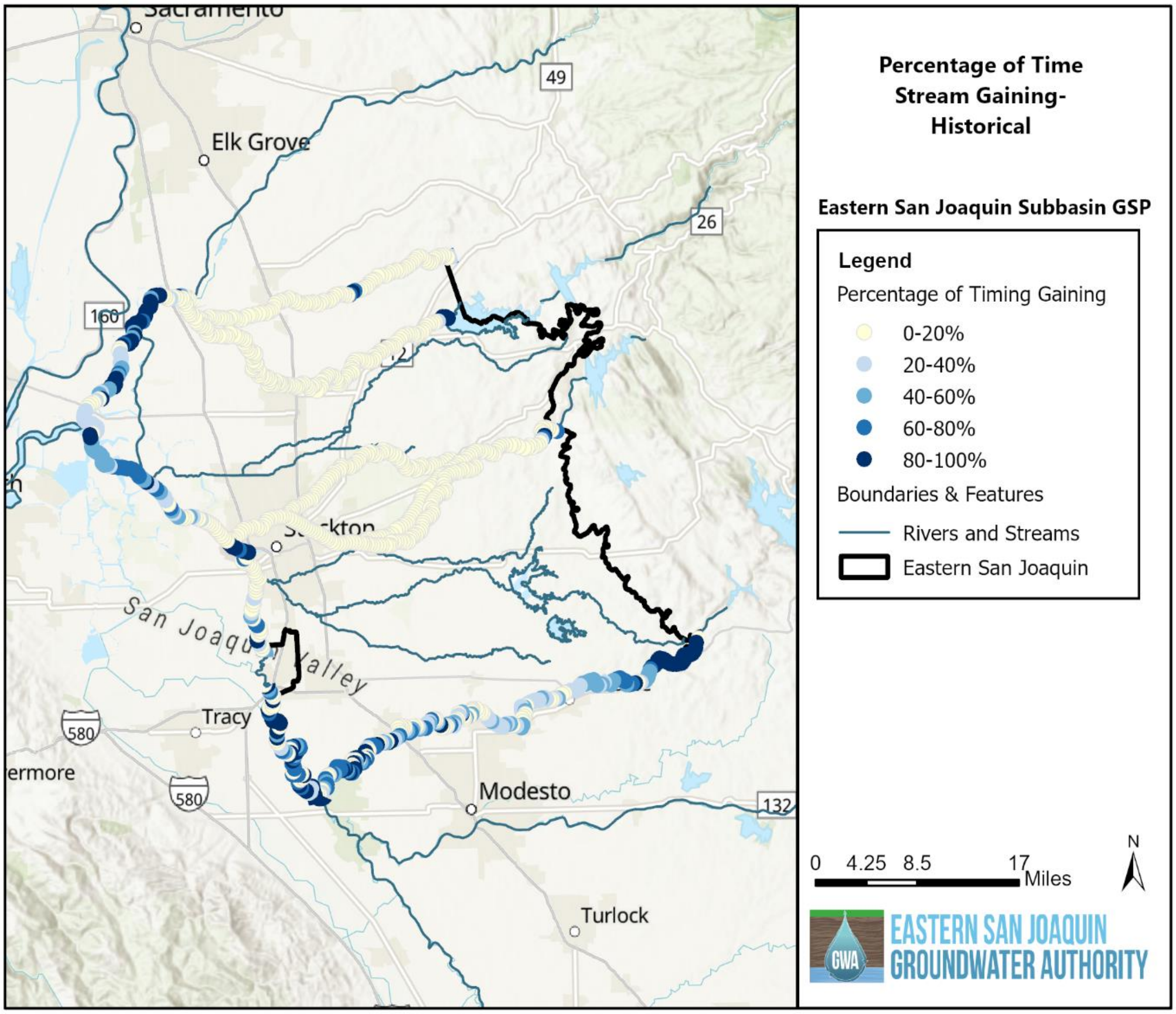


Figure 10: Average Annual Simulated Stream Gains by River in Eastern San Joaquin – Historical

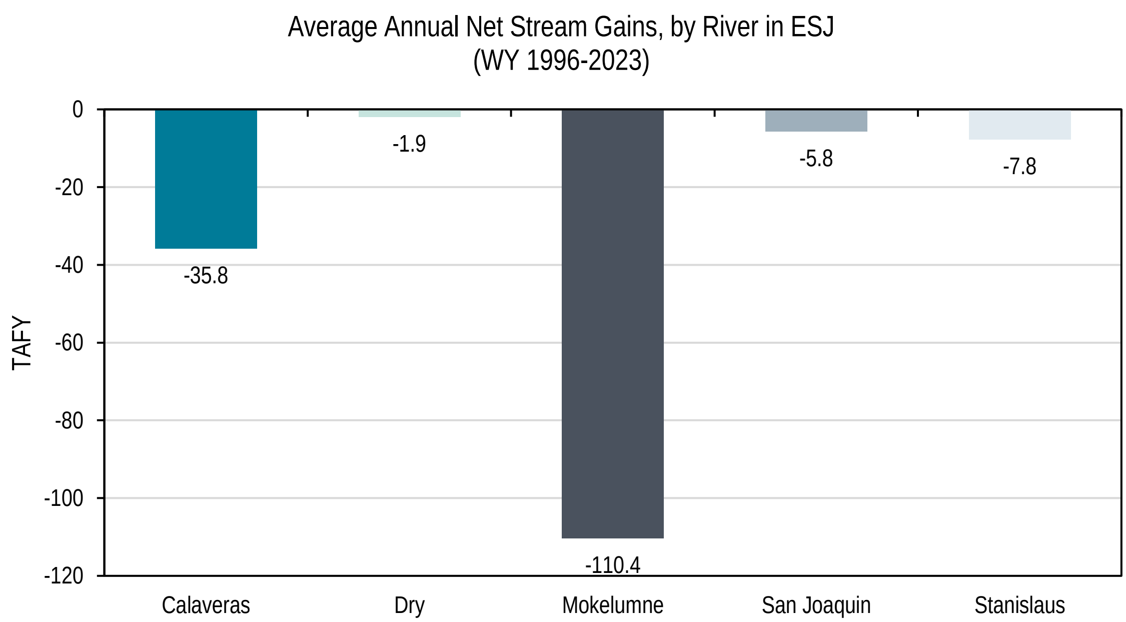


Figure 11: Annual Stream Simulated Gains by River in Eastern San Joaquin – Historical

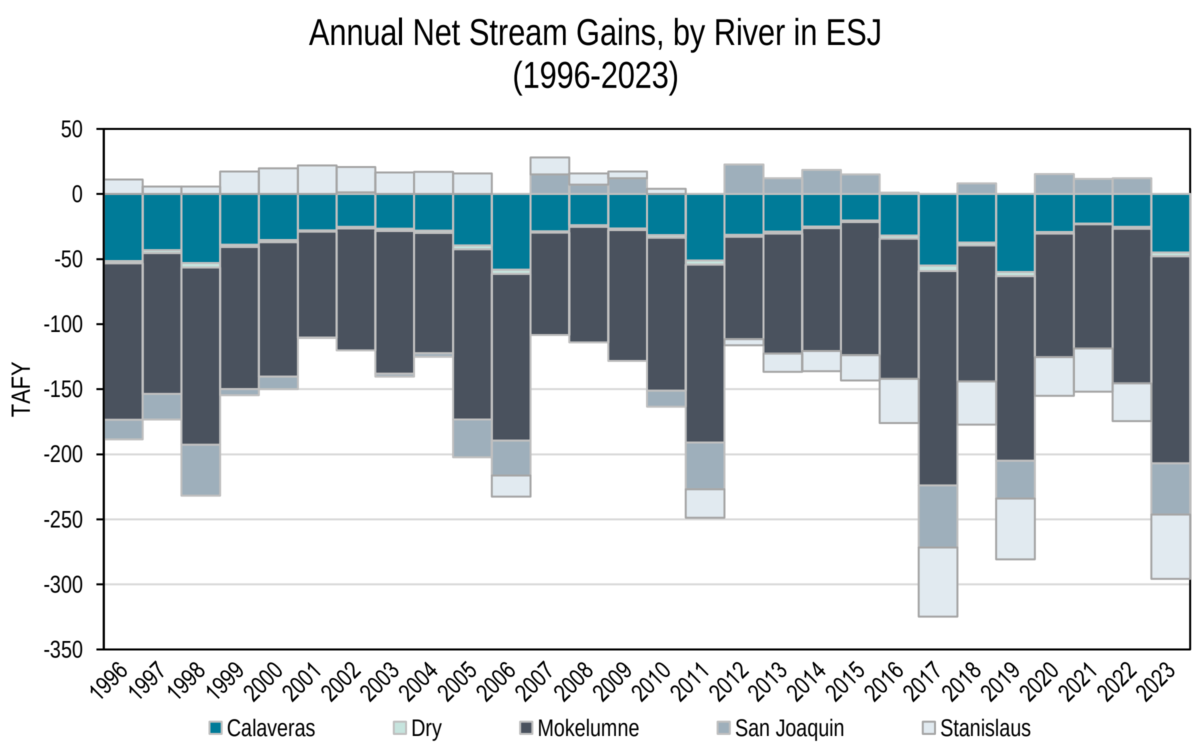


Figure 12: Average Annual Simulated Stream Gains by River and Water Year Type in Eastern San Joaquin – Historical

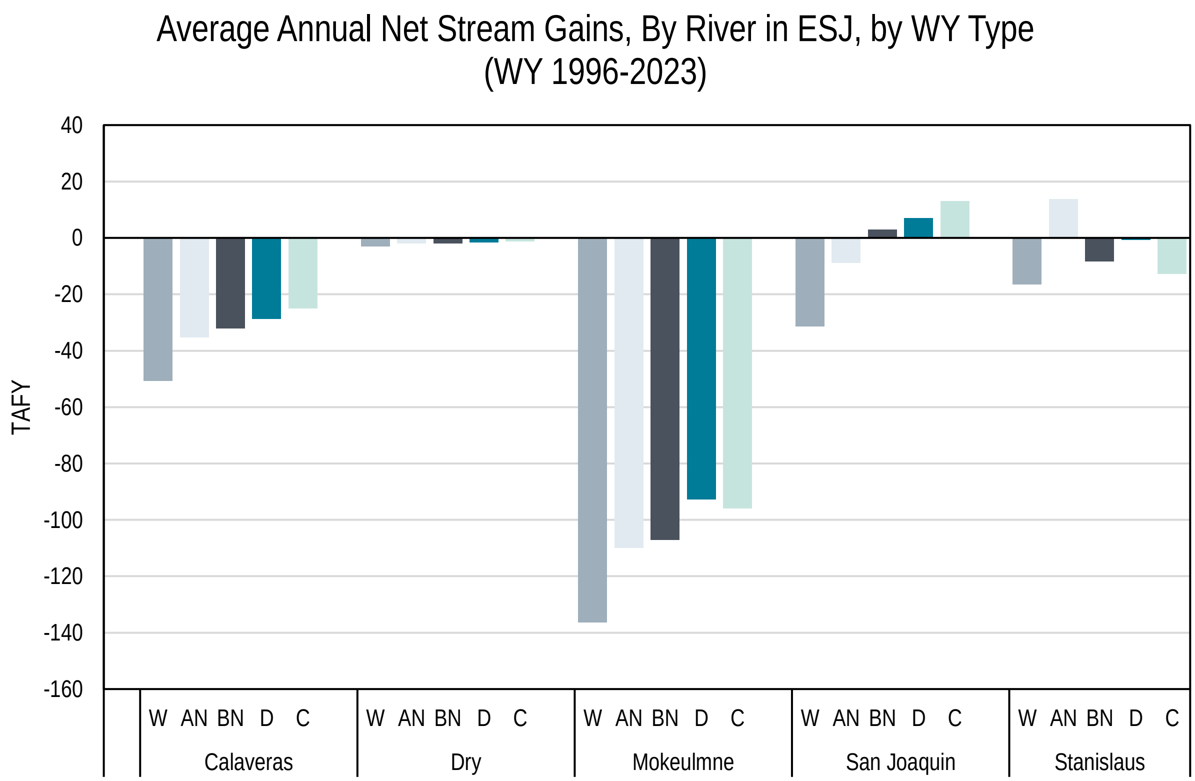


Figure 13: Monthly Simulated Stream Gains by River in Eastern San Joaquin – Historical

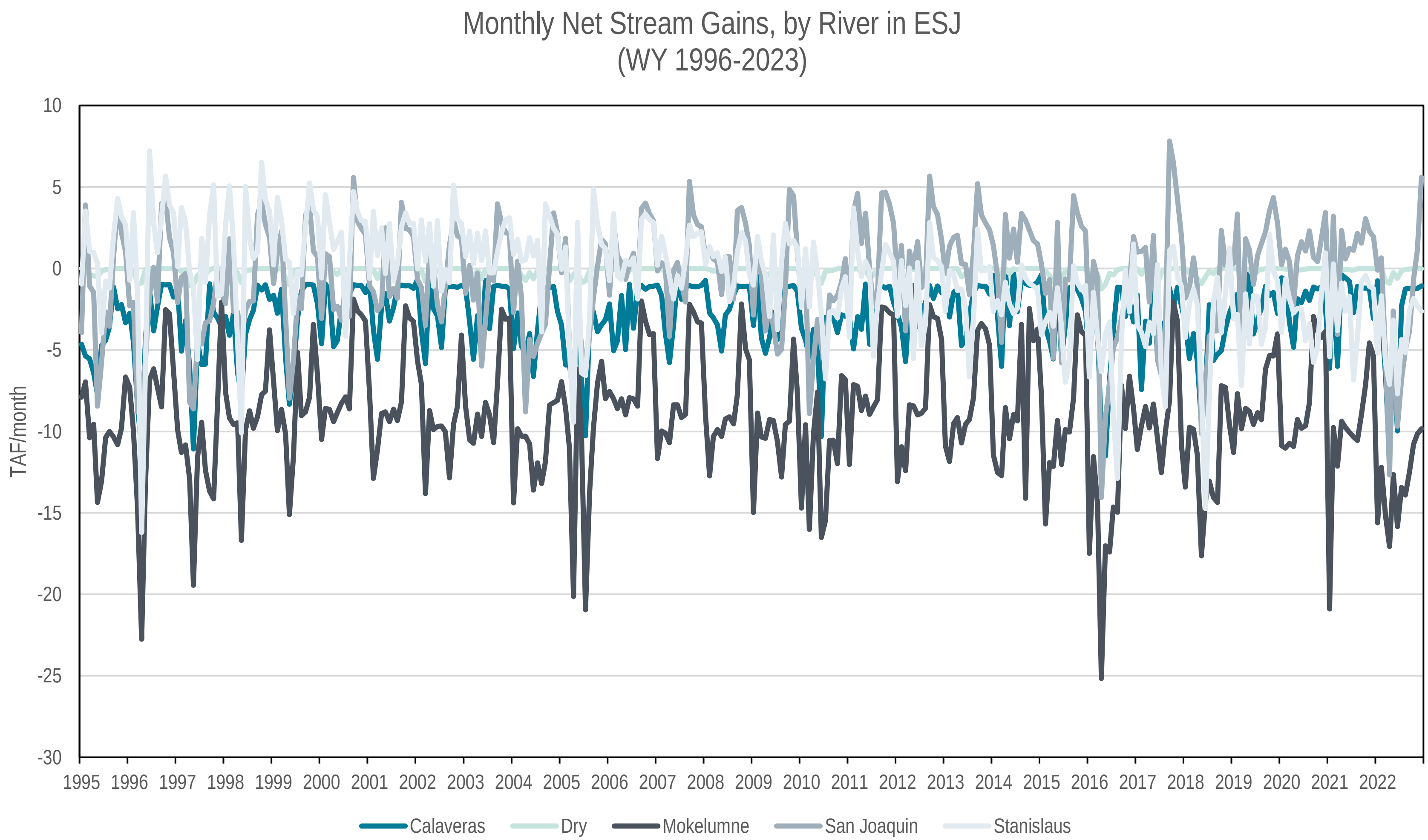
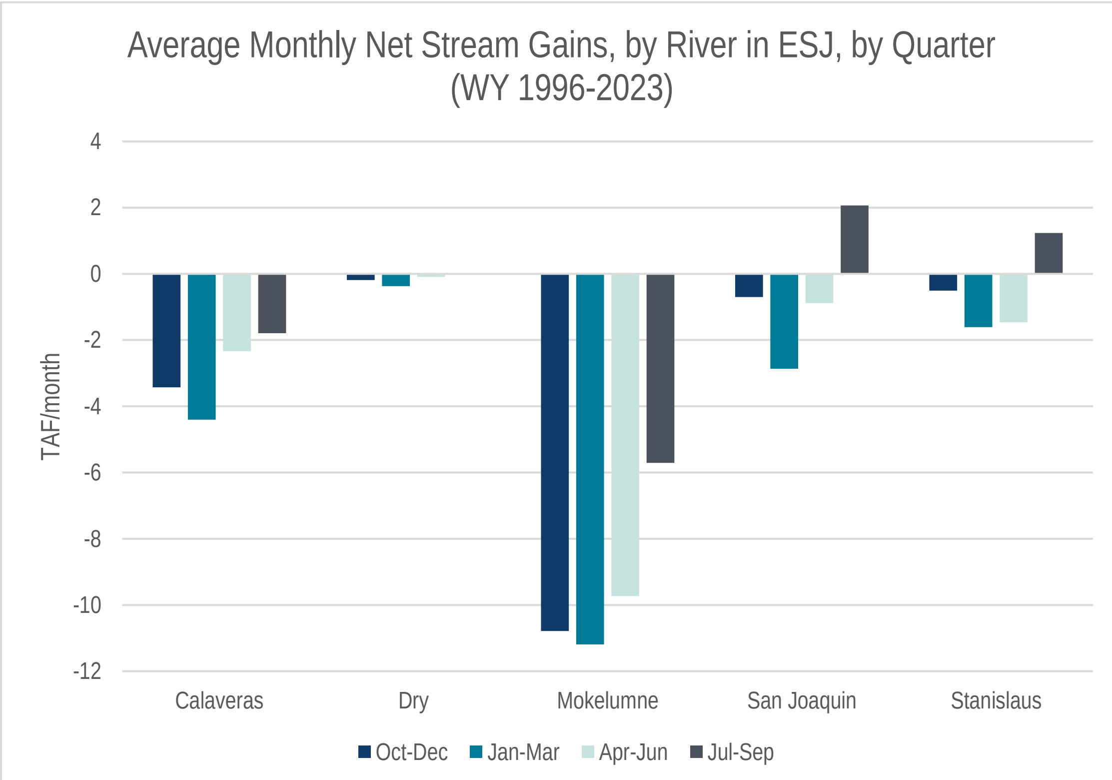


Figure 14: Average Monthly Simulated Stream Gains by River and Quarter in Eastern San Joaquin – Historical



4. IDENTIFY UNDESIRABLE RESULTS

The undesirable result related to depletions of interconnected surface water is defined in SGMA as: *Depletions of interconnected surface water that have significant and unreasonable adverse impacts on beneficial uses of the surface water.* Major rivers and streams that potentially have a hydraulic connection to the groundwater system in certain reaches are the Calaveras River, Dry Creek, the Mokelumne River, the San Joaquin River, and the Stanislaus River. Many of the smaller creeks and streams are substantially used for the conveyance of irrigation water and these systems have not been considered in the analysis of depletions.

If depletions of interconnected surface water were to reach levels causing undesirable results, impacts could include reduced flow and stage within rivers and streams in the Subbasin to the extent that insufficient surface water would be available to support diversions for agricultural or urban uses or to support regulatory environmental requirements. These effects could result in decreased surface water diversions and/or changes in irrigation practices and crops grown and could cause adverse effects on property values and the regional economy. Reduced flows and stage, along with potential associated changes in water temperature and quality, could also negatively impact aquatic species and habitats in the rivers and streams and along the riparian environments. Federally threatened aquatic species include California Central Valley steelhead (*Oncorhynchus mykiss*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*). All freshwater species in the Subbasin are listed in Appendix 1-G of the 2022 Revised GSP.

Minimum flow requirements are defined for the Calaveras, Mokelumne, Stanislaus, and San Joaquin Rivers; these requirements are met through the management of operations at upstream reservoirs, including New Hogan Reservoir, Camanche Reservoir, Woodbridge Dam, New Melones Reservoir. **Table 1** summarizes the major rivers in the Subbasin along with contributing upstream reservoirs, operators, primary water users, and flow requirements that could be affected by significant and unreasonable stream depletions. Additionally**, Figure 15** visualizes the major compliance locations and diversions. Note that most compliance points and diversions (Camanche Dam on the Mokelumne River, New Hogan Reservoir on the Calaveras River, and Goodwin Dam on the Stanislaus) are upstream of the Eastern San Joaquin Subbasin and are therefore unaffected by management actions in the Subbasin.

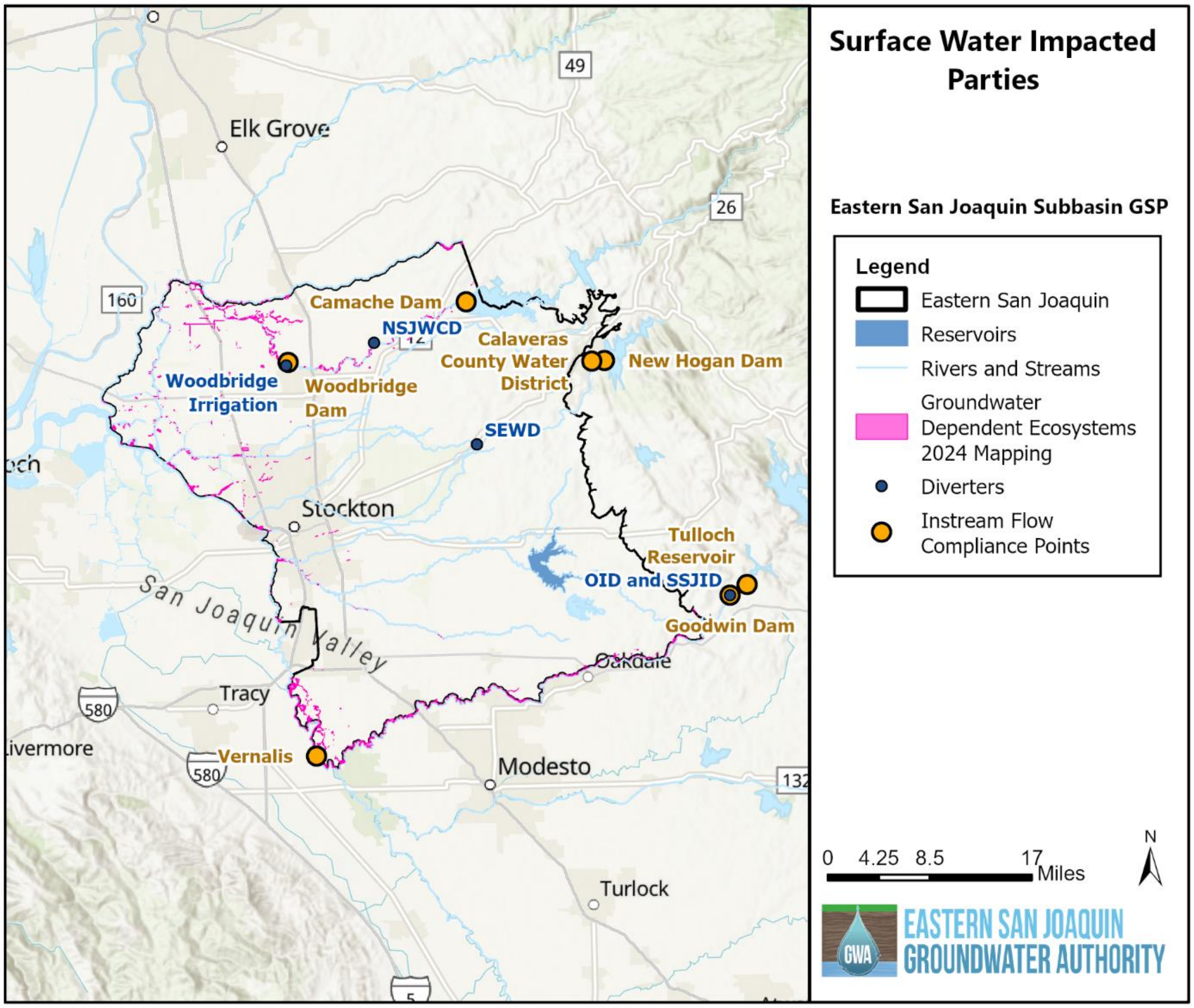
The Subbasin GSAs are also prioritizing collaborating and coordinating with local, state, and federal regulatory agencies, as well as other interested parties, to better understand the full suite of beneficial uses and users that may be impacted by pumping-induced surface water depletion within the GSA's jurisdictional area and to look for opportunities to coordinate in projects and actions to support interconnected surface waters. As previously mentioned, impacted parties include surface water diverters, reservoir owners and operators, groundwater dependent ecosystems, fish and freshwater species, and adjacent groundwater subbasins. Section 7.7 of the 2024 Amended GSP describes GSA engagement and outreach plans.

Table 1: Summary of Major Rivers and Flow Considerations

River	Reservoir	Operator	Flow Requirements and Notes	Primary Surface Water Diverters
Mokelumne River	Camanche Reservoir (Pardee Reservoir upstream)	East Bay Municipal Utility District	There are regulated releases at Pardee Dam, Camanche Dam, and Woodbridge Dam. Minimum flows below Camanche Dam range from between 100 to 325 cubic feet per second (cfs), as specified in FERC 2916-029, 1996 Joint Settlement Agreement. The minimum flows below the Woodbridge Diversion Dam range from between 25 to 300 cfs. Camanche Reservoir must maintain at least 28 TAF of hypolimnium water below 16.4 degrees C through October. Camanche Dam releases will not decrease by more than 50 cfs/day (Oct-March) or 100 cfs/day (all other times).	EBMUD, Woodbridge Irrigation District, North San Joaquin Water Conservation District, Jackson Valley Irrigation District (at Pardee)
Calaveras River	New Hogan Reservoir	US Army Corps of Engineers	Minimum instream flow requirements are established by the Calaveras River Habitat Conservation Plan. New Hogan Dam releases 75-250 cfs during irrigation season and 20-85 cfs non-irrigation seasons. There is a minimum flow of 10 cfs at the Bellota Diversion Facility for fish ladder operation. There is a minimum guaranteed continuous instream flows in Calaveras River at Shelton Road of 20 cfs.	Stockton East Water District, Calaveras County Water District

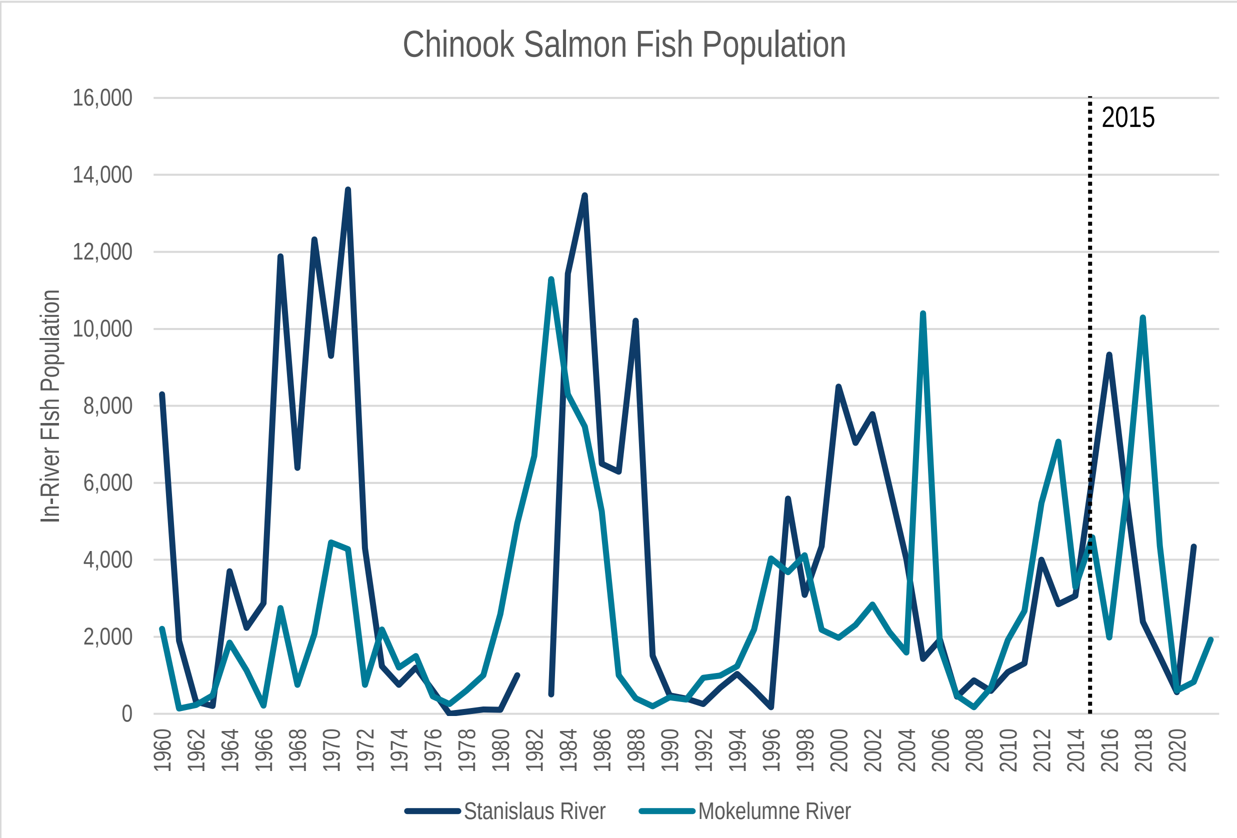
River	Reservoir	Operator	Flow Requirements and Notes	Primary Surface Water Diverters
Stanislaus River	New Melones (Tulloch and Goodwin Dam down-stream)	US Bureau of Reclamation	The instream flow compliance location is downstream of Goodwin Dam, which is just downstream of New Melones and Tulloch Reservoir and where water is primarily diverted. Minimum releases are made as required by SWRCB D-1422, the Sacramento-San Joaquin River Delta Water Quality Control Plan, and the Central Valley Project OCAP Biological Opinions.	South San Joaquin Irrigation District, Oakdale Irrigation District,
San Joaquin River	Collects many regulated tributary rivers		The flow compliance location is at Vernalis. The new flow objectives are to "[m]aintain inflow conditions from the San Joaquin River watershed to the Delta at Vernalis sufficient to support and maintain the natural production of viable native San Joaquin River watershed fish populations migrating through the Delta." The numerical objectives are still being litigated and have not yet been enforced.	Many upstream diverters

Figure 15: Surface Water Impacted Parties



Undesirable results would occur if there were significant and unreasonable adverse impacts on beneficial users and uses of the surface water, including disconnecting stream reaches that were previously connected. Water Year 2015 is used as a reference point in the analyses since it was a dry year after a multi-year drought and hydrologic conditions, including stream depletions, put challenges on the surface water operations systems at that time. Additionally, SGMA regulations state "The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015." [California Water Code Section 10727.2(b)(4)]. Despite the challenging conditions in Water Year 2015, no undesirable results related to stream depletions occurred since minimum instream flow requirements and agreements were met and the GSA Project Management Committee reported no significant and unreasonable depletions. Additionally, the Chinook salmon population was recovering after a decline in the late 2000s, as shown in **Figure 16**. However, the population dynamics of Chinook salmon are not dependent solely on streamflow depletions and do not reflect survival rates or spawning success, and therefore cannot be used solely as an indicator of ISW undesirable results.

Figure 16: Chinook Salmon Population on Connected Rivers in Eastern San Joaquin Subbasin



As a reference point for the sustainable management criteria, simulated stream connectivity and gains and losses in the Fall of Water Year 2015 are displayed below in **Figure 17**. The Stanislaus River, lower San Joaquin River, and portions of the Mokelumne River are connected based on the 75 percent comparison point. Note that a portion of the Mokelumne River became not connected in Water Year 2015 as compared to historical conditions. **Figure 18** shows the annual stream gains and losses in Water Year 2015. Lastly, **Figure 19** summarizes the volume of stream reach gains and losses in Water Year 2015. Most stream losses occurred on the Mokelumne River, with fewer stream losses on the Calaveras River and Stanislaus River. In Water Year 2015, the lower San Joaquin River is net gaining. All of these results are derived from modeled stream-aquifer interactions in ESJWRM.

Figure 17: Water Year 2015 Surface Waters Connected with the Groundwater System at least 75% of All Months in ESJWRM

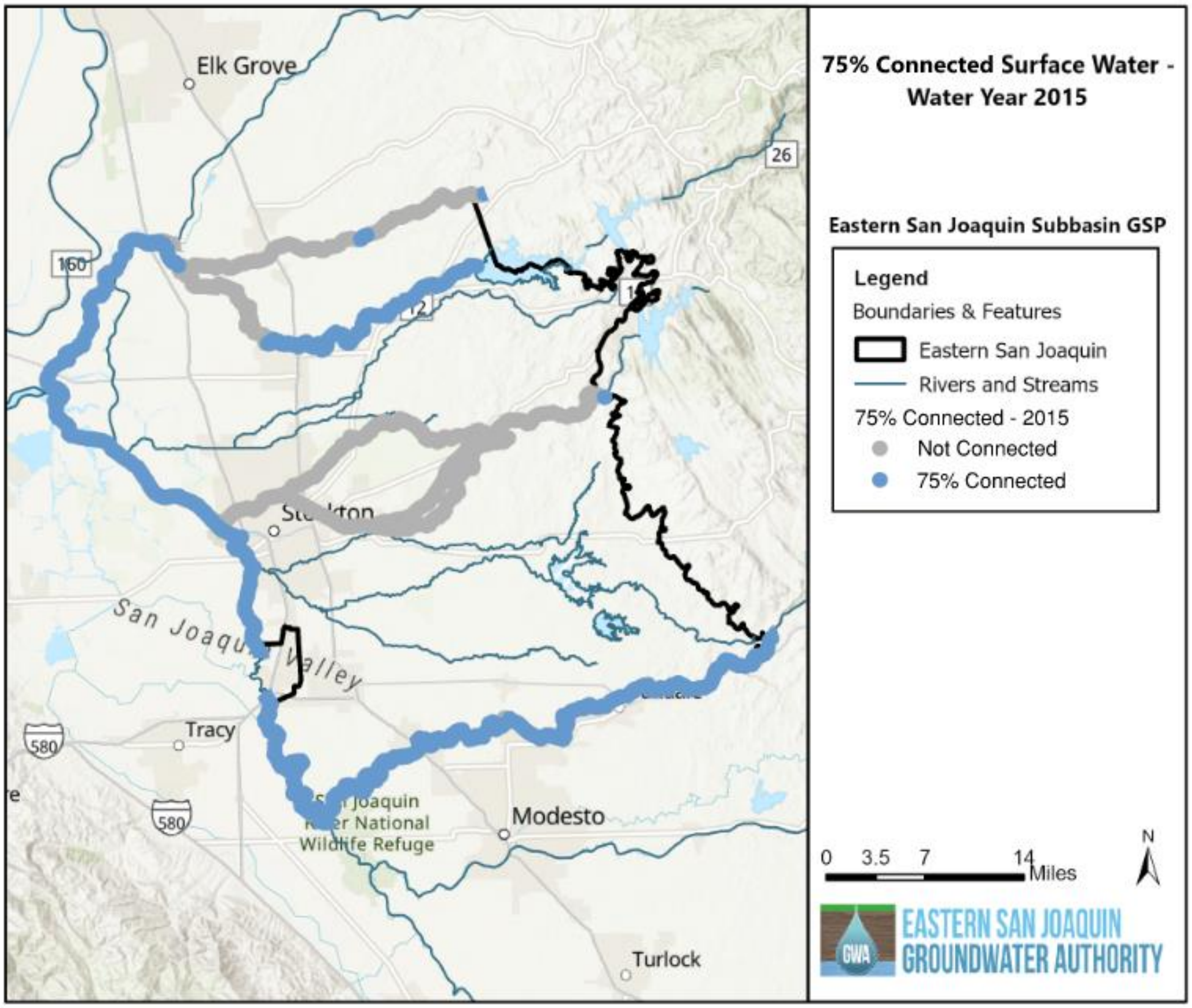


Figure 18: Water Year 2015 Average Annual Stream Gains by Stream Node in ESJWRM

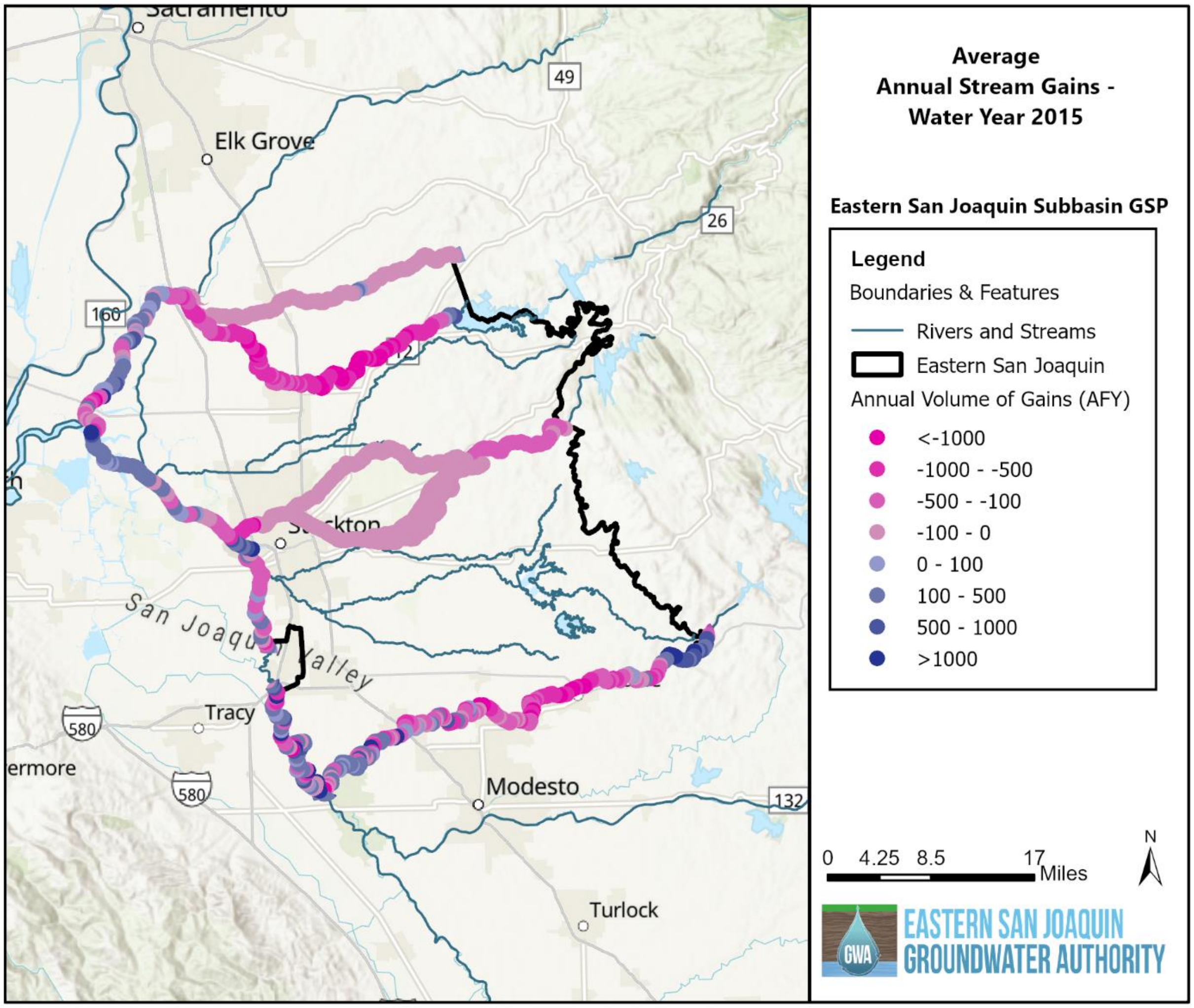
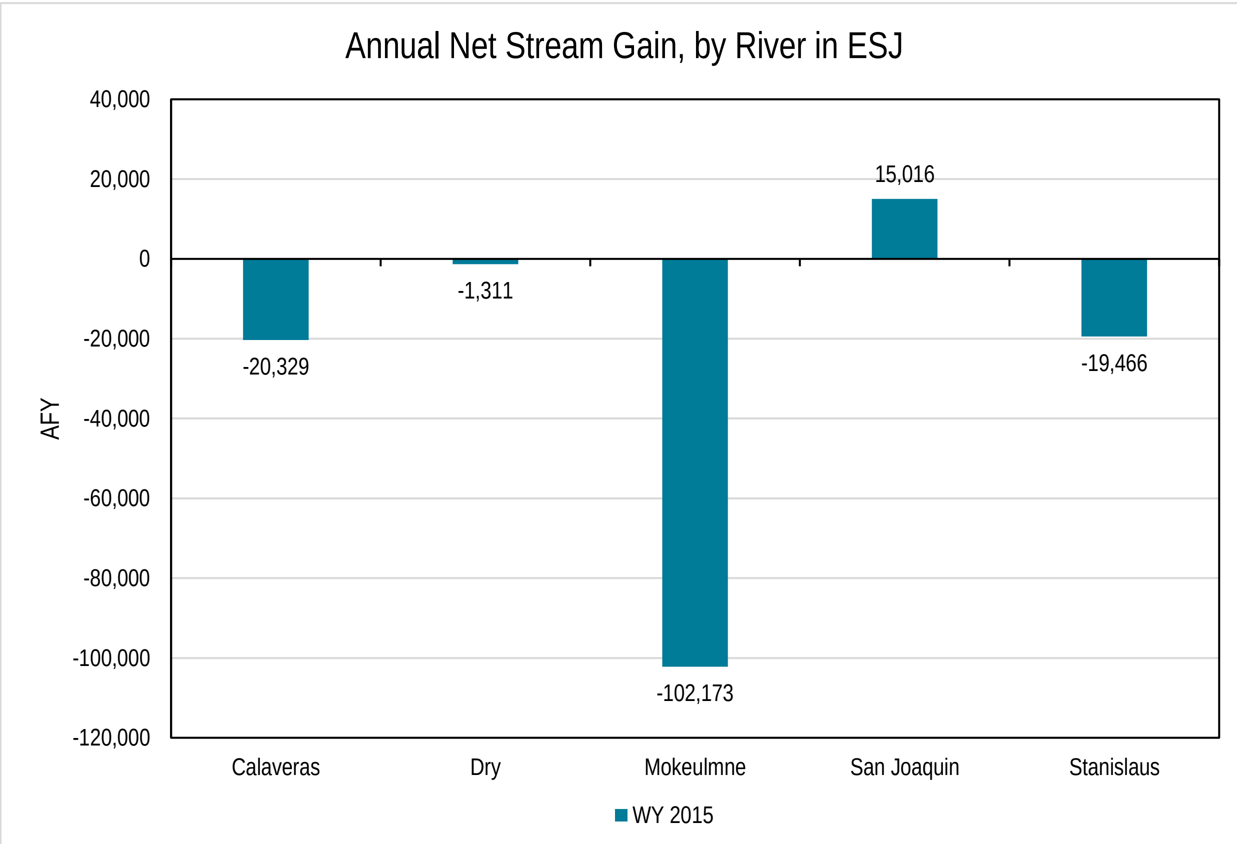


Figure 19: Annual Stream Simulated Gain in Water Year 2015 by River in the Eastern San Joaquin Subbasin



5. UPDATE REPRESENTATIVE MONITORING NETWORK FOR ISW

5.1 Fill Data Gaps

As stated in *Depletions of ISW: An Introduction* (DWR 2024), quantifying and managing interconnected surface waters and stream depletions is inherently challenging for water managers due to the dynamic nature, inability to directly observe stream depletions, and data gaps. In Section 4.7.3 of the 2022 Revised GSP, interconnected surface water was highlighted as a data gap due to a lack of data from shallow monitoring wells near streams. Several actions were identified in the 2020 GSP and 2022 Revised GSP to fill these data gaps and improve the understanding of stream aquifer interactions. **Table 2** lists these actions and their status.

Table 2: Status of Actions to Fill ISW Data Gaps, 2022 Revised GSP

2020/2022 GSP Action to Fill Data Gap	Status and Notes
Proposed new shallow groundwater monitoring wells	Complete. Five (5) new wells were funded by the DWR Proposition 1 Sustainable Groundwater Planning Grant and were constructed in 2022. These wells are included in the ISW Representative Monitoring Network.
Mokelumne River Loss Study	NSJWCD is continuing to work on strategic plan and funding options for the implementation of this Project.
ESJ WRM Model Recalibration	Complete. The model recalibration was completed in 2024 and provides an enhanced understanding of the stream-aquifer interactions, which is analyzed and reported in this TM to support the 5-Year GSP update.

In addition to the 2020 and 2022 GSP data gap actions, the GSAs have examined supplementary streamflow and groundwater level data, in addition to other possible monitoring locations, to better understand stream-aquifer interactions outside of the representative monitoring network.

Streamflow at active stream gages in and near the Subbasin is collected for ISW analysis and ESJWRM model calibration. **Figure 20** displays the stream gages used for ESJWRM model calibration and **Table 3** lists the location and period of record of these stream gages. **Attachment 1** includes the daily streamflow of these gages in standard and log basis, for reference.

Table 3: List of Stream Gages in Eastern San Joaquin Subbasin

Gage ID	Gage Name	Latitude, Longitude	Period of Record	Monitoring Agency
MRS	Mormon Slough at Bellota	38.054, -121.012	12/10/1997 - 7/29/2024	CDEC
OBB	Stanislaus River below Orange Blossom Bridge	37.791, -120.765	1/1/1984 - 7/29/2024	CDEC
11290000	Tuolumne River at Modesto	37.627153, -120.9843777	4/1/1940 - 7/28/2024	USGS

Gage ID	Gage Name	Latitude, Longitude	Period of Record	Monitoring Agency
11303000	Stanislaus River at Ripon	37.72965078, -121.1104934	10/1/1940 - 7/28/2024	USGS
11303500	San Joaquin River at Vernalis	37.6760406, -121.2663293	10/1/1923 - 7/28/2024	USGS
11323500	Mokelumne River below Camanche Dam	38.2261111, -121.0233333	10/1/1904 - 9/30/2023	USGS
11325500	Mokelumne river at Woodbridge	38.15852914, -121.3035592	6/1/1924 - 9/30/2023	USGS
11329500	Dry Creek near Galt	38.24797116, -121.2268913	10/1/1926 - 12/6/1997	USGS
11336000	Consumnes River at McConnell	38.3579675, -121.343839	10/1/1941 - 10/15/1982	USGS

In addition to stream gages, the GSAs are utilizing data that are being collected elsewhere to help the understanding of ISW conditions and stream depletions. **Figure 21** depicts wells that are within three miles of a connected river, are monitoring wells, have shallow wells depths (100 feet or less), and have recent groundwater level observations (at least one observation since the start of Water Year 2015). Note that some of these wells fall outside of the Subbasin. These wells are *not* part of the Representative Monitoring Network for ISW and are identified solely to provide supplemental groundwater level data to support further stream depletion analysis, as needed.

The GSAs acknowledge that data gaps continue to exist relative to monitoring for ISW-related impacts. The GSAs have worked to fulfill commitments to address identified data gaps and will continue to collect additional monitoring data and define segments of interconnectivity and timing as part of GSP implementation. Before the next 5-year Periodic Evaluation in 2030, it is expected that DWR will release the outstanding interconnected surface water (ISW) guidance documents, additional groundwater level data for the new ISW representative monitoring wells will have been collected, and the ESJWRM model will have been enhanced to allow for a reevaluation of the streams and creeks included in the ISW analysis, the definition of the ISW undesirable result, and the subsequent ISW sustainable management criteria.

The following section details recent updates to the ISW representative monitoring network to include the newly constructed ISW monitoring wells. These previous efforts and a commitment to continued monitoring and analysis directly address RCA #6b.

Figure 20: Streamflow Gages in and Adjacent to the Eastern San Joaquin Subbasin

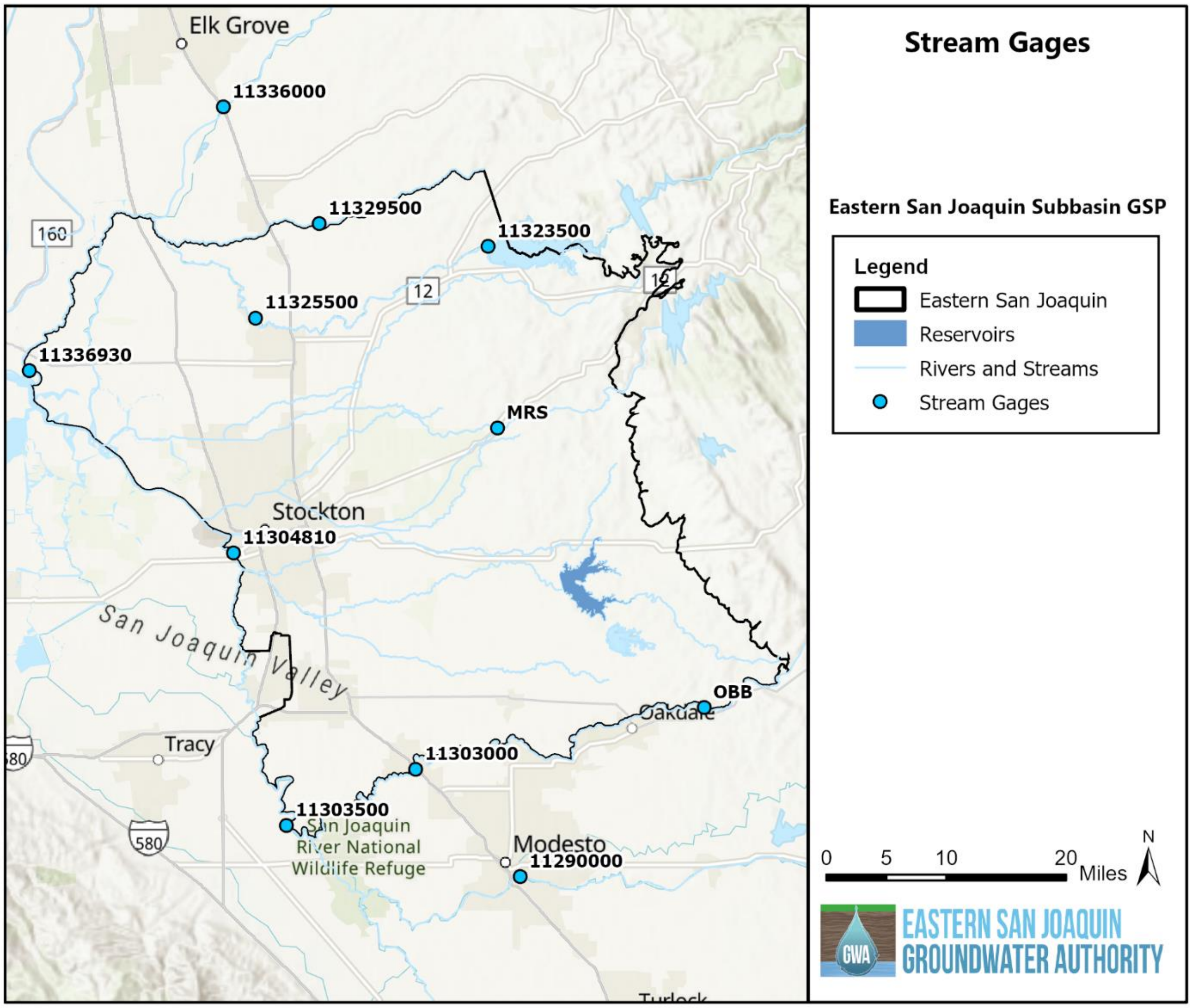
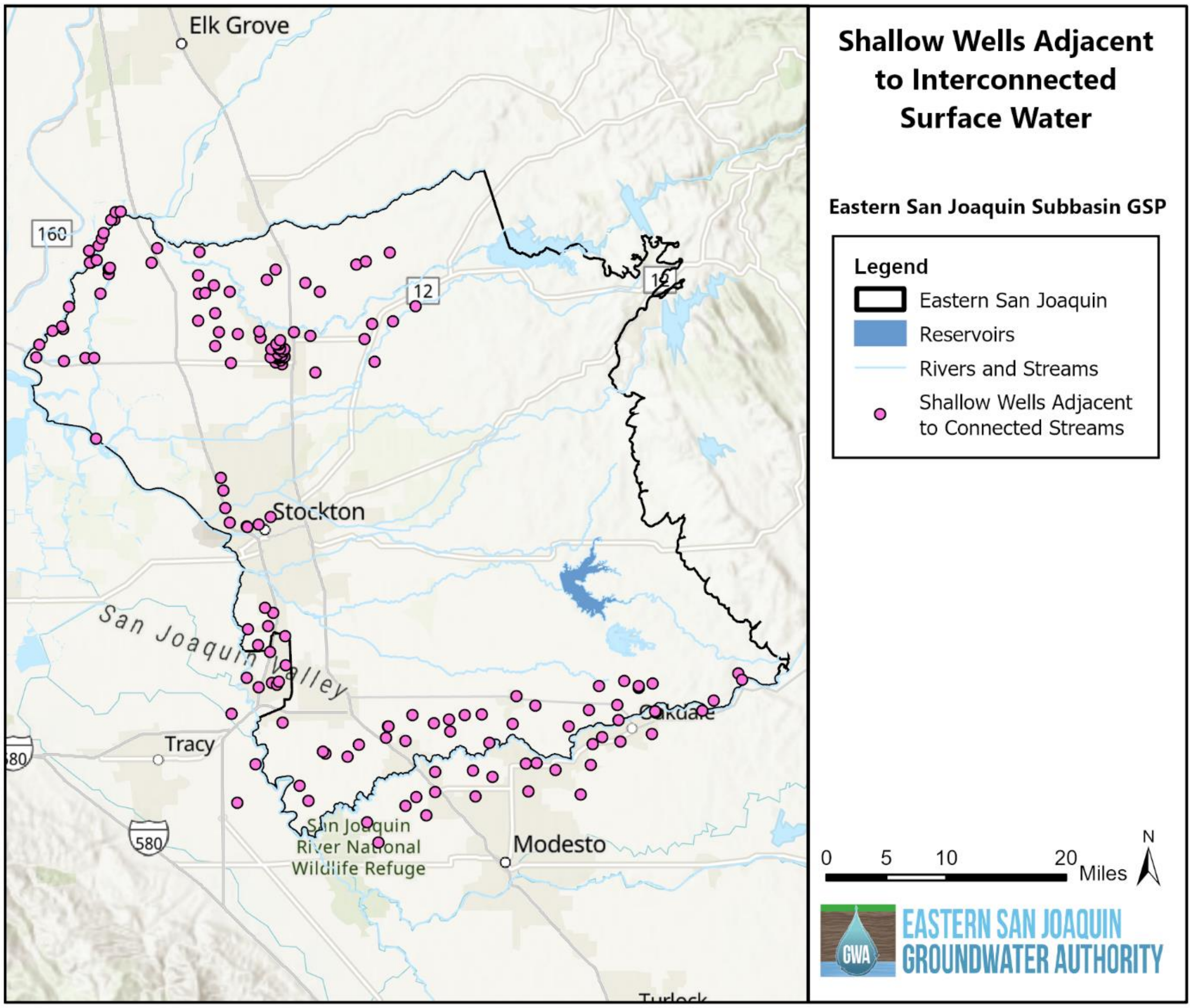


Figure 21: Supplemental Groundwater Level Monitoring Wells for ISW Analysis



5.2 Representative Monitoring Network

The Subbasin GSAs have established a new Representative Monitoring Network (RMN) specifically for ISW. The RMN includes the newly constructed ISW shallow monitoring wells near streams that were installed specifically to address data gaps around understanding stream-aquifer dynamics. It also includes the new multi-completion Delta Well that was funded by the Subbasin's Sustainable Groundwater Planning Proposition 68 grant funding and constructed in 2024. The siting of the newly constructed wells is discussed in **Attachment 2**, *Technical Memorandum: Data Gap Identification in the Eastern San Joaquin Subbasin*. Lastly, the ISW RMN includes a subset of the groundwater level (GWL) RMN wells that are within five miles of connected surface waters. Only one well (the shallowest well in a gap area) was selected from the GWL

RMN along the Mokelumne River since there are the new ISW wells along other sections of the Mokelumne River. Wells from the GWL RMN were selected for their thorough and recent groundwater level observations and known perforations. A five-mile buffer was selected to include a larger subset of GWL RMN wells which can reveal pumping trends on a regional scale, since pumping influences stream depletions. The ISW RMN wells were selected to reflect both shallow, dynamic interactions between streams and the aquifer, as well as deeper regional pumping trends. **Table 4** lists the RMN for ISW, including the well names, locations, perforation information, adjacent stream, and SMC category. **Figure 22** shows the ISW RMN by SMC category (new ISW well or GWL RMN), and **Figure 23** illustrates the ISW RMN with the well names labeled.

Table 4: ISW RMN

Well ID	Latitude, Longitude	Well Perforations (feet below ground surface)	Nearest Adjacent Stream	Well Category
Well A	38.23583, -121.41869	14 – 31.5	Mokelumne River	New ISW Well
Well B	38.245966, -121.217862	25 – 35	Dry Creek	New ISW Well
Well C	38.20457, -121.09278	15 – 30	Mokelumne River	New ISW Well
Well E	38.15838, -121.14675	35 – 50	Mokelumne River	New ISW Well
Well G	37.86248, -120.77601	26 – 41	Little Johns Creek	New ISW Well
Delta Well	38.1229, -121.4932	125 – 150, 275 – 300	Mokelumne River	New ISW Well
04N05E36H003	38.1559, -121.3727	50 – 112	Mokelumne River	GWL RMN
Swenson-3	38.0067, -121.3458	194 – 204	San Joaquin River	GWL RMN
Frankenheimer (01S10E26J001M)	37.8163, -120.8321	323 – 599	Stanislaus River	GWL RMN
Burnett (OID-4)	37.7909, -120.86752	168 – 249	Stanislaus River	GWL RMN
02S07E31N001	37.7136, -121.2508	130 – 226	San Joaquin River	GWL RMN
02S08E08A001	37.781, -121.1142	50 – 180	Stanislaus River	GWL RMN

Figure 22: ISW RMN by SMC Category

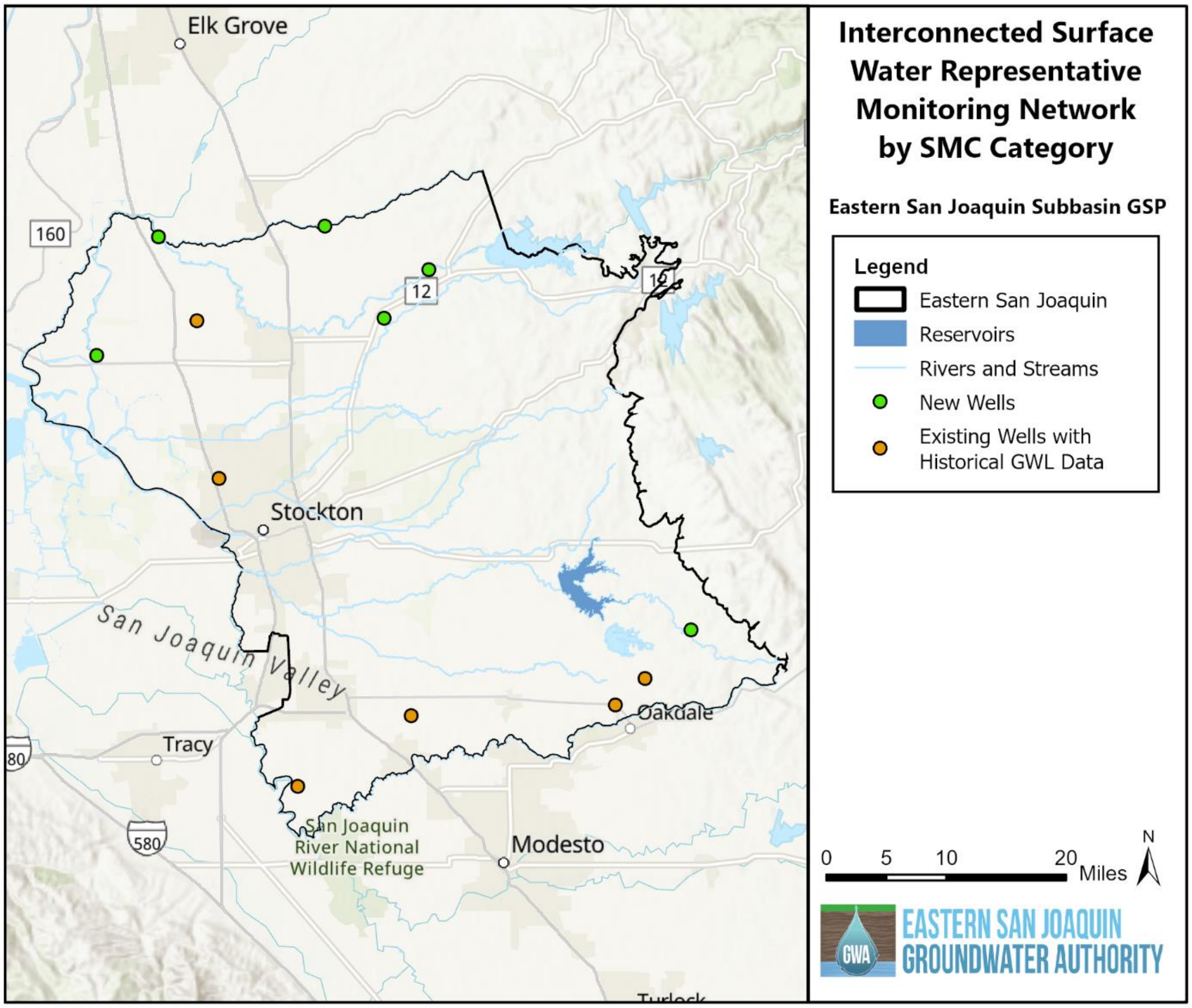
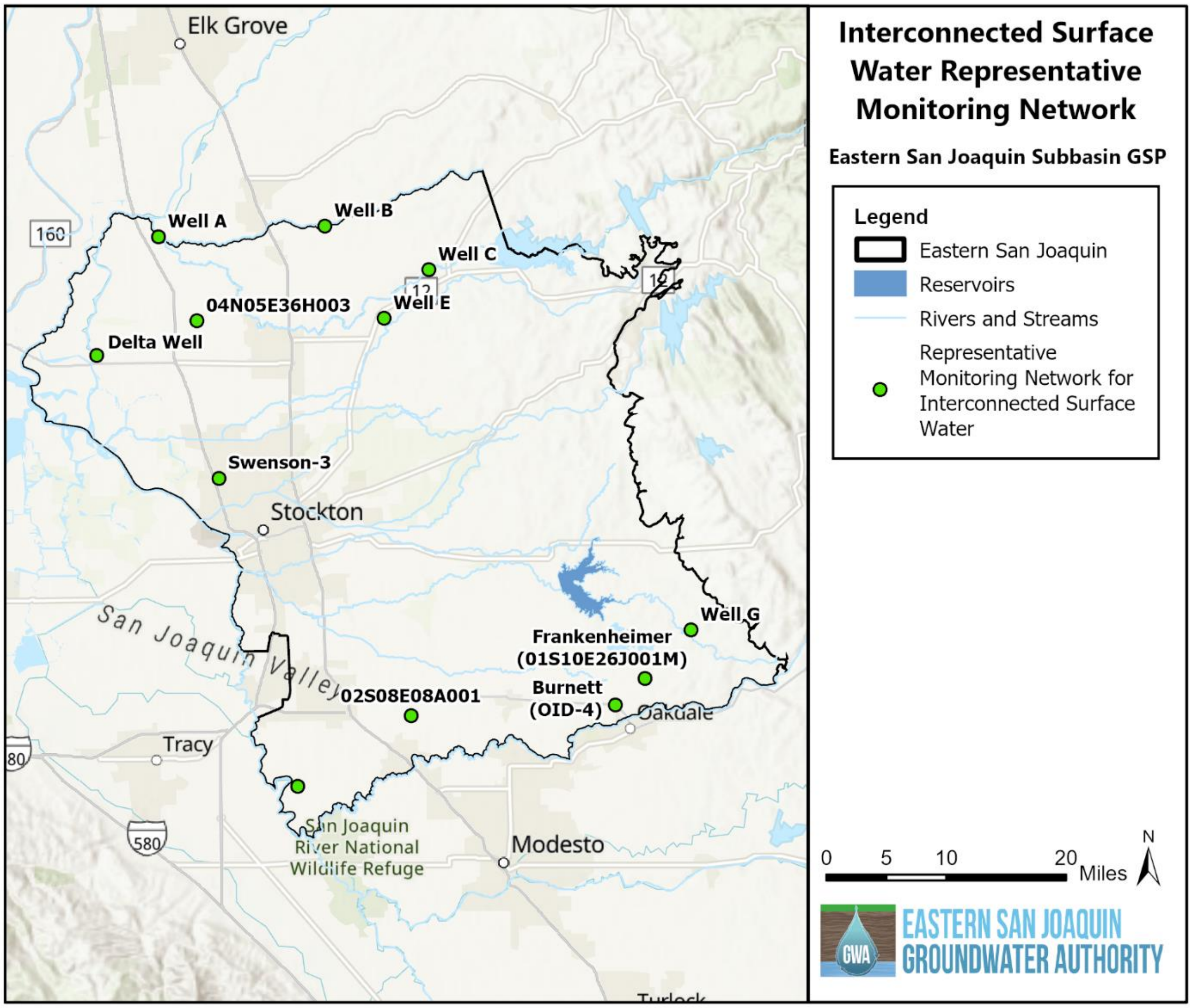


Figure 23: ISW RMN



6. ESTABLISH SMCS FOR ISW

Sustainable Management Criteria (SMCs) were established for the ISW RMN to avoid undesirable results related to stream depletions. Groundwater levels are used as a metric for the ISW SMCs. Groundwater level data are used to calculate water table gradients and, therefore, the volume of water gained and lost. Without additional DWR guidance and more certainty around stream depletions due to pumping with the existing modeling toolset, the SMCs rely on the best available information at the time of analysis. The ISW SMCs using groundwater levels as a metric aim to be "sufficiently protective to ensure significant and unreasonable occurrences of [stream depletions] will be prevented," as prescribed in the DWR's *Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria* (DWR, 2017).

The SMCs for existing wells with historically observed groundwater levels are described below in Section 6.1. The process for establishing ISW-specific SMCs for new wells without historically observed groundwater levels is discussed in Section 6.2.

6.1 SMCs for RMN with Historical Groundwater Level Data

There are six wells in the ISW RMN with historical groundwater level data, as displayed in **Figure 22** and discussed in Section 5.2. In lieu of refined data and certainty in stream depletions, the SMCs at representative monitoring wells with historical groundwater level data are set to be the same as the SMCs for groundwater levels. According to the DWR's *Best Management Practices for the Sustainable Management of Groundwater: Sustainable Management Criteria* (DWR, 2017), "To use the minimum thresholds for chronic lowering of groundwater levels as a proxy for interconnected surface water, the stream depletions which would occur when undesirable results for groundwater levels are reached must not be significant and unreasonable." The following sections detail the justification that SMCs for the chronic lowering of groundwater levels for wells in the ISW RMN is protective of undesirable stream depletions.

Stream-aquifer interactions were examined under a hypothetical Projected Conditions Baseline (PCBL) – Minimum Thresholds scenario with the addition of climate change and additional pumping to drive groundwater levels to their minimum thresholds. The undesirable result for the chronic lowering of groundwater levels is defined as groundwater levels in 25 percent of the RMN wells dropping to their minimum thresholds for two consecutive years. In the test scenarios conducted for the analyses, pumping was artificially induced at five selected wells in order to "force" groundwater levels to decline. Many iterations of different combinations of wells were explored, and the version selected for the ISW analysis was the most extreme version since it had the highest induced pumping volumes with wells closest to interconnected streams.

The resulting stream-aquifer interactions in ESJWRM were analyzed in the PCBL-Minimum Thresholds scenario and compared to 2015 conditions: (1) spatial stream connectivity, (2) average annual stream gains and losses, and (3) seasonal stream gains and losses. While this TM just includes comparisons to Water Year 2015, since that water year is used as the basis for undesirable results as described in Section 4, **Attachment 3** includes the same comparisons to historical and current conditions for reference. The toolset to thoroughly evaluate the impacts on stream temperatures was beyond reach at the time of this analysis; however, changes in stream gains and losses were used to inform potential impacts on stream temperatures.

6.1.1 Stream Connectivity

Connected stream reaches in the PCBL-Minimum Thresholds scenario based on the 75 percent comparison point are the Mokelumne River, Stanislaus River, and lower San Joaquin River, as displayed in **Figure 24**. **Figure 25** illustrates the stream locations that were 75 percent connected in Water Year 2015 and disconnected under the PCBL-Minimum Thresholds scenario in ESJWRM. The major connected stream reaches – Mokelumne River, Stanislaus River, and lower San Joaquin River – remain 75 percent connected. This means that the chronic lowering of groundwater levels SMCs are protective of stream connectivity and do not cause streams to lose connection. Note that there is a single stream node on Dry Creek that is connected in Water Year 2015 and disconnected in the PCBL-Minimum Thresholds scenario, but the remainder of the creek is disconnected in historical and current conditions and in Water Year 2015 in ESJWRM.

Figure 26 displays the percentage of time that the Subbasin's 75 percent connected streams are gaining in the PBCL-Minimum Thresholds scenario in ESJWRM. **Figure 27** compares the difference in the percentage of time that the 75 percent connected streams are connected between the PCBL-Minimum Thresholds scenario and Water Year 2015. Areas in blue are connected more frequently in the PCBL-Minimum Thresholds scenarios and areas in pink are connected less frequently in the PCBL-Minimum Thresholds scenario as compared to Water Year 2015 conditions. The frequency of connection in Water Year 2015 is based on the number of connected months out of the 12 months in that water year. The model shows that the Mokelumne River is connected more frequently and greater than 80 percent of the time under the PCBL-Minimum Thresholds scenario, showing an improvement in stream conditions compared to Water Year 2015. The Stanislaus River is connected slightly less frequently in the central portion of the reach; however, the stream is still connected in the PCBL-Minimum Thresholds scenario at least 80 percent of the time. There are minimal differences in other stream reaches. Simulated comparisons to historical and current conditions are included in **Attachment 3**.

Figure 24: PBCL-Minimum Thresholds Surface Waters Connected with the Groundwater System at least 75% of All Months in ESJWRM

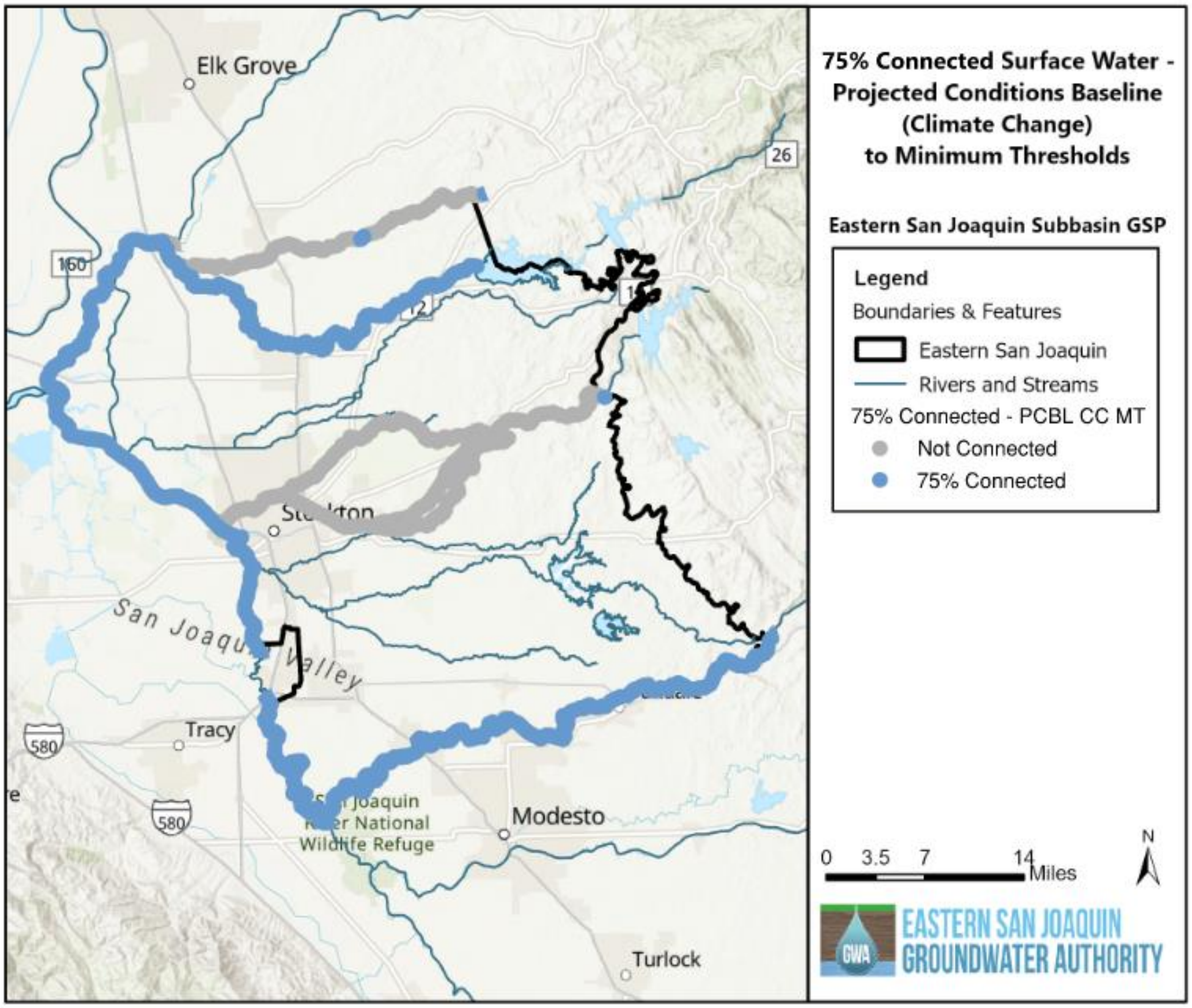


Figure 25: Locations Where ISWs were 75% Connected or Not Connected in the PCBL-Minimum Thresholds Scenario compared to Water Year 2015 in ESJ WRM

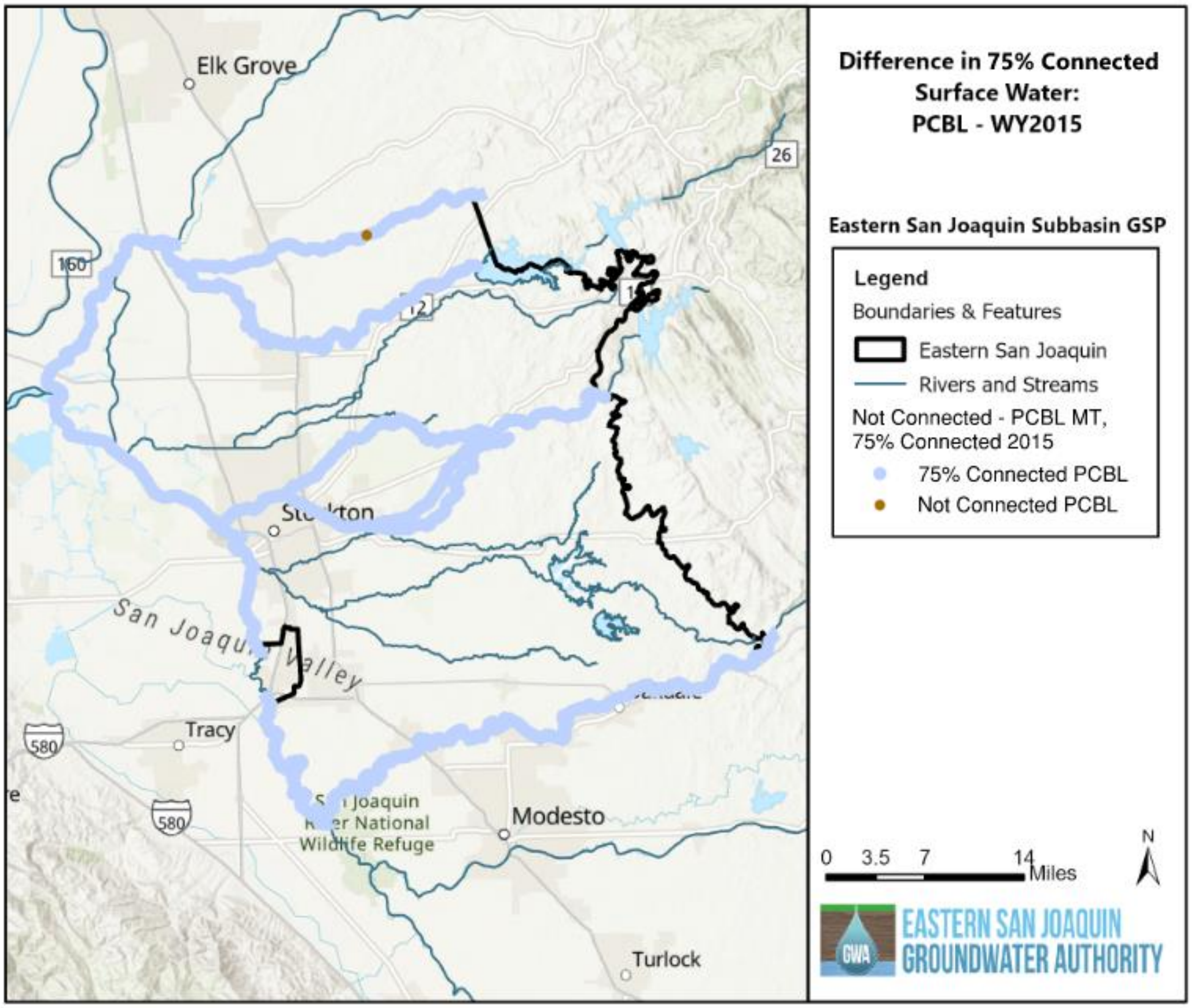


Figure 26: Percentage of Time Streams are Connected – ESJWRM PCBL-Minimum Thresholds Conditions

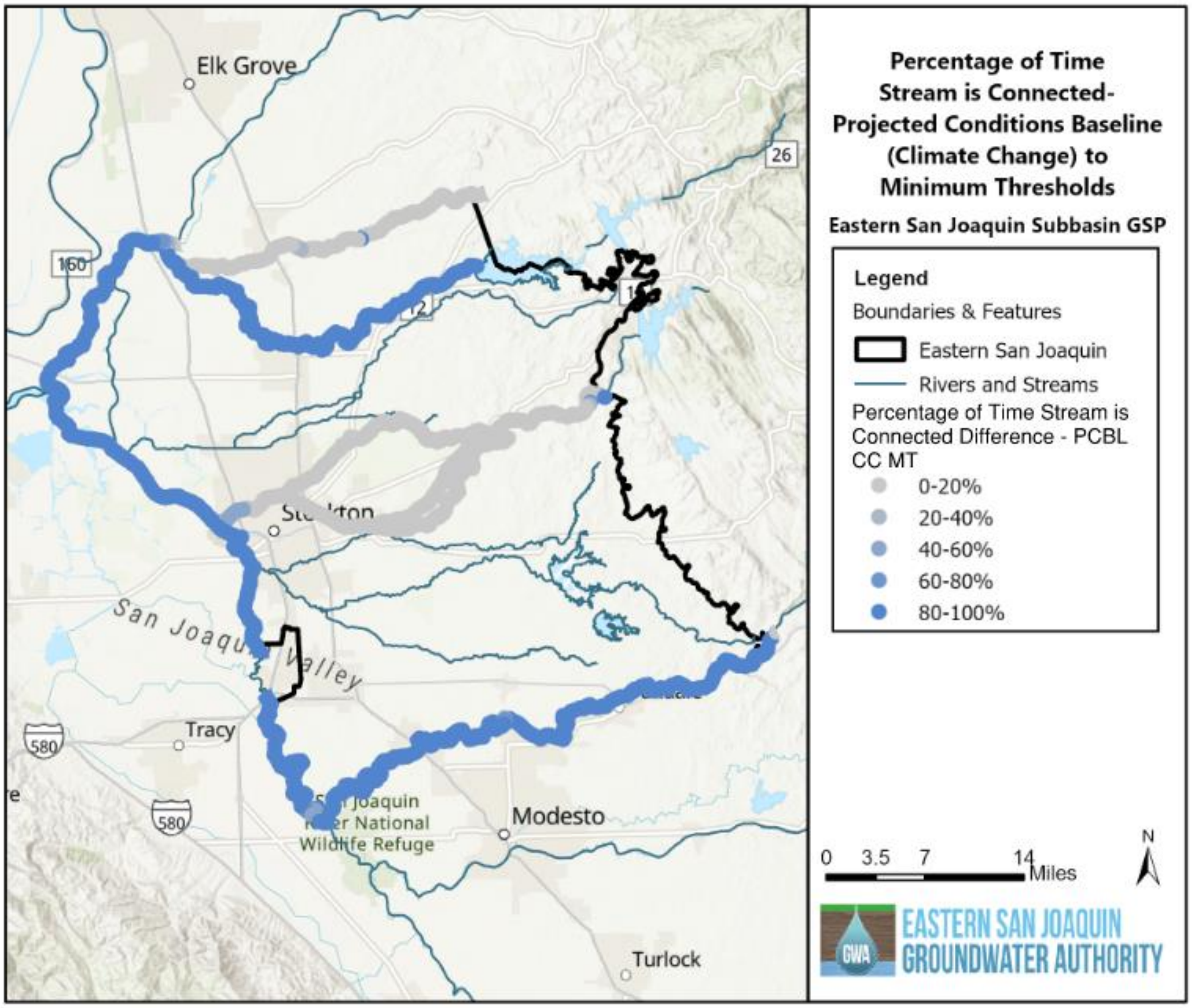
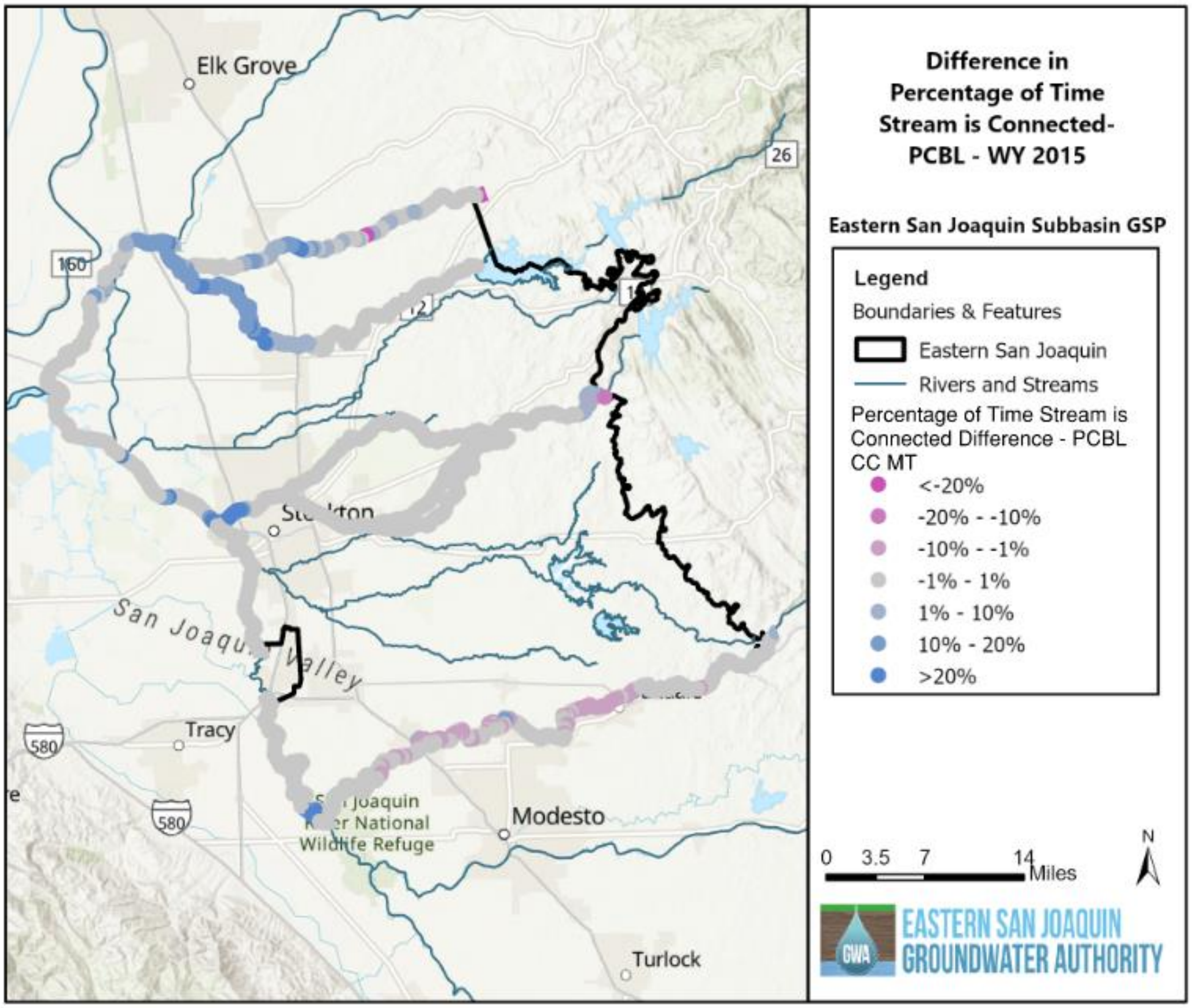


Figure 27: Difference in the Percentage of Time Streams are Connected between PCBL-Minimum Thresholds Scenario and Water Year 2015 in ESJWRM



6.1.2 Annual Stream Gains and Losses

In addition to looking at the stream connectivity, the impact on stream gains and losses were evaluated. **Figure 28** displays the average annual stream gain for each river under historical conditions, Water Year 2015, and in the PCBL-Minimum Thresholds scenario in ESJWRM. Water Year 2015 shows the smallest volumes of stream losses (or most stream gains for the lower San Joaquin River) compared to historical and PCBL-Minimum Thresholds scenarios. There are greater stream losses in the PCBL-Minimum Thresholds scenario, particularly on the Mokelumne River and Stanislaus River. This is expected since the PCBL-Minimum Thresholds scenario intentionally increases pumping to reduce groundwater levels.

Figure 29 displays a similar figure but shows the stream gains and losses as a percentage of stream inflow in ESJWRM. Note that Dry Creek was excluded because of misrepresentative ratios of accretions and depletions due to low stream flows. As a proportion of stream inflow, the stream losses on Calaveras River and Mokelumne River are less in the PCBL-Minimum Threshold scenario than in Water Year 2015 and are similar to historical trends. The model shows that the Calaveras River has a ratio higher than 100 percent since the stream accretes runoff from precipitation, increasing the total stream inflow, which is later seeped. The Stanislaus River loses slightly more, increasing from 10 percent in Water Year 2015 to 14 percent in the PCBL-Minimum Thresholds scenario. One potential cause for the increase on the Stanislaus River is the boundary conditions with the Modesto Subbasin as simulated by ESJWRM. While induced pumping occurs only in the Eastern San Joaquin Subbasin in the PCBL-Minimum Thresholds scenario, there are additional stressors on the system from climate change in the Modesto Subbasin that are driving groundwater levels lower outside of the Eastern San Joaquin Subbasin, resulting in additional depletions. Under ideal circumstances, the neighboring subbasins will reach sustainability in concert with Eastern San Joaquin Subbasin; however, the modeling assumptions assume the worst-case scenario.

Figure 30 and **Figure 31** visualize the results of the analysis spatially. **Figure 30** illustrates the average annual stream gains and losses in the PCBL-Minimum Thresholds scenario. The model shows the greatest stream losses occur on the upper Mokelumne River, central portion of the Stanislaus River (halfway between Goodwin Dam and the confluence with the San Joaquin River), and the lower San Joaquin River just upstream of the confluence with the Calaveras River. Dry Creek and the Calaveras River are losing slightly less from the stream system, on average. The lower Mokelumne River, upstream and downstream segments of the Stanislaus River, and lower San Joaquin River all experience net stream gain from the aquifer system. This generally occurs in areas with high groundwater levels.

Figure 31 shows the differences in average annual simulated stream gains between the PCBL-Minimum Thresholds scenario and Water Year 2015. The areas with more pink show greater losses in the PBCL-Minimum Thresholds scenario. The model shows the greatest difference in stream losses occurs in the central segment of the Stanislaus River. As previously discussed, this increase could be partially driven by the impacts of simulated climate change across the Eastern San Joaquin Subbasin boundary in the Modesto Subbasin as simulated by ESJWRM.

Figure 28: Average Annual Simulated Stream Gain by River in the Eastern San Joaquin Subbasin

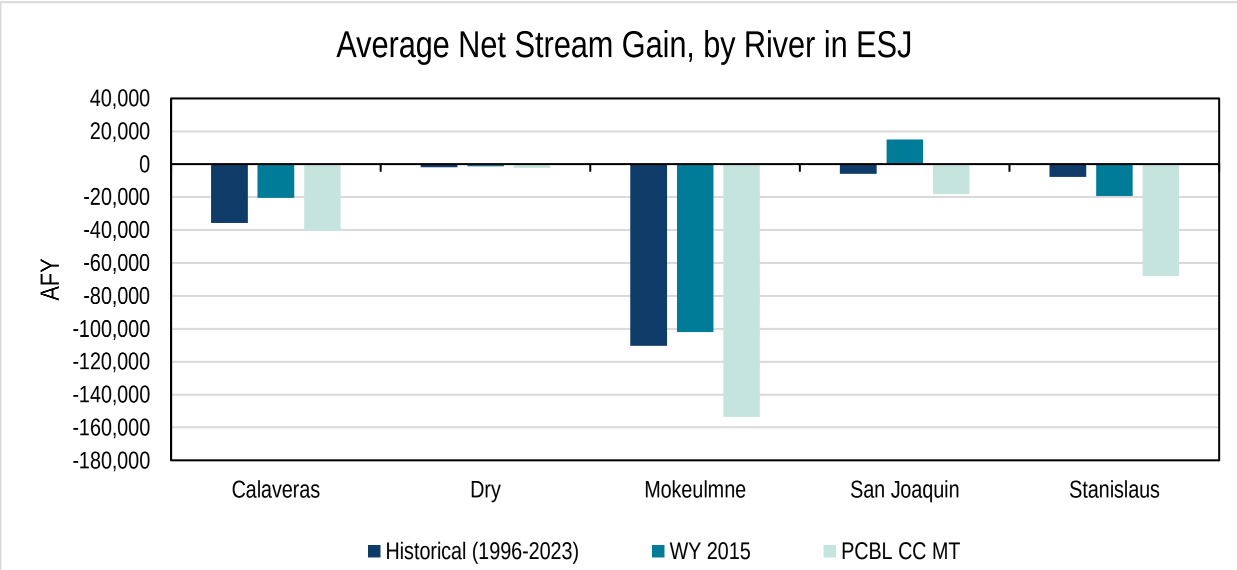
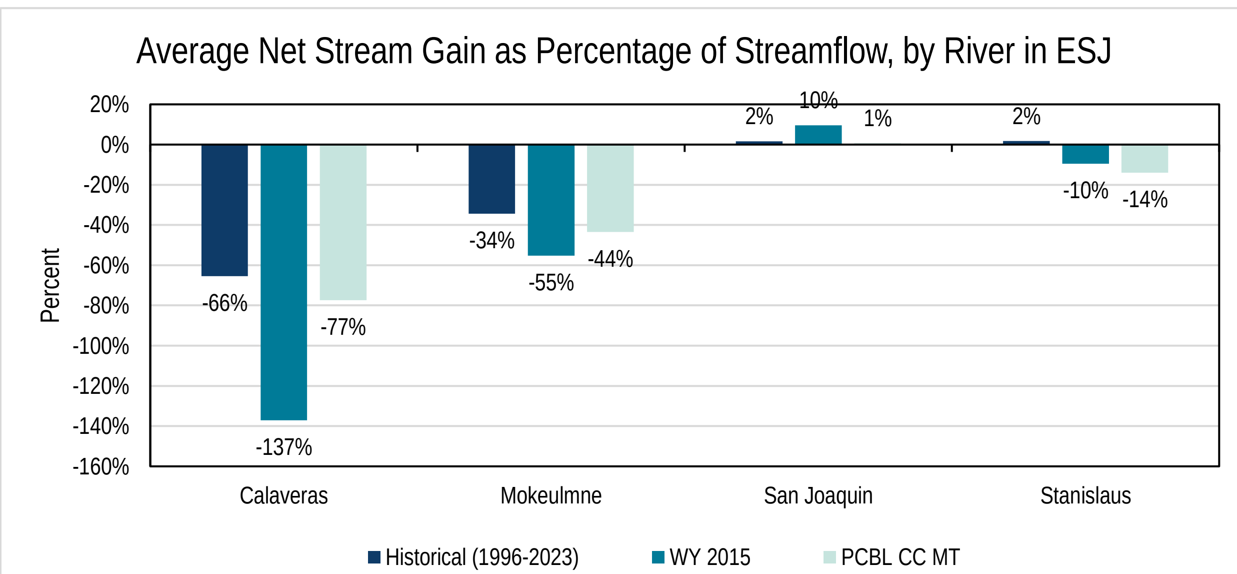


Figure 29: Average Annual Simulated Stream Gain as a Percentage of Streamflow by River in the Eastern San Joaquin Subbasin



Note: Dry Creek was excluded due to low and zero stream flows skewing the resulting ratios.

Figure 30: Average Annual Simulated Stream Gains in the PCBL-Minimum Thresholds Scenario

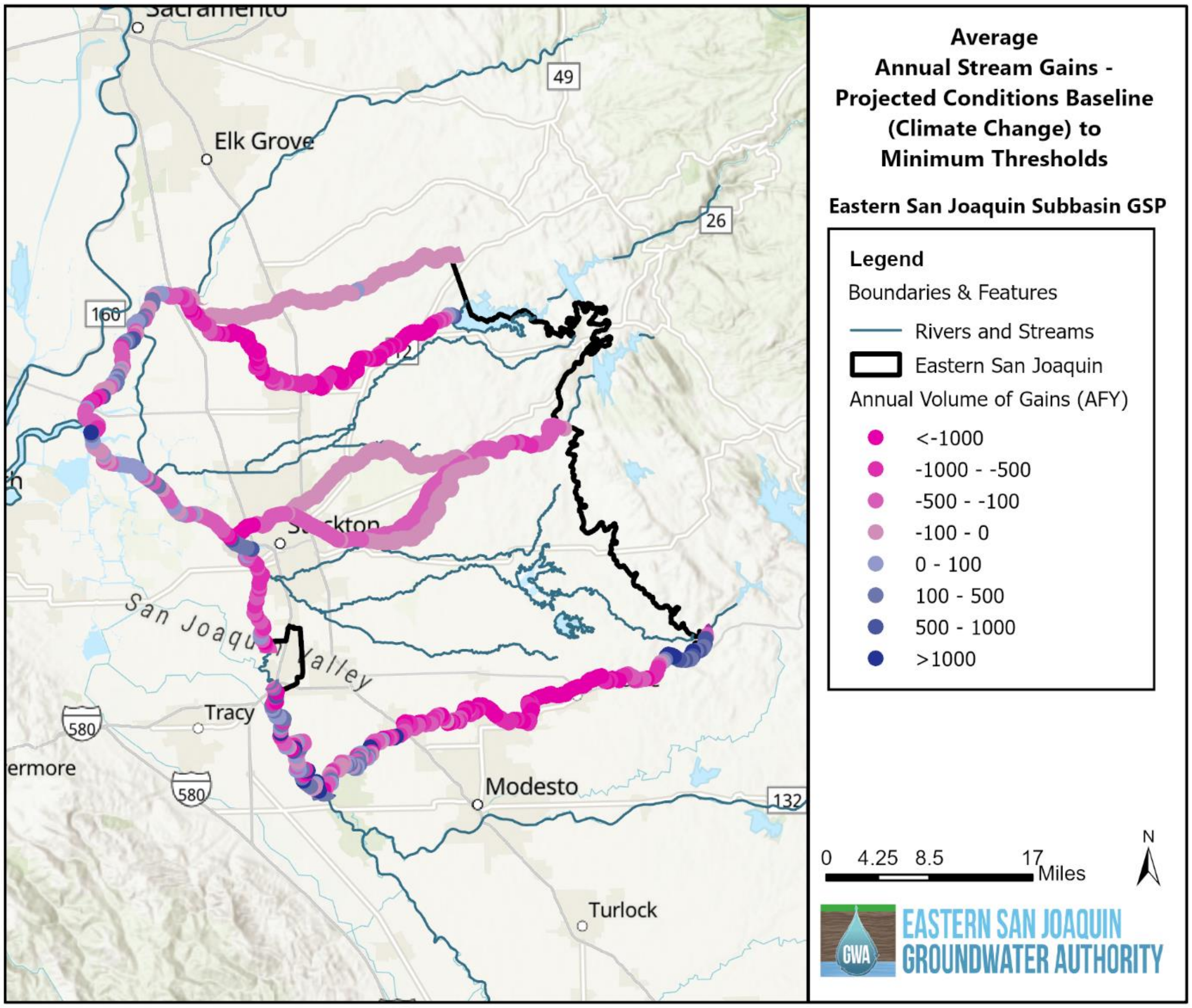
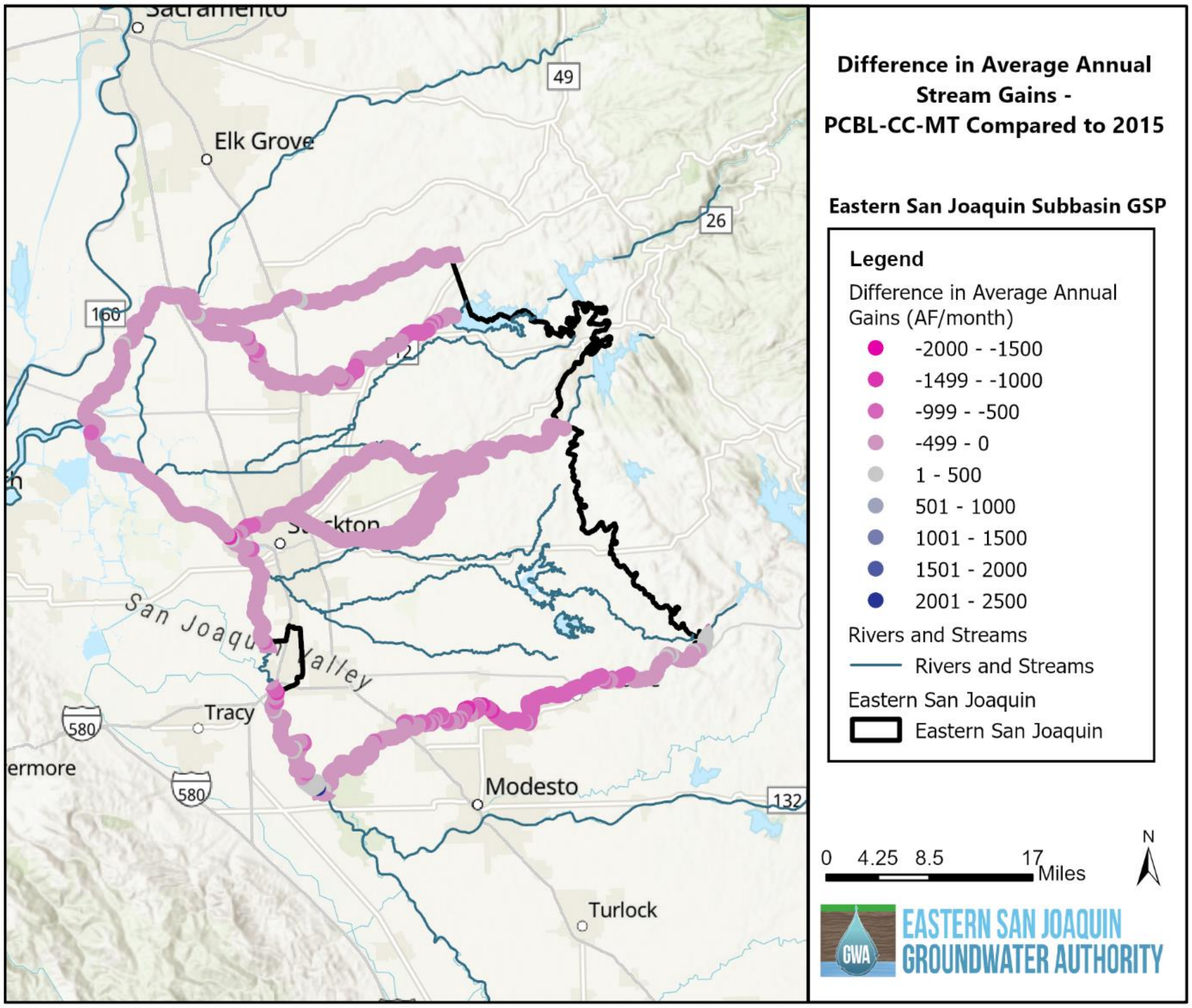


Figure 31: Difference in Average Annual Simulated Stream Gains between PCBL-Minimum Thresholds Scenario and Water Year 2015



Note: Negative numbers (pink) indicated additional stream losses under the PCBL-Minimum Thresholds Scenario

6.1.3 Seasonal Stream Gains and Losses

It is important to look at seasonal stream flows and depletions since beneficial users of the stream rely on stream flows during specific times of year. For example, surface water diverters generally divert water during the irrigation season. Additionally, fish spawning and rearing are critical time periods for aquatic health. Groundwater dependent ecosystems rely on high groundwater levels in the summertime when precipitation declines.

Figure 32 below shows the stream gains and losses for each river in the Eastern San Joaquin Subbasin by quarter for historical conditions, Water Year 2015, and the PCBL-Minimum Thresholds scenario in ESJWRM. Note that the y-axis of the chart shows the average monthly stream gains for the months within that quarter specifically for the stream-aquifer interactions within the ESJ Subbasin. There are additional stream losses in the PCBL-Minimum Thresholds scenario for all rivers in all quarters compared to historical conditions and Water Year 2015 (with the exception of the Calaveras River in the Fall, which is not a connected river). Specifically, the Mokelumne River and Stanislaus River in the model see the greatest increase in stream losses under the PCBL-Minimum Thresholds scenario in all quarters. As previously discussed, this is expected since the PBCL-Minimum Thresholds scenario artificially increases pumping to drive down groundwater levels.

Figure 33 shows the stream gains as a percentage of stream inflow by quarter for each model scenario and timeframe. Note that Dry Creek was excluded because misrepresentative ratios of accretions and depletions due to low stream flows. The simulated results show that the Calaveras River has a ratio higher than 100 percent since the stream accretes runoff from precipitation, increasing the total stream inflow, which is later seeped. This is especially evident in the Fall of 2014 (in Water Year 2015) when the stream inflows are relatively low, and the Calaveras River is seeping runoff into the aquifer system. Stream losses as a proportion of streamflow are generally equal to or less than Water Year 2015 or historical conditions in all quarters.

Figure 32: Average Simulated Monthly Net Stream Gain by River in Eastern San Joaquin Subbasin

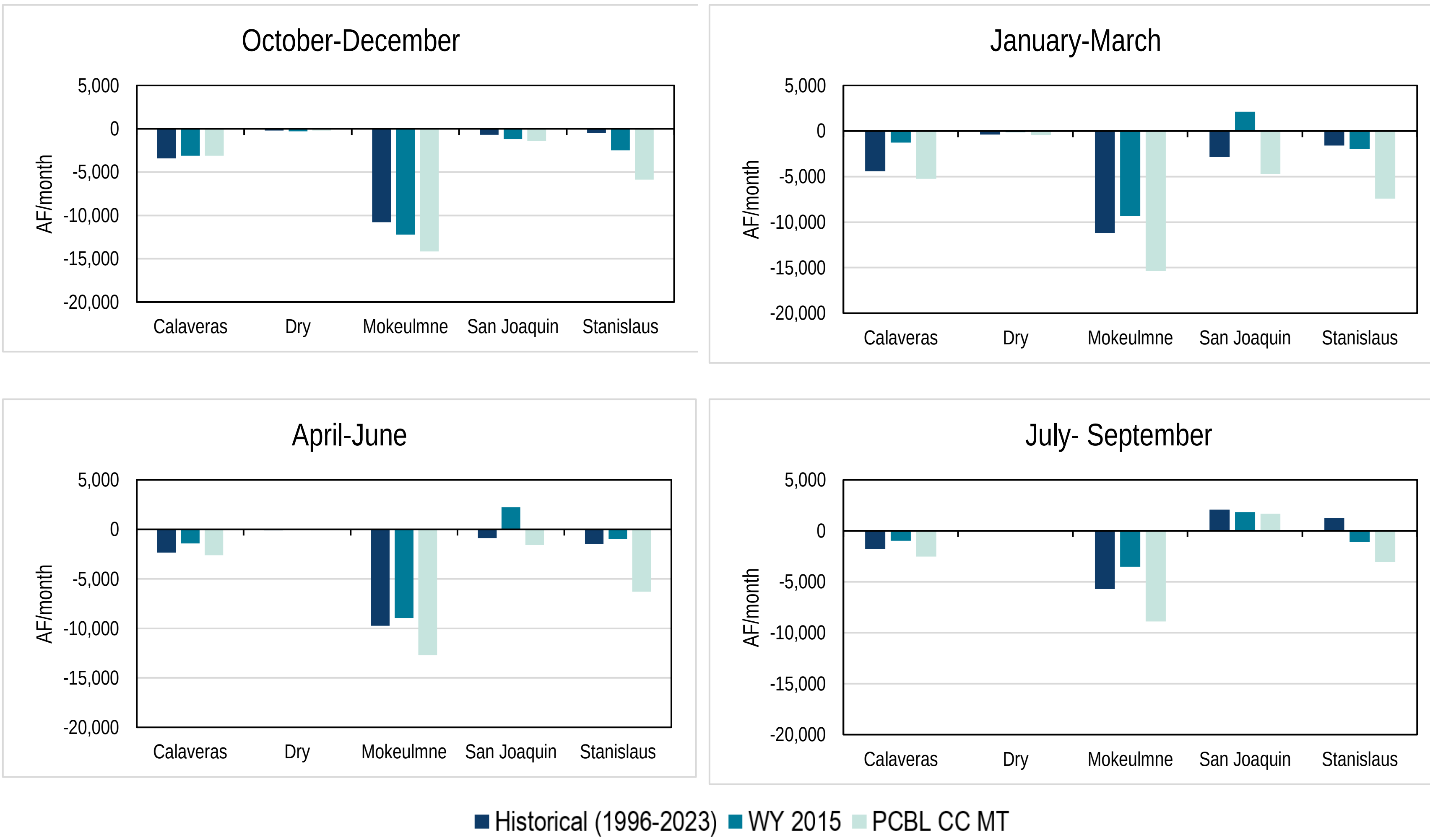
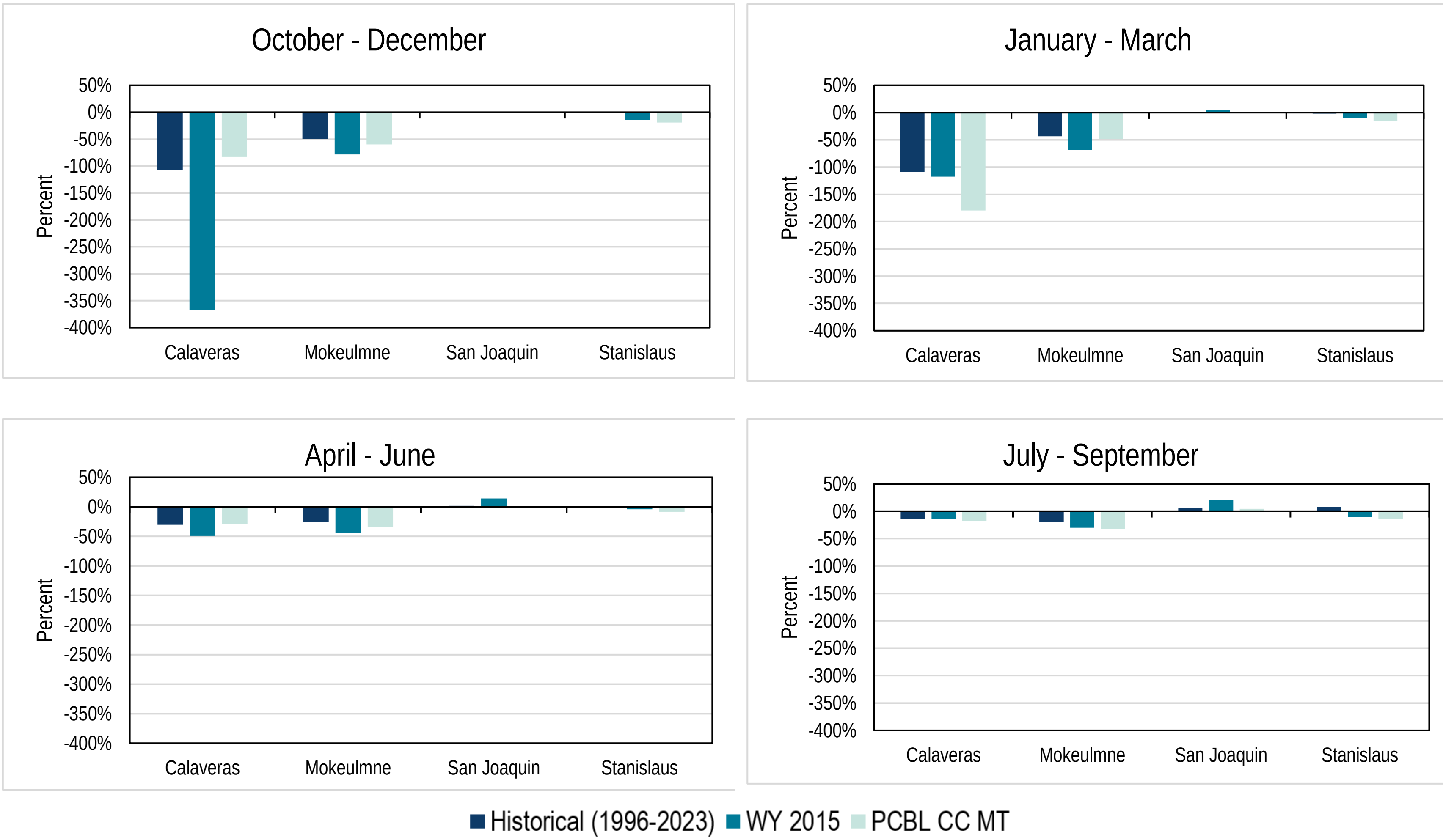


Figure 33: Average Simulated Monthly Stream Gain as a Percentage of Flow by River in Eastern San Joaquin Subbasin



Note: Dry Creek was excluded due to low and zero stream flows skewing the resulting ratios.

6.1.4 Conclusions

The ISW SMCs for wells with historical groundwater level observations are the same as those for the chronic lowering of groundwater level SMCs for representative monitoring wells with historic data. The analysis to justify that the groundwater level SMCs are protective of stream depletions compared stream-aquifer interactions (stream connectivity, stream gains and losses, and stream gains and losses as a percentage of streamflow) of historical and Water Year 2015 conditions to a PCBL-Minimum Thresholds scenario.

The PCBL-Minimum Thresholds model scenario artificially induces additional pumping to lower groundwater levels to their minimum thresholds, "forcing" undesirable results. The result of the analysis showed that the groundwater level SMCs used as ISW SMC keep connected streams connected based on the 75 percent comparison point. While stream losses increase when groundwater levels drop, the percentage of stream losses as a percentage of stream inflow is similar to historical and Water Year 2015 conditions. The Stanislaus River shows higher stream losses as a proportion of streamflow, from 10 percent in Water Year 2015 to 14 percent in the PCBL-Minimum Thresholds scenario. However, the influence of climate change on groundwater levels in the neighboring subbasin could be driving additional stream depletions from lower groundwater levels due to climate change. The seasonal analysis of stream-aquifer interactions revealed similar trends by quarter. These additional stream losses do not cause undesirable results because the percentage of stream losses as a percentage of streamflow is generally equal to or better than Water Year 2015 conditions, and therefore the Subbasin did not "experience" undesirable results (as discussed in Section 4).

Understanding stream depletions due to pumping remains a data gap, despite recent progress and updates. The ISW SMCs established here will be reconsidered after additional DWR guidance on the subject has been released.

6.2 SMCs for New Wells

The ISW RMN includes new monitoring wells that have been recently constructed specifically to collect data to better understand stream-aquifer interactions. **Table 5** summarizes the construction information for the new monitoring wells. These new wells fill a data gap as discussed in Section 5.1; however, there are insufficient groundwater level observations to establish SMCs for these new wells. Bi-annual collection of groundwater levels at these sites will continue to fill the data gap. Some wells will have transducers installed using American Rescue Plan Act (ARPA) funding allowing for more frequent groundwater level observation collection to enhance understanding of stream-aquifer interactions and model calibration. SMCs will be established at these representative monitoring sites after at least four years of data have been collected, including data for at least one wet year and one dry or critical year during that time period. If wet and dry/critical years do not occur during this initial period, then additional years of data collection may be required before establishing SMCs.

Minimum Thresholds for these and other new wells that may be constructed in the future will be established based on adjusted recent groundwater levels from a dry/critical year. The adjustment of groundwater levels is the difference in *simulated* groundwater levels in ESJWRM between Water Year 2015 (a dry year) and the recent dry/critical year when groundwater level observations are measured. The calculation for the Minimum Threshold is:

$$Minimum\ Threshold = Observed\ Recent\ Dry/Critical\ GWL - (Simulated\ Recent\ Dry\ Year\ GWLs - Simulated\ 2015\ GWLs)$$

As a hypothetical example, suppose Water Year 2027 is a critical year and the observed groundwater elevation for Well C is 75 feet mean sea level (msl) in 2027. Assuming that the *simulated* groundwater elevations in ESJWRM at Well C increase by 8 feet between 2015 and 2027. The Minimum Threshold would be 75 feet minus 8 feet, or 67 feet msl.

Conversely, Measurable Objectives will be established from an adjustment in groundwater levels from a wet year. The adjustment will add the difference in *simulated* groundwater levels from ESJWRM between Water Year 2011 (a wet year) and a recent wet year when groundwater level observations are collected. The calculation for Measurable Objectives is:

$$\begin{aligned} &Measurable\ Objectives \\ &\quad = Observed\ Recent\ Wet\ GWL + (Simulated\ Recent\ Wet\ Year\ GWL \\ &\quad - Simulated\ 2011\ GWLs) \end{aligned}$$

As a hypothetical example, suppose Water Year 2026 is a wet year, and the observed groundwater elevation for Well C is 82 feet msl that year. Suppose that the *simulated* groundwater elevations in ESJWRM at Well C decrease by 15 feet between Water Year 2011 and 2026. The Measurable Objective would be 82 feet minus negative 15 feet, equaling 97 feet msl.

In the absence of historical data, this methodology is meant to estimate historical conditions as closely as possible.

Table 5: New ISW Wells' Drill Date, Perforation, and Groundwater Depth

Well ID	Drill End Date	**Well Perforations** (feet below ground surface)	**Groundwater Depth** (at drill date, feet)	**Ground Surface Elevation** (ft msl)
Well A	11/15/2022	14 – 31.5	15	
Well B	11/16/2022	25 – 35	50.5	
Well C	11/17/2022	15 – 30	16	94.4
Well E	11/21/2022	35 – 50	51.5	89
Well G	11/18/2022	26 – 41	26	214.5
Delta Well	8/23/2024	125 – 150, 275 – 300	11.4 – Shallow 28.2 – Deep	

ft msl – feet mean sea level

6.3 2024 Amended GSP ISW SMCs

The ISW SMCs, including the Minimum Thresholds, Measurable Objectives, and Interim Milestones, are summarized below in **Table 6**. As previously discussed, SMCs for new ISW RMN wells will be established after a minimum of four years of groundwater level data have been collected. The ISW SMCs for wells with historical groundwater level data available are the same as the chronic lowering of groundwater level SMCs for the same wells; these SMCs have been shown to protective of connected surface waters and will not result in significant and unreasonable undesirable impacts for stream depletions, as described in Section 6.1.

Table 6: ISW SMCs

Well ID	Minimum Threshold (ft msl)	Measurable Objective (ft msl)	Interim Milestones (ft msl)		
			2025	2030	2035
Well A	New well – need to collect data				
Well B	New well – need to collect data				
Well C	New well – need to collect data				
Well E	New well – need to collect data				
Well G	New well – need to collect data				
Delta Well	New well – need to collect data				
04N05E36H003	-31.1	-5.1	-5.1	-5.1	-5.1
Swenson-3	-26.6	-19.3	-19.3	-19.3	-19.3
Frankenheimer (01S10E26J001M)	43.7	81.7	81.7	81.7	81.7
Burnett (OID-4)	60.8	79.7	79.7	79.7	79.7
02S07E31N001	0.8	12.3	13.8	13.8	13.1
02S08E08A001	0.6	24	22.2	22.2	23.1

ft msl = feet mean sea level

7. CONCLUSIONS AND NEXT STEPS

The Eastern San Joaquin Subbasin GSAs are making significant progress on improving the understanding of and proactively managing interconnected surface waters and stream depletions. This technical memorandum summarizes a robust analysis of stream-aquifer interactions conducted using the existing modeling toolset, given the absence of DWR guidance on the subject. The GSAs are continuing to work towards filling ISW data gaps, including the recent construction of six new monitoring wells that are included in the ISW RMN. Additionally, the recalibration and introduction of a new shallow alluvium stratigraphic layer in ESJWRM supports a better analysis of stream-aquifer interconnectivity.

The 2024 Amended GSP includes a dedicated ISW RMN (Chapter 4 of the Amended GSP). The SMCs for new ISW-specific wells will be developed after at least four years of groundwater level observations have been collected. The SMCs for existing wells draw upon existing thresholds from the chronic lowering of groundwater levels sustainability criterion. Groundwater level SMCs have been shown to be protective of groundwater dependent ecosystems and domestic wells, and this report reveals that they are also protective of stream depletions. Streams that are 75 percent connected historically and in Water Year 2015 remain connected in a hypothetical model scenario that artificially lowers groundwater levels to minimum thresholds. When groundwater levels lower to minimum thresholds, there are additional stream losses, especially on the Mokelumne River and Stanislaus River. However, as a percentage of streamflow, they are generally equal to or less than historical or 2015 conditions in all seasons.

Next steps for the Subbasin GSAs include engaging with entities to improve the understanding of impacts on beneficial users of interconnected surface waters, additional data collection for existing and new wells, possible revisions of the ISW SMCs following release of DWR guidance documents on the subject, and refining the ESJWRM and analyses based on newly collected data to reevaluate the ISW undesirable result and SMCs in the next 5-year Periodic Evaluation in 2030.

8. REFERENCES

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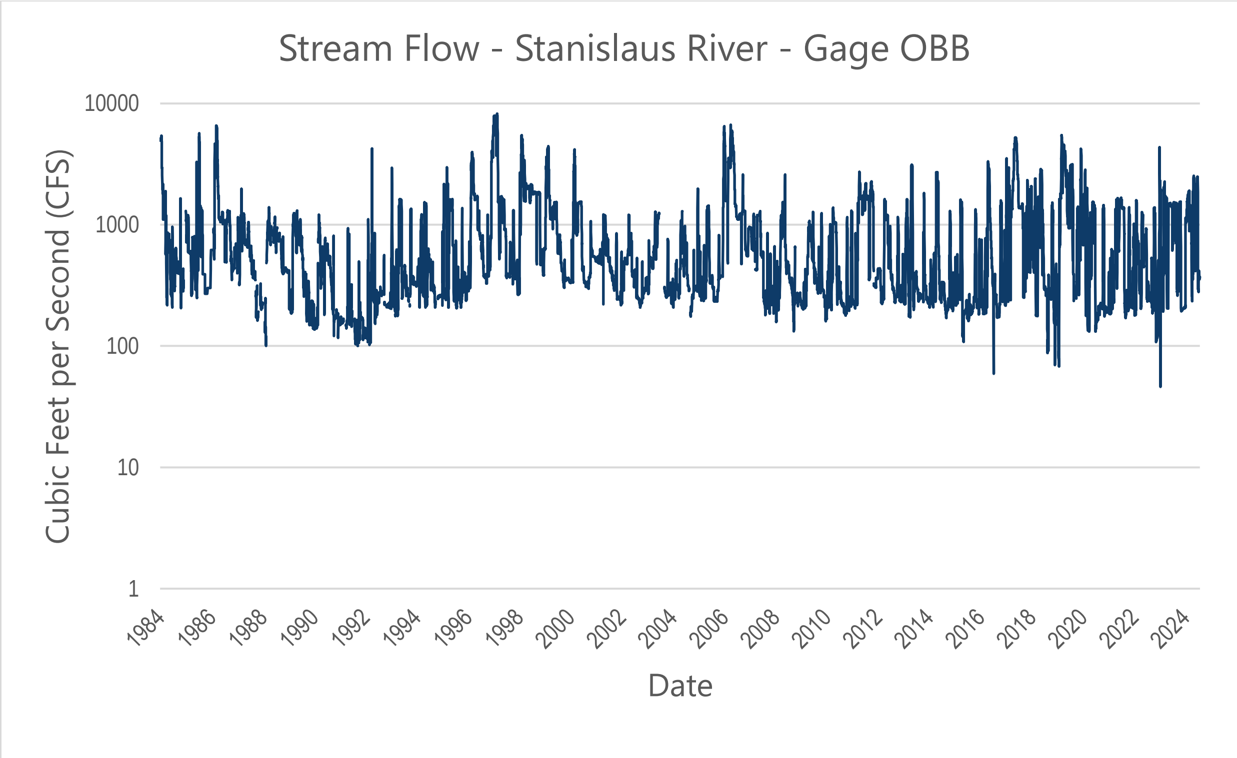
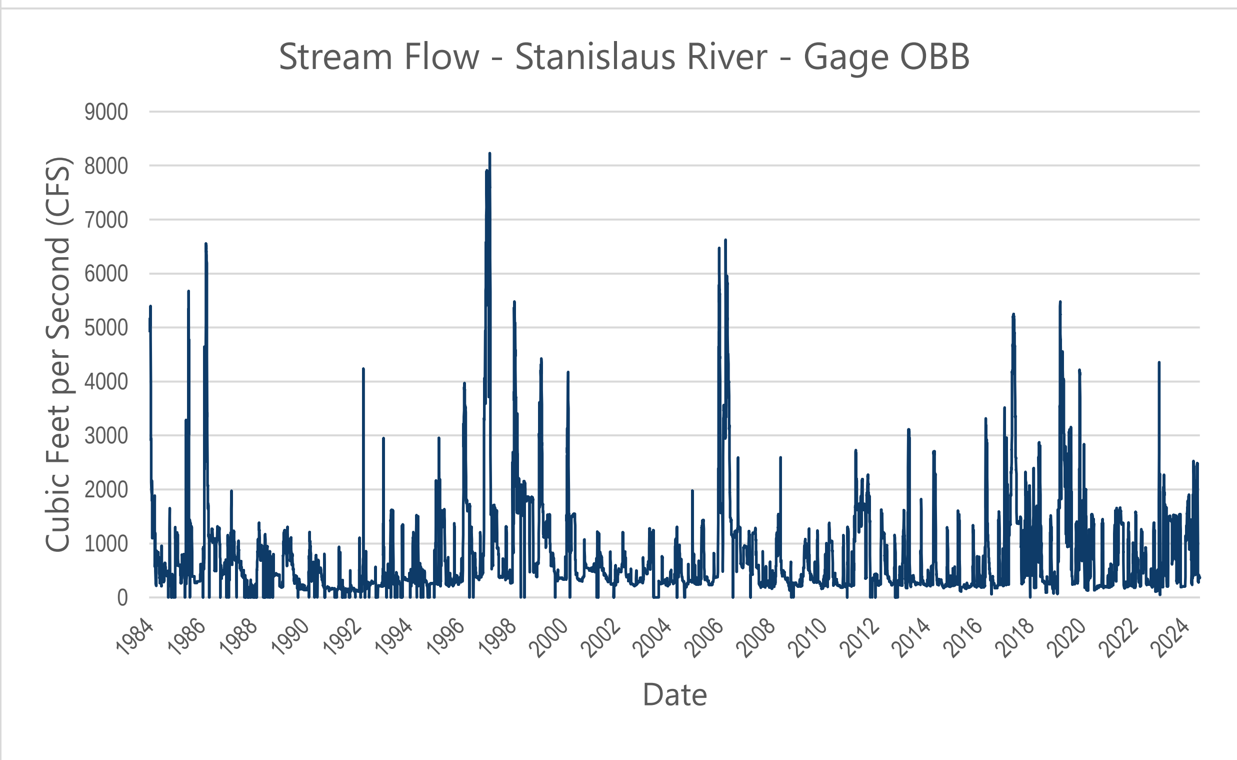
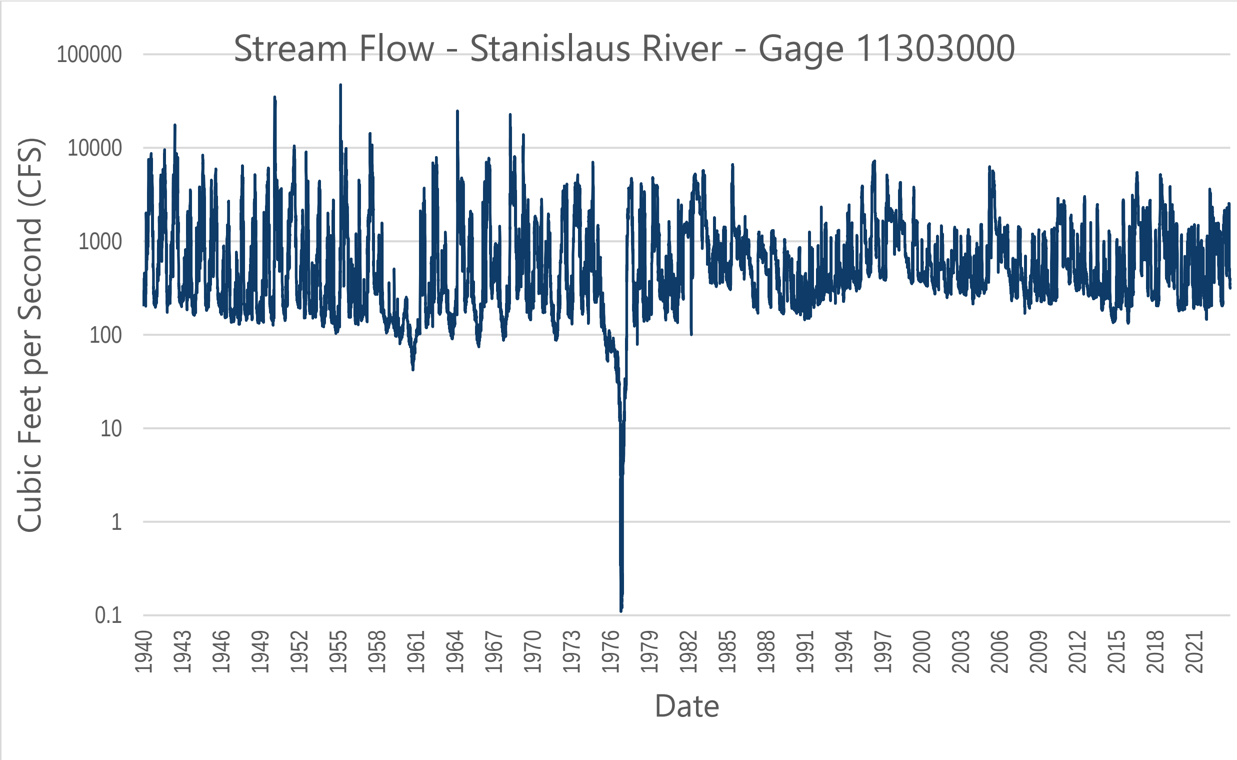
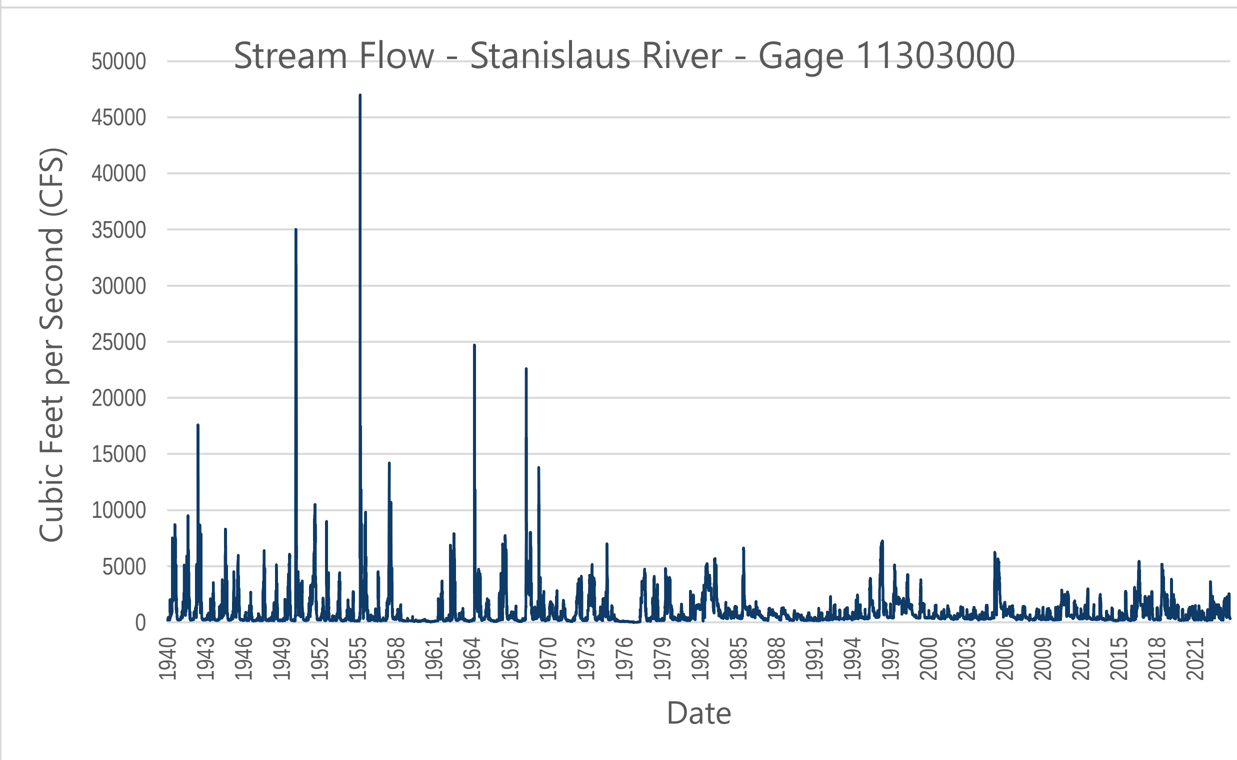
ATTACHMENT 1 – DAILY STREAMFLOW AT MAJOR STREAM GAGES IN ESJ SUBBASIN

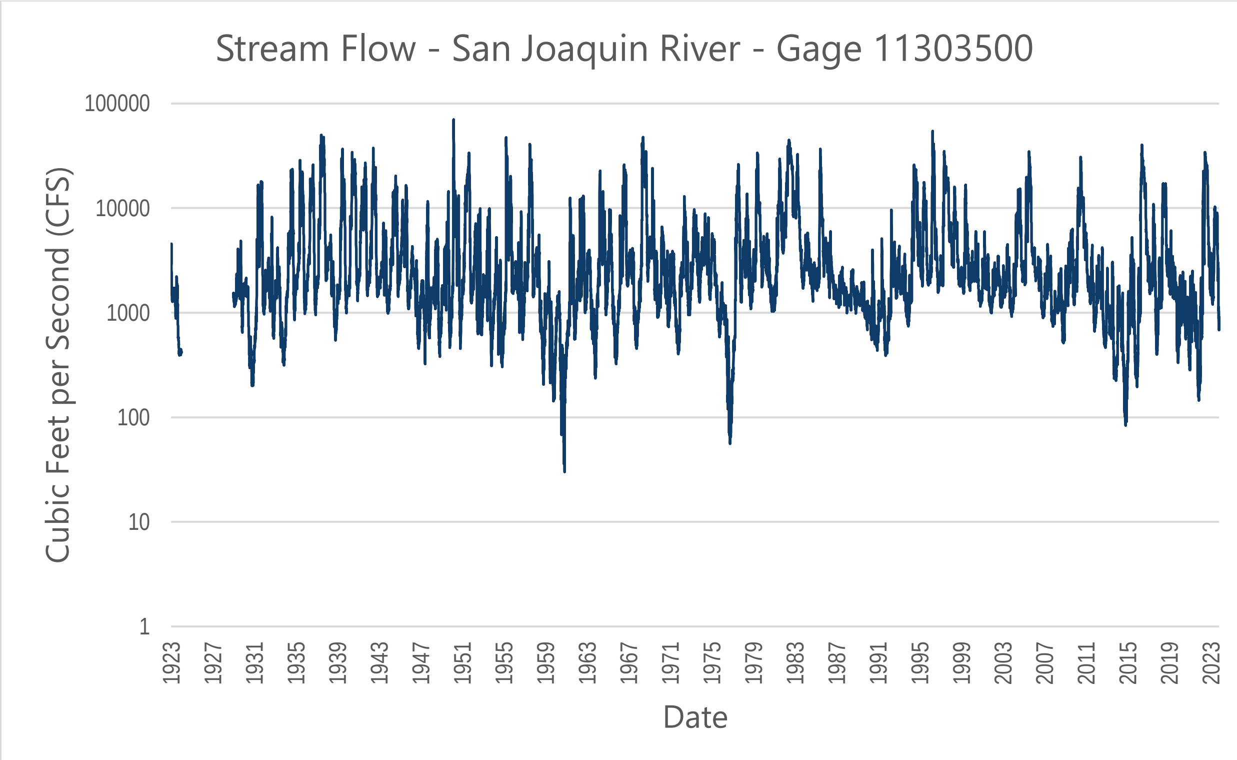

Stream Flow - Stanislaus River - Gage OBB
Cubic Feet per Second (CFS)
10000
1000
100
10
1
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
Date


Stream Flow - Stanislaus River - Gage OBB
Cubic Feet per Second (CFS)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
Date

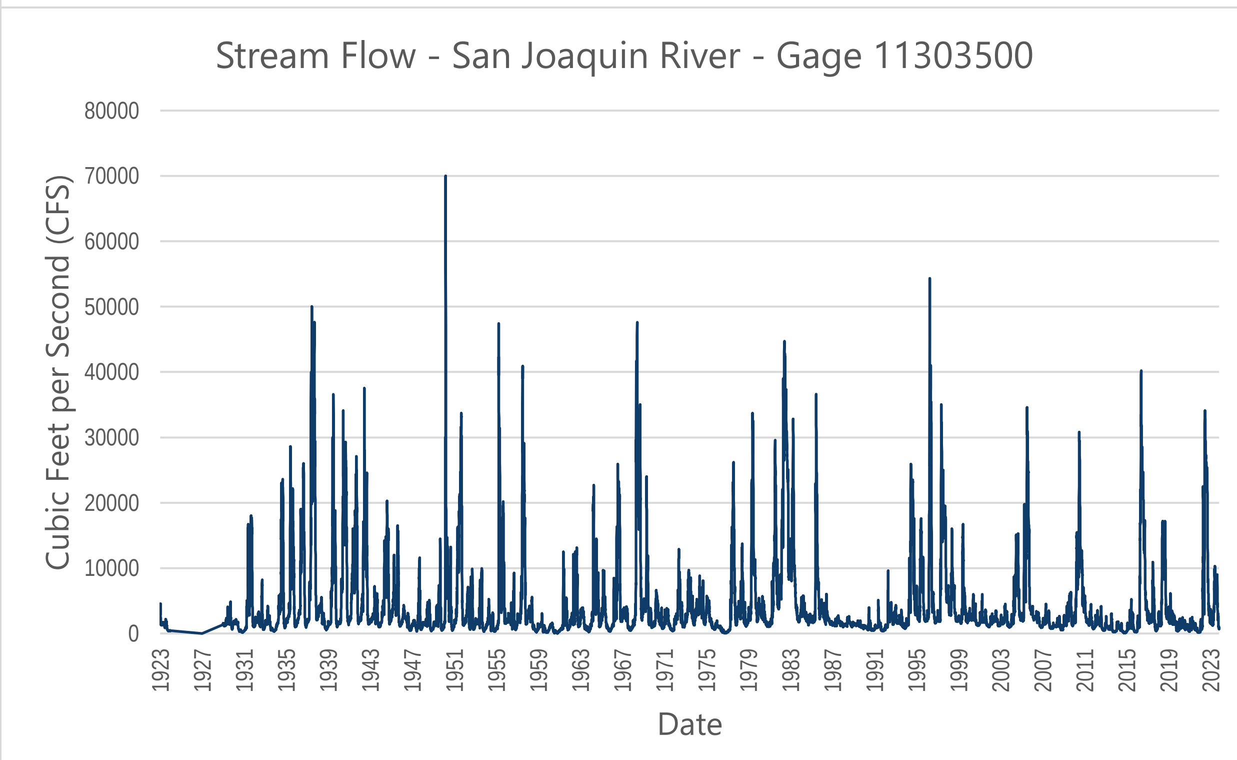
ATTACHMENT 2





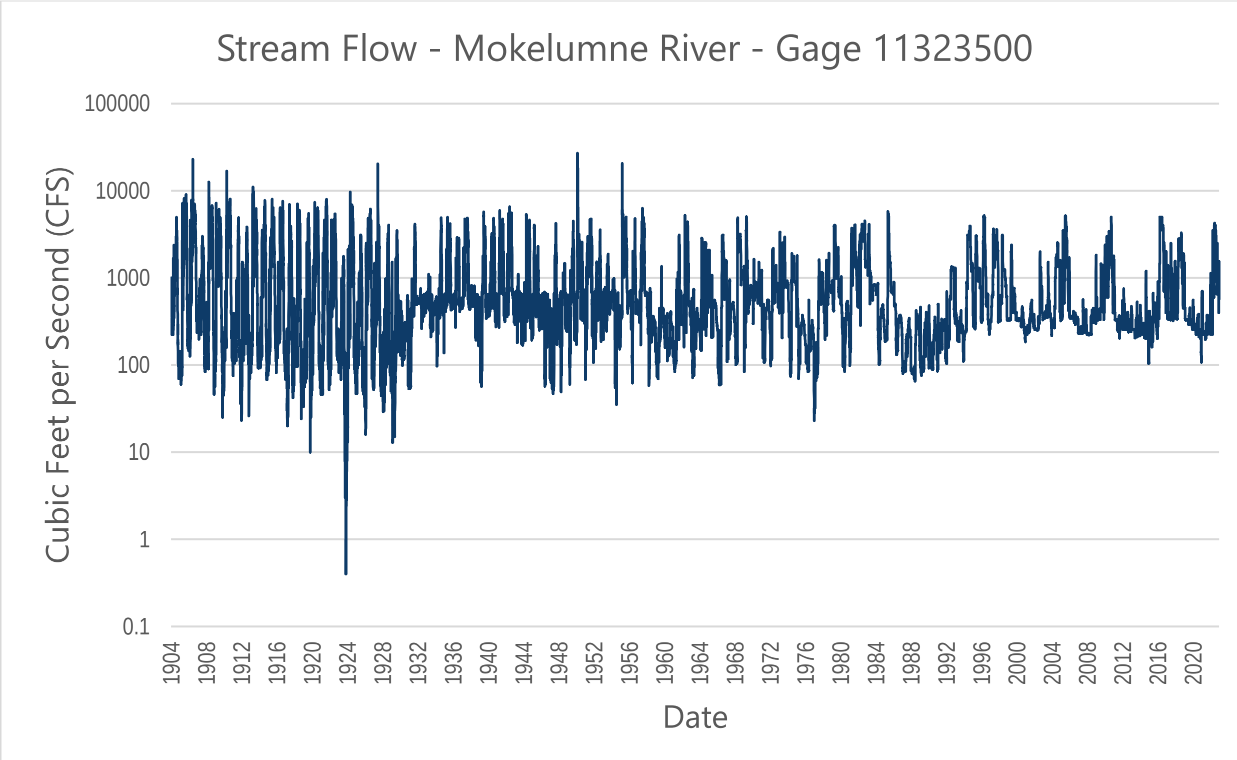


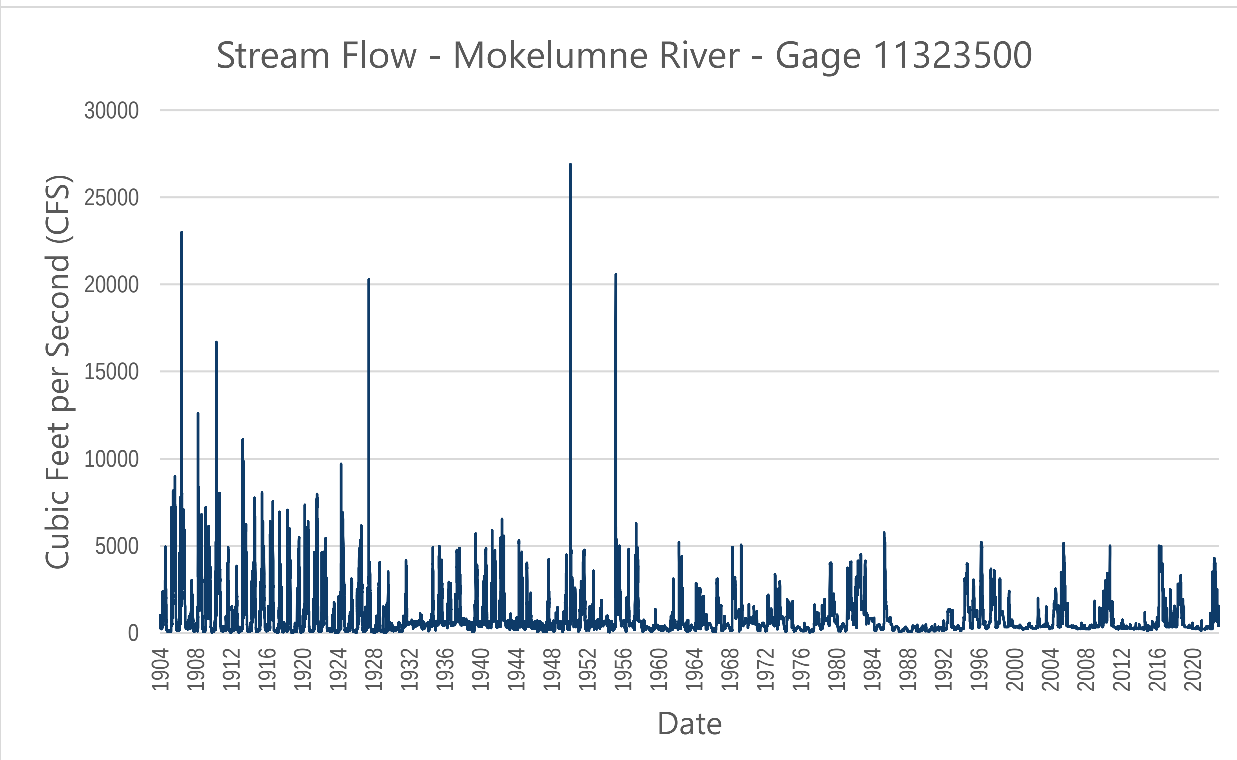
Stream Flow - San Joaquin River - Gage 11303500
Cubic Feet per Second (CFS)
100000
10000
1000
100
10
1
1923
1927
1931
1935
1939
1943
1947
1951
1955
1959
1963
1967
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
Date

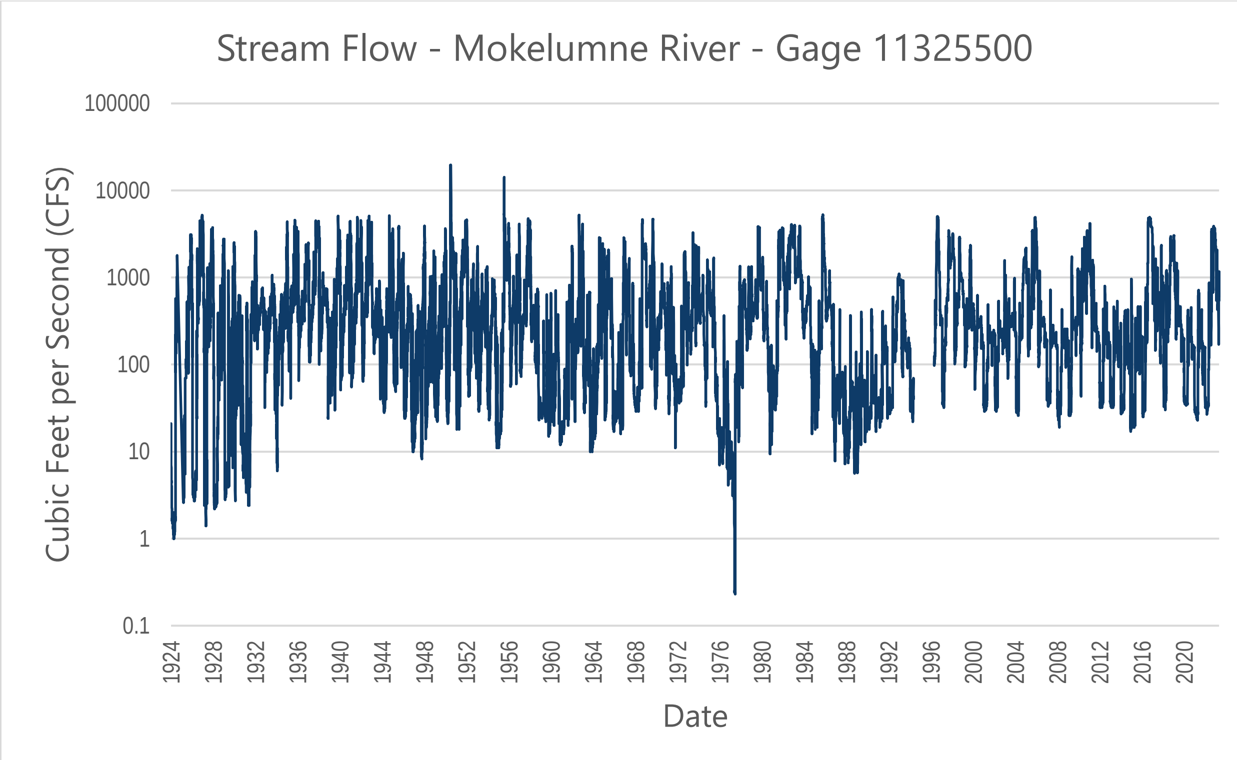


Stream Flow - San Joaquin River - Gage 11303500
Cubic Feet per Second (CFS)
80000
70000
60000
50000
40000
30000
20000
10000
0
1923
1927
1931
1935
1939
1943
1947
1951
1955
1959
1963
1967
1971
1975
1979
1983
1987
1991
1995
1999
2003
2007
2011
2015
2019
2023
Date

ATTACHMENT 2



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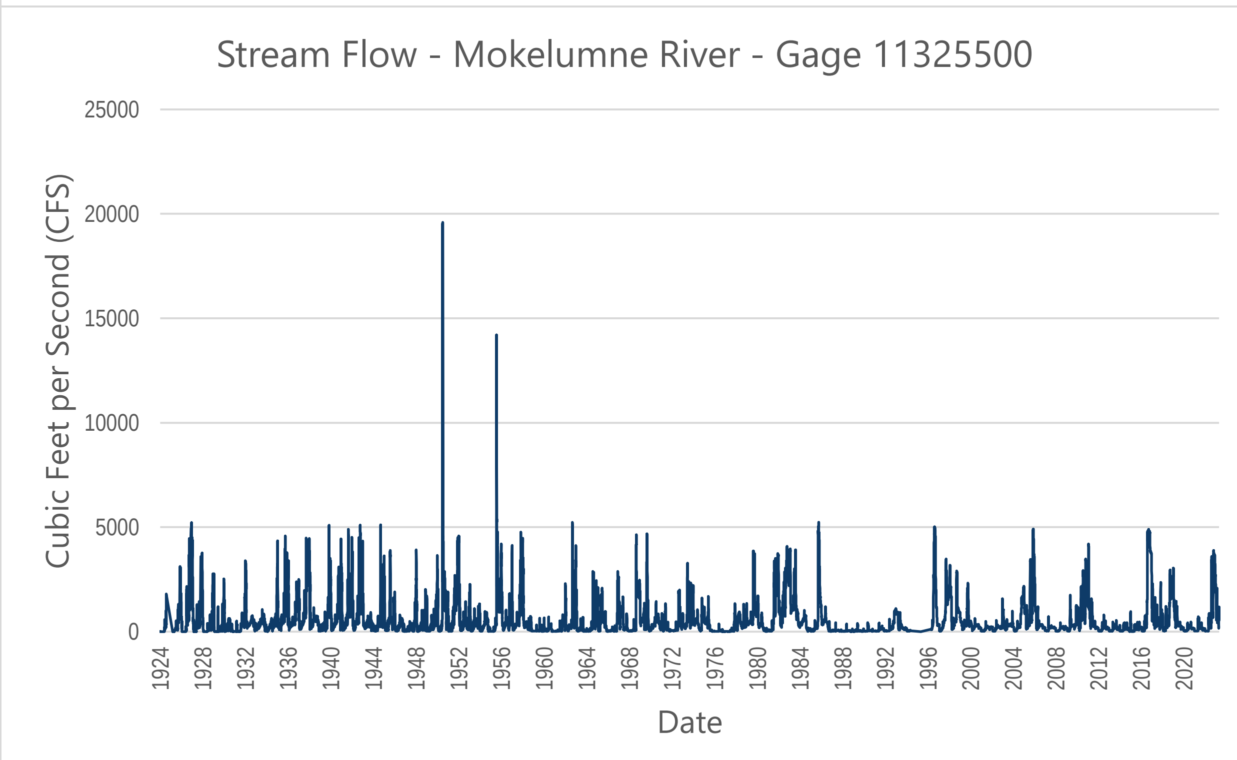
100000
10000
1000
100
10
1
0.1
Cubic Feet per Second (CFS)
1924
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012
2016
2020
Date


Stream Flow - Mokelumne River - Gage 11325500
25000
20000
15000
10000
5000
0
Cubic Feet per Second (CFS)
1924
1928
1932
1936
1940
1944
1948
1952
1956
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1976
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1992
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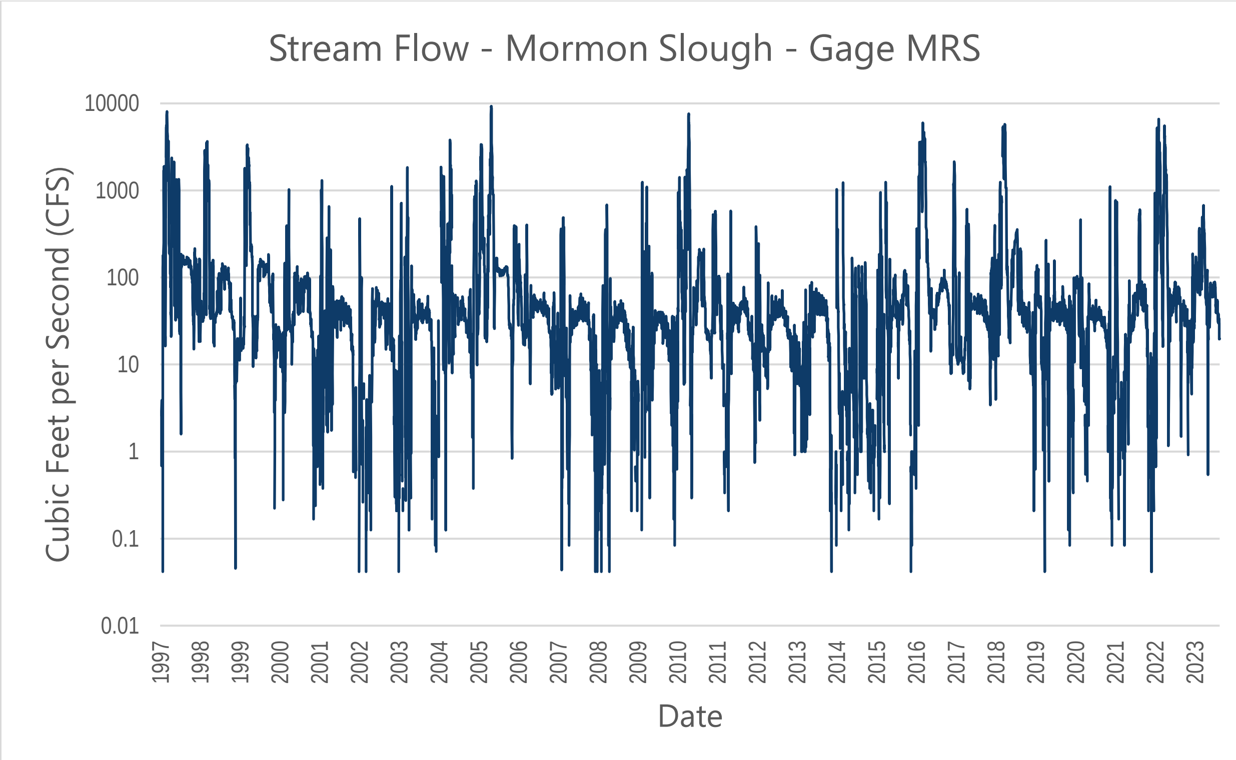
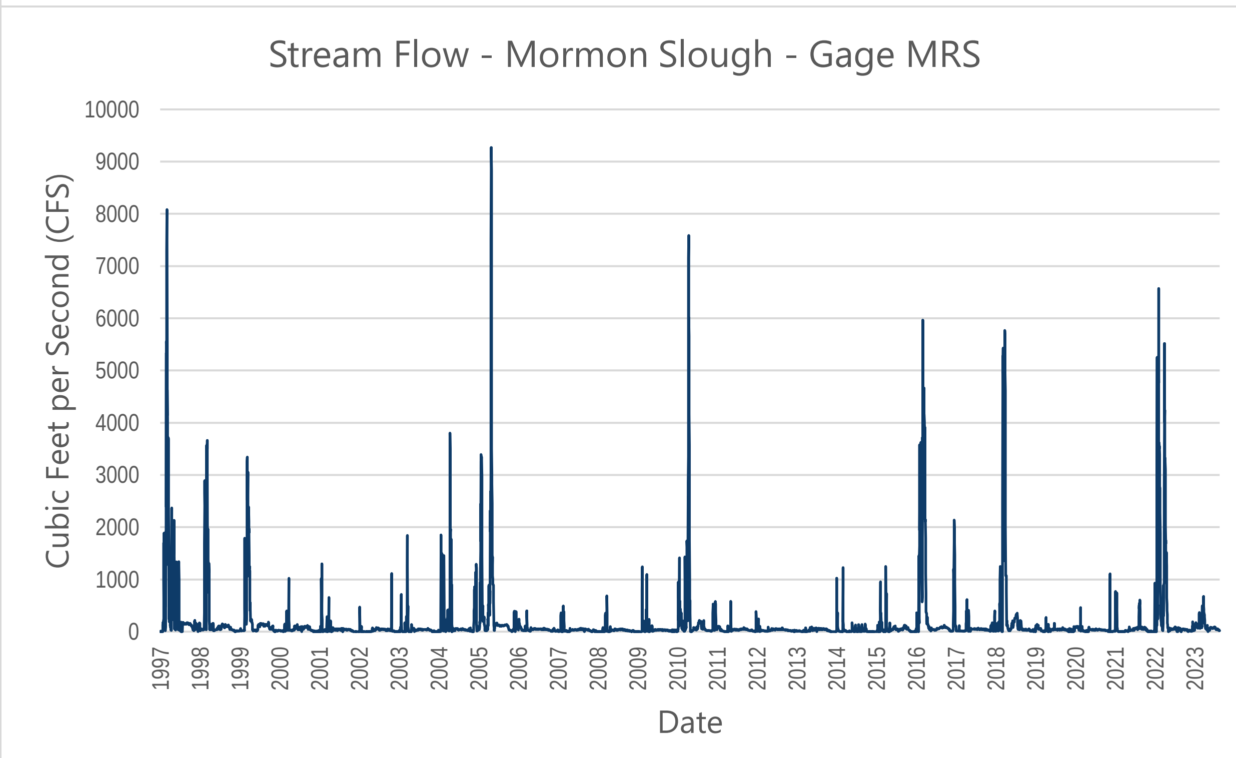
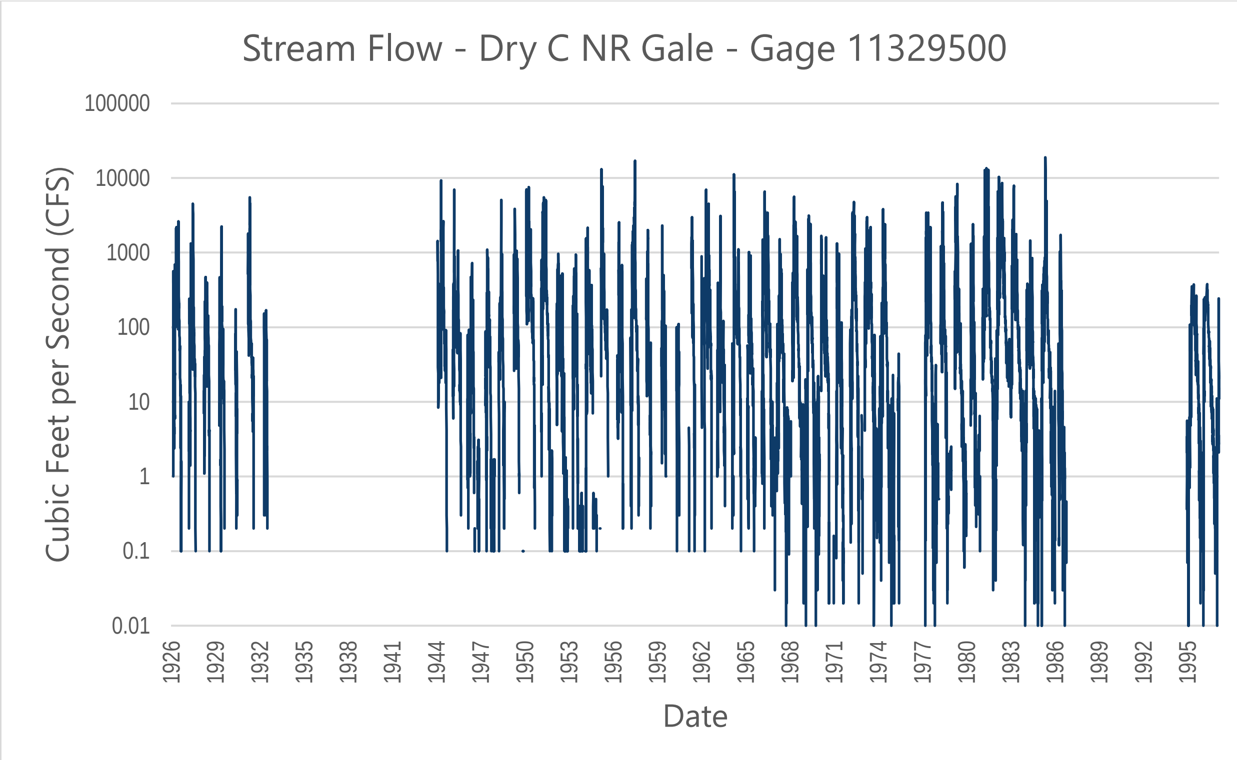
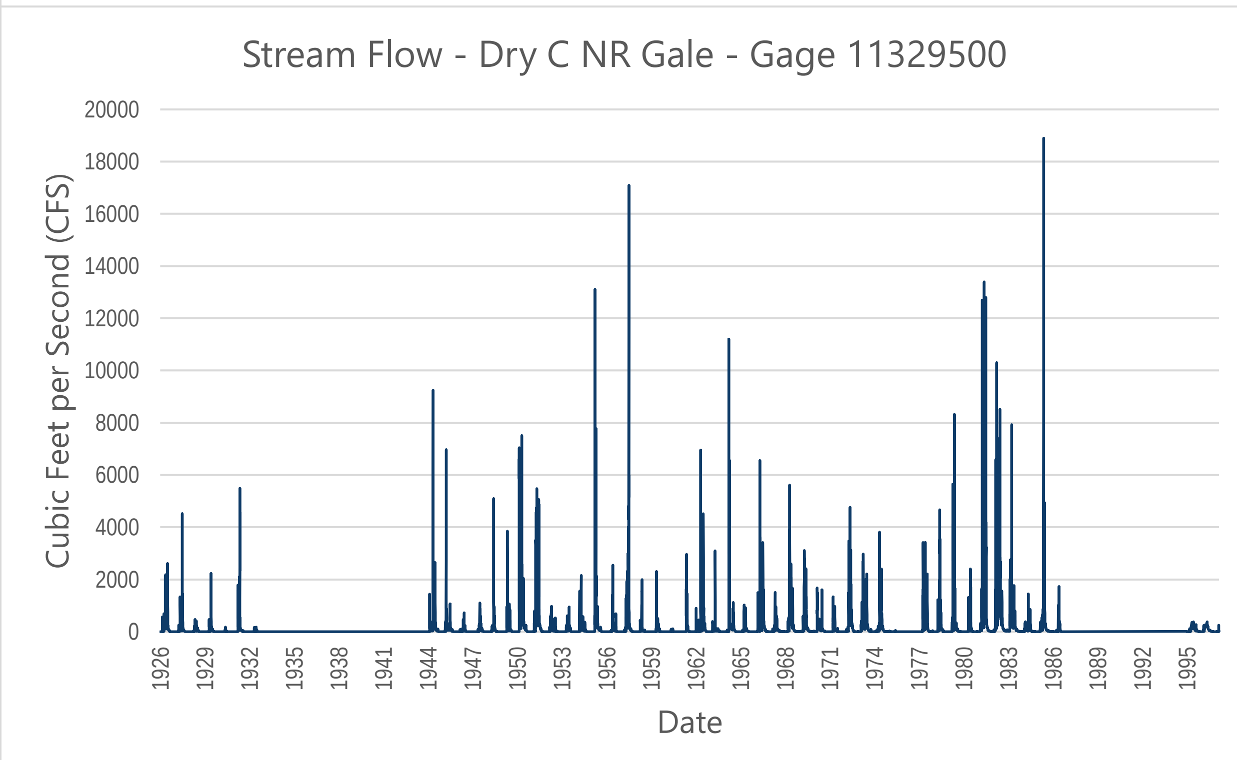
2016
2020
Date

ATTACHMENT 2






Stream Flow - Dry C NR Gale - Gage 11329500
Cubic Feet per Second (CFS)
100000
10000
1000
100
10
1
0.1
0.01
1926
1929
1932
1935
1938
1941
1944
1947
1950
1953
1956
1959
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
Date


Stream Flow - Dry C NR Gale - Gage 11329500
Cubic Feet per Second (CFS)
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1926
1929
1932
1935
1938
1941
1944
1947
1950
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1959
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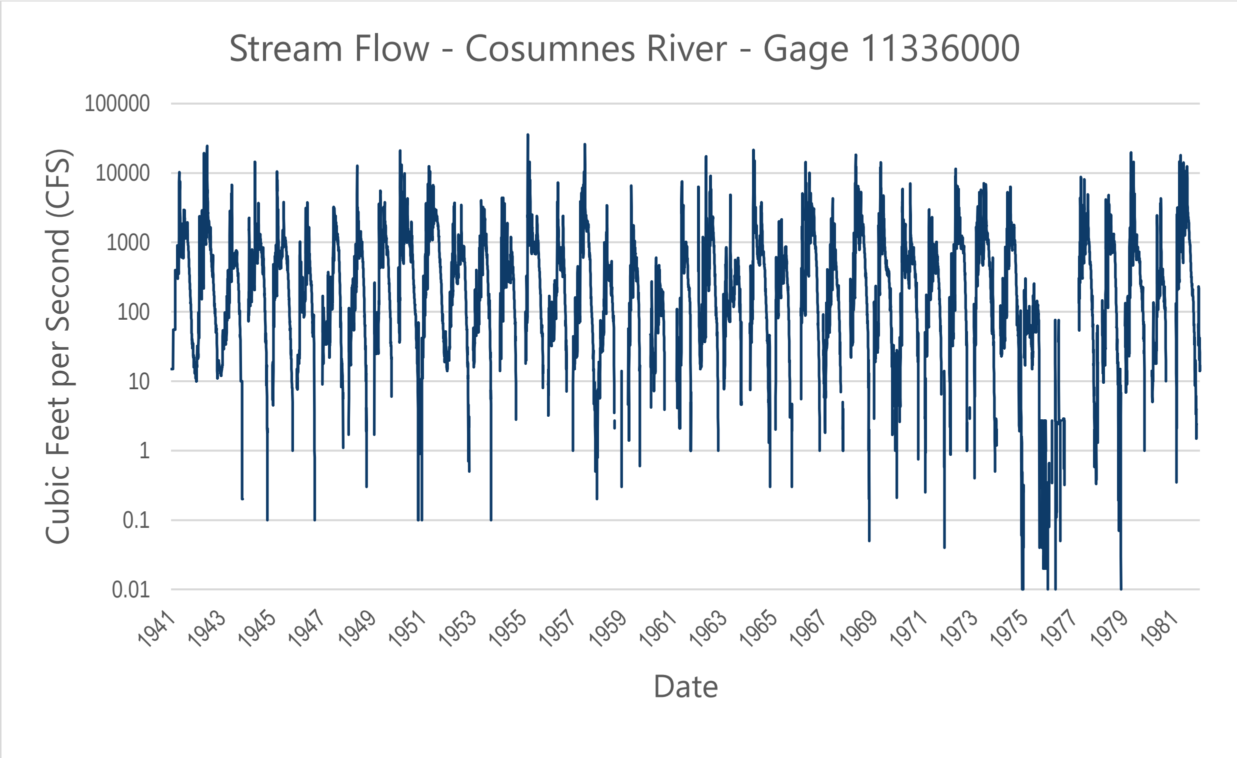
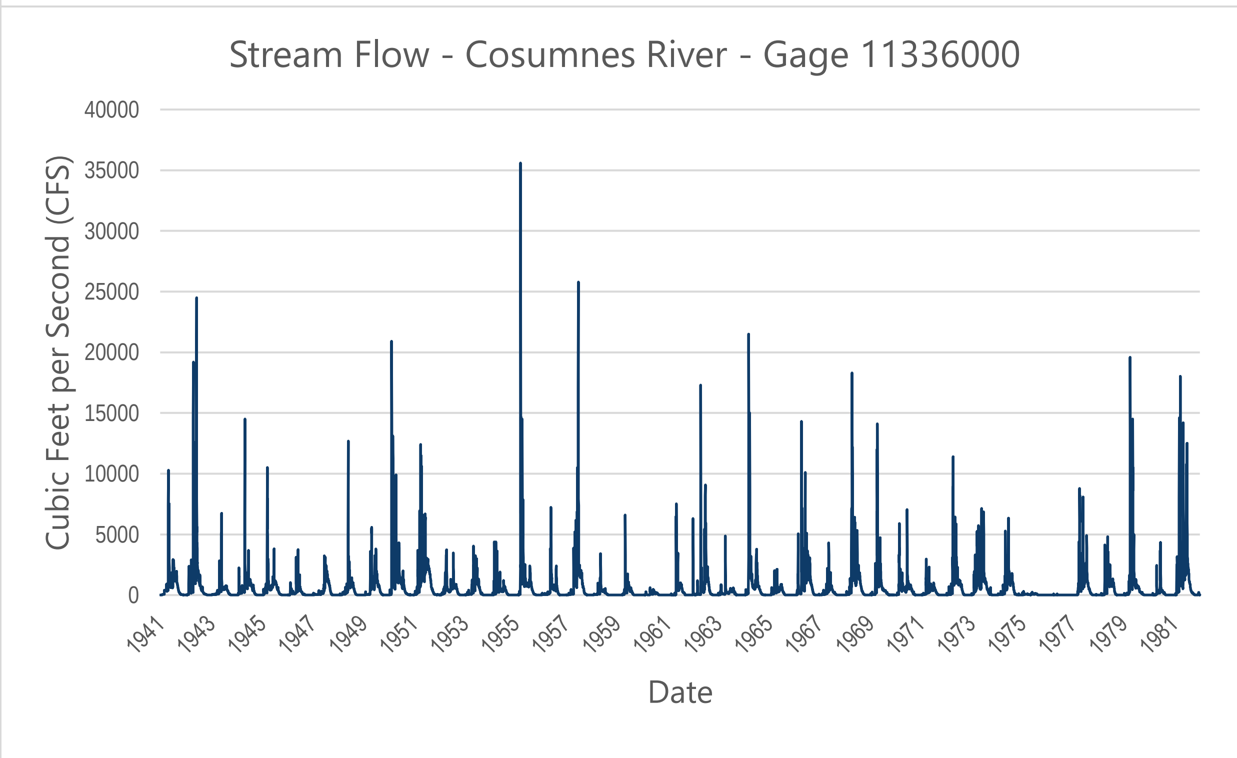
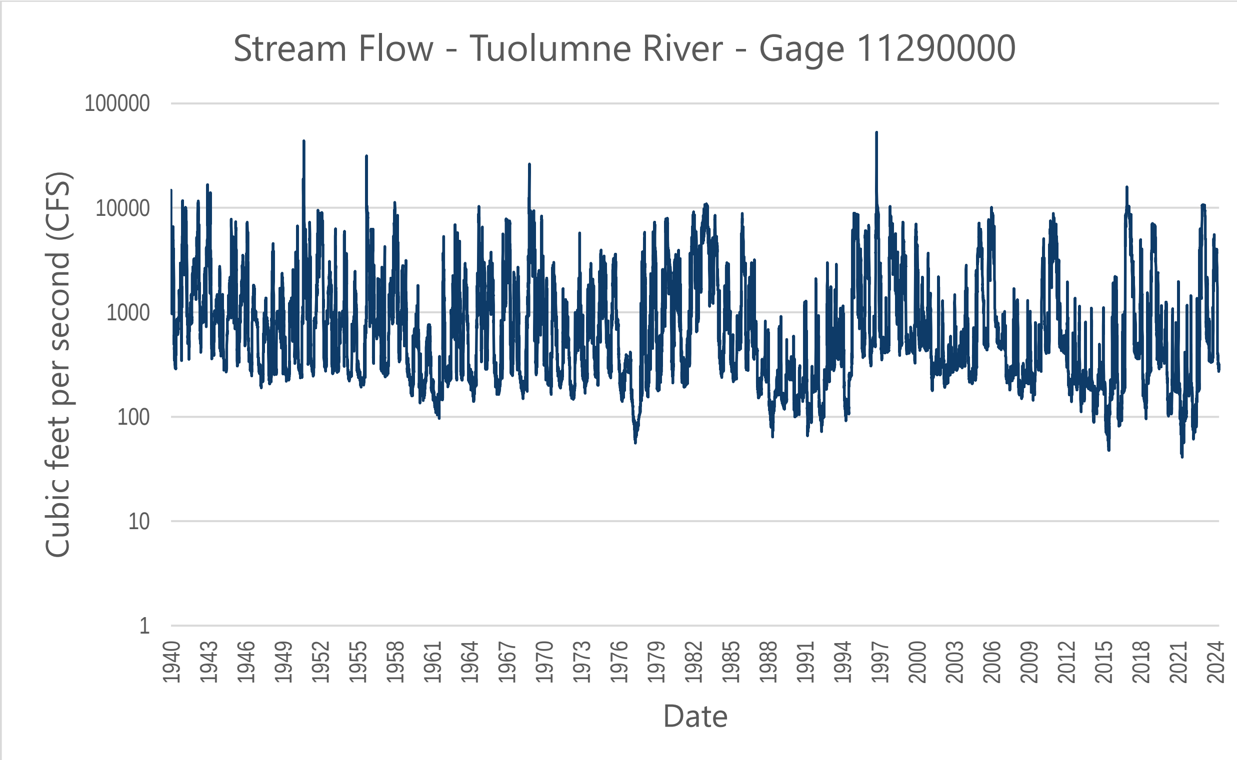
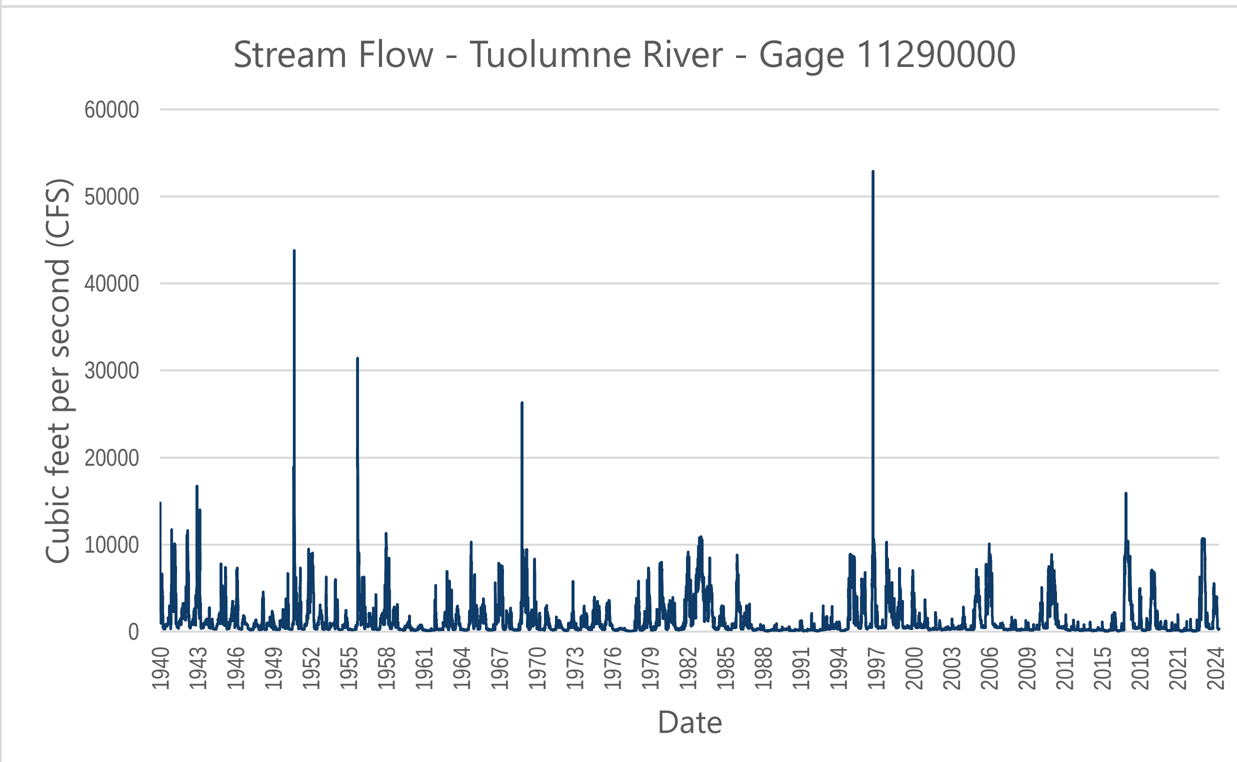
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
Date

ATTACHMENT 2





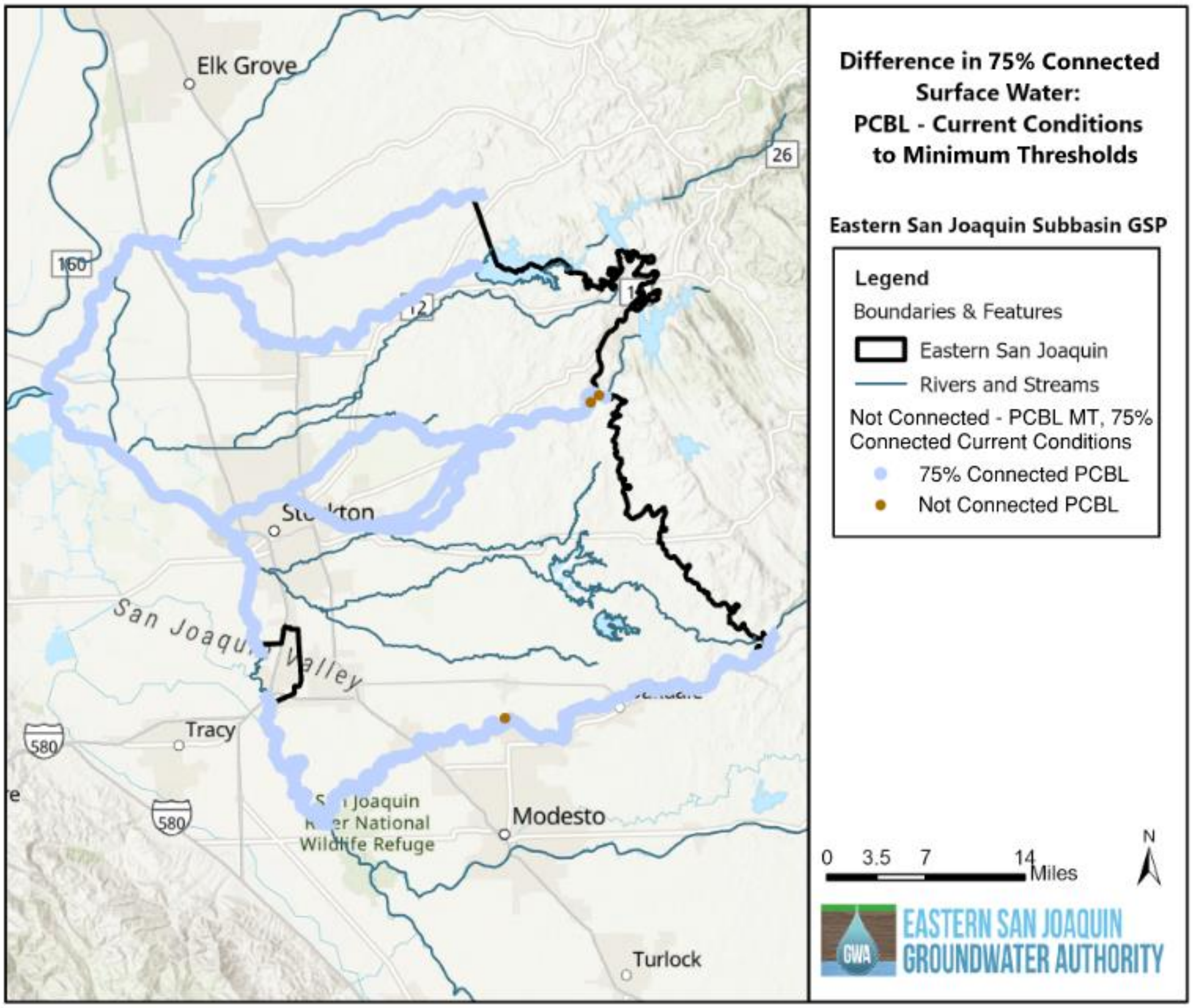

Stream Flow - Tuolumne River - Gage 11290000
100000
10000
1000
100
10
1
Cubic feet per second (CFS)
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024
Date

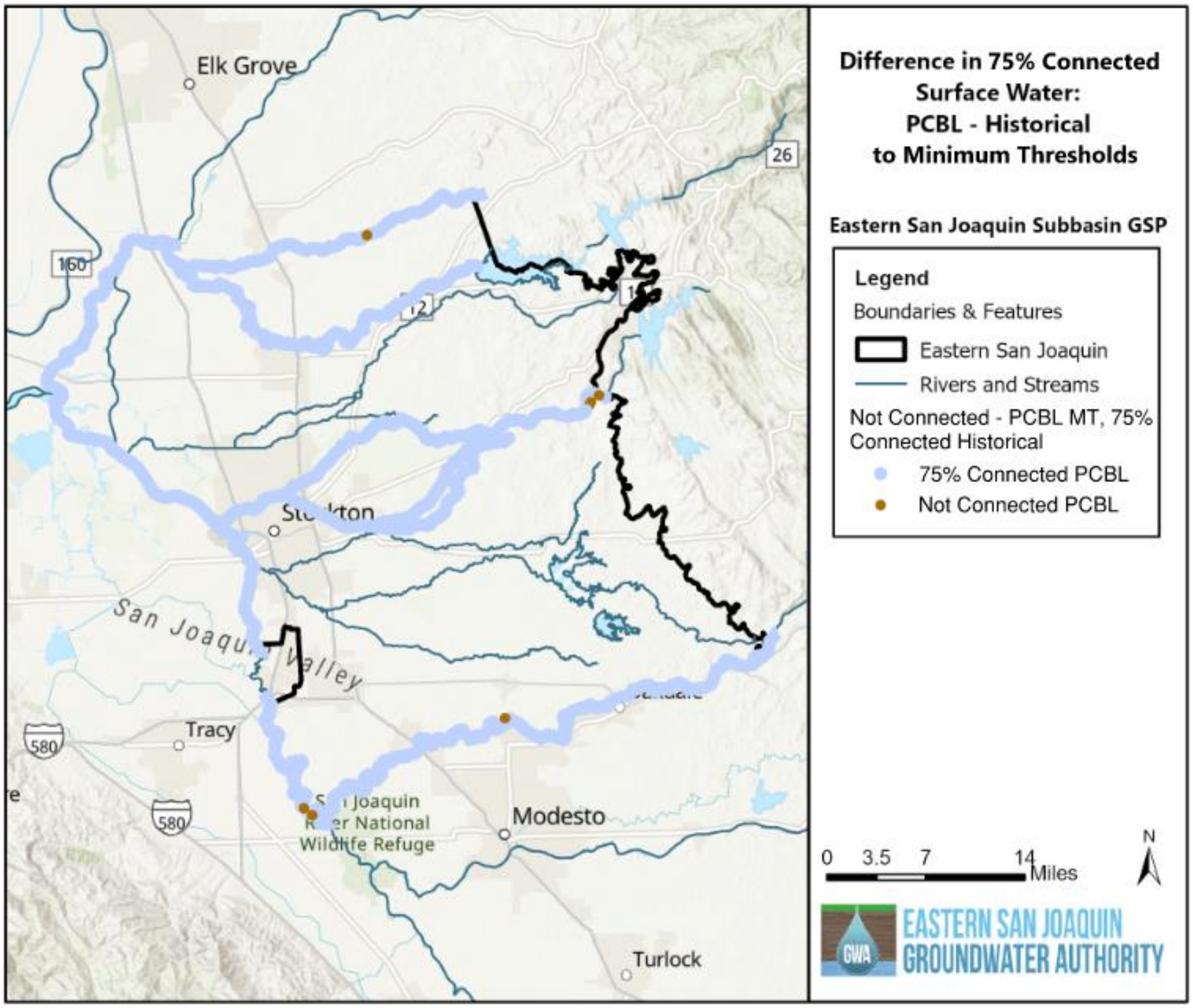

Stream Flow - Tuolumne River - Gage 11290000
60000
50000
40000
30000
20000
10000
0
Cubic feet per second (CFS)
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
2024
Date

ATTACHMENT 2 – TECHNICAL MEMORANDUM: DATA GAP IDENTIFICATION IN THE EASTERN SAN JOAQUIN SUBBASIN

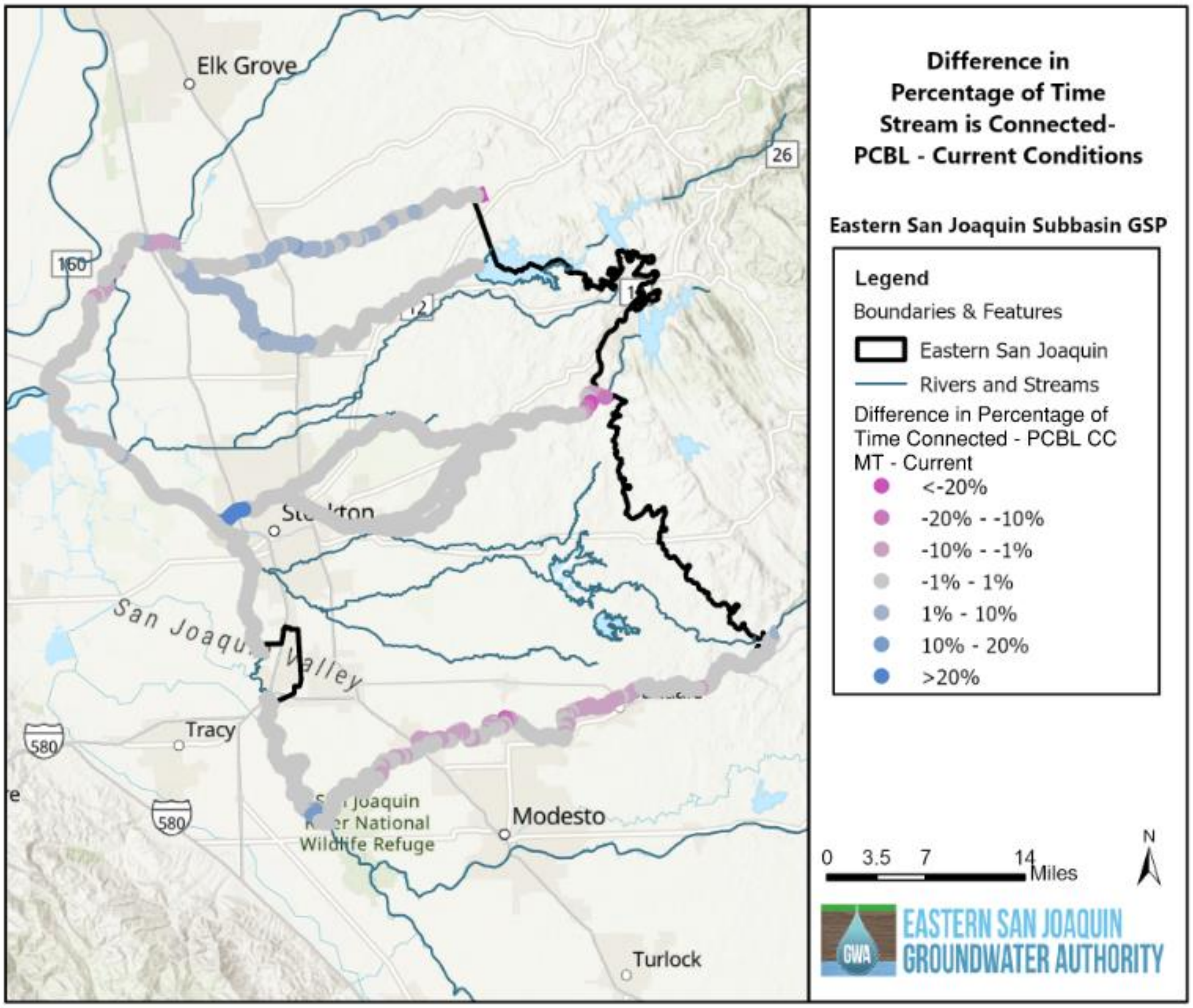
ATTACHMENT 3 – ADDITIONAL MAPS COMPARING STREAM-AQUIFER INTERACTIONS UNDER PROJECTED CONDITIONS BASELINE-MINIMUM THRESHOLDS SCENARIO COMPARED TO HISTORICAL AND CURRENT CONDITIONS

ATTACHMENT 2

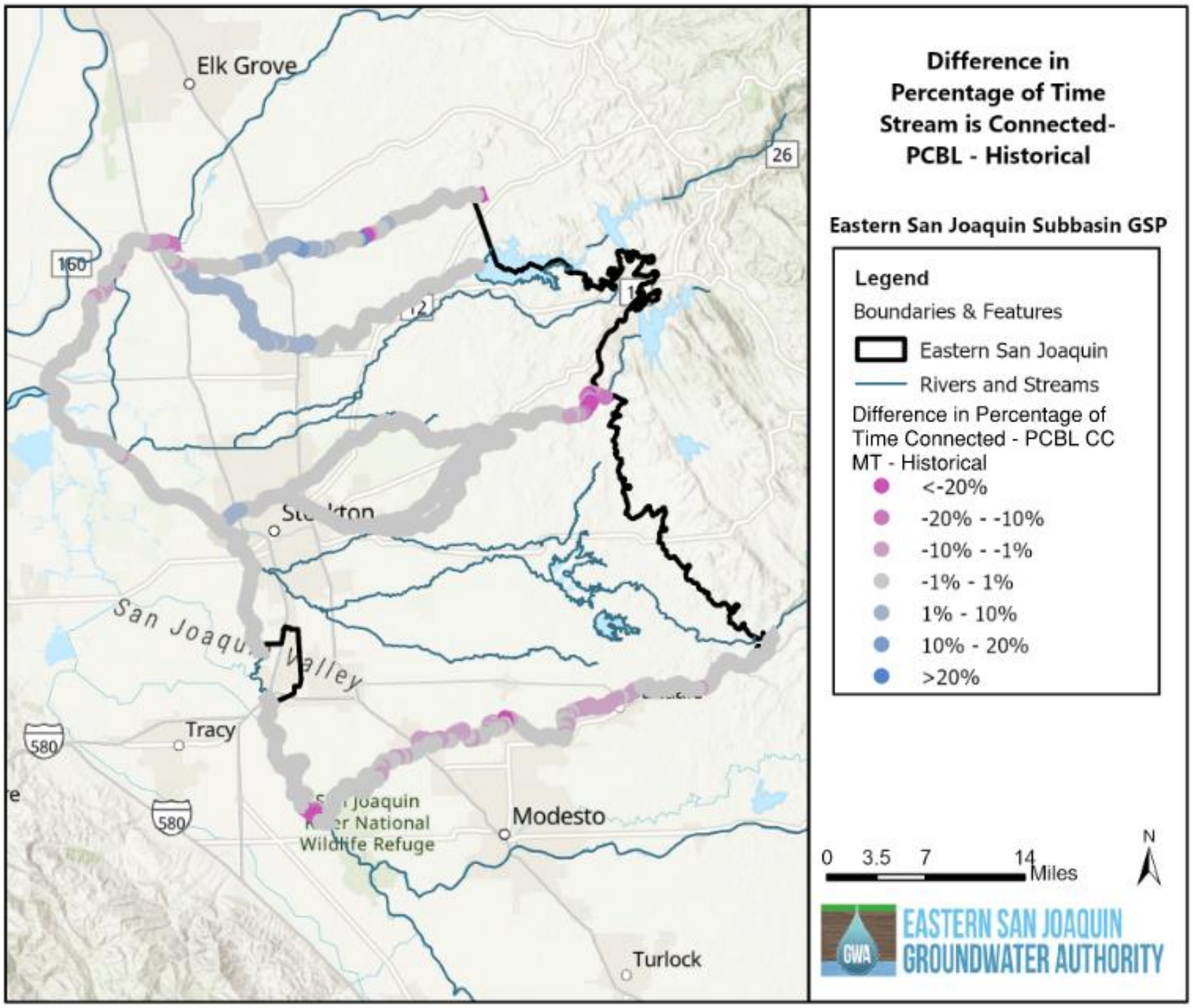



Elk Grove
Stockton
San Joaquin Valley
Tracy
Modesto
Turlock
San Joaquin River National Wildlife Refuge
Difference in 75% Connected Surface Water: PCBL - Historical to Minimum Thresholds
Eastern San Joaquin Subbasin GSP
Legend
Boundaries & Features
Eastern San Joaquin
Rivers and Streams
Not Connected - PCBL MT, 75% Connected Historical
75% Connected PCBL
Not Connected PCBL
0 3.5 7 14 Miles
N
EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

ATTACHMENT 2



ATTACHMENT 2



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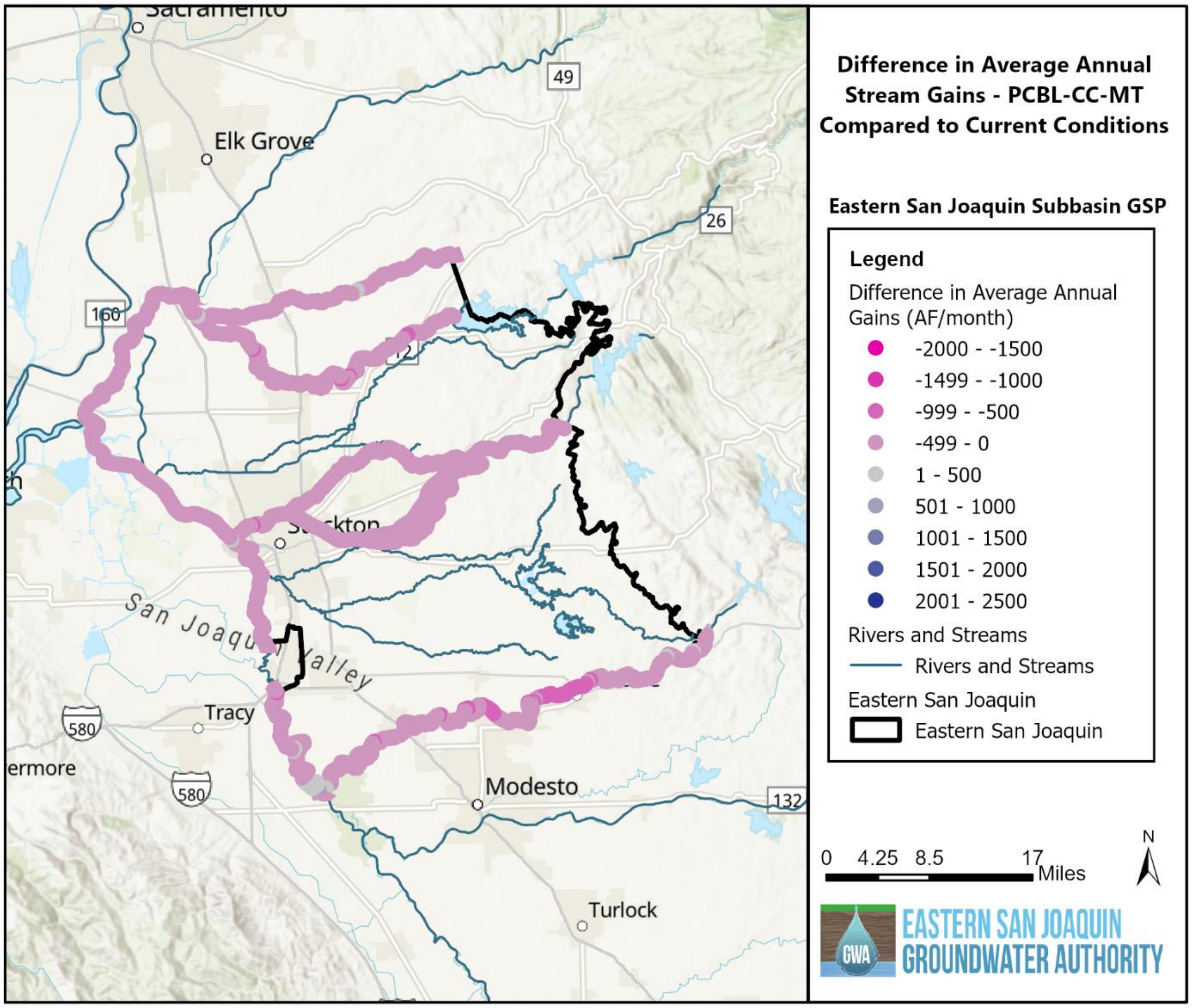
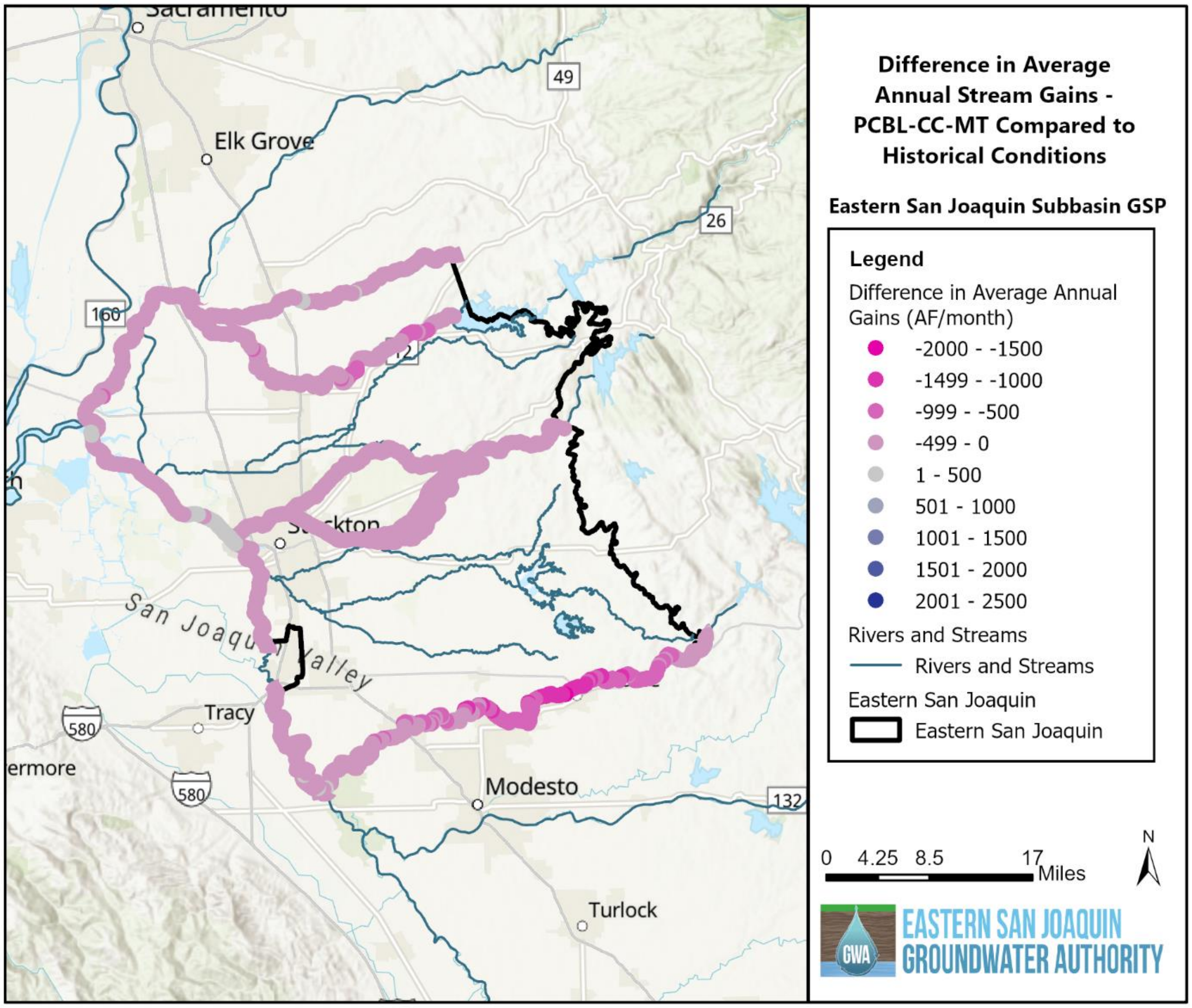


ATTACHMENT 2



APPENDIX 3-H.
SUPPLEMENTAL DATA FOR GROUNDWATER LEVEL MINIMUM THRESHOLDS

ATTACHMENT 2

CASGEM ID	Local ID	GSA Well is Located In	Historical Drought Low (2015) (ft msl)	Total Well Depth (ft bgs)	Calculated Buffer (ft msl)	Depth of 10th Percentile Nearby Domestic Well (ft msl)*	Historical Drought Low + Buffer (ft msl)	Minimum Threshold (ft msl)	Measurable Objectives (ft msl)	Current Condition (2013-2016) (ft msl)
378824N1210000W001	01S09E05H002	Central San Joaquin Water Conservation District	-8.6	256.0	54.3	-49.8	-62.9	-49.8	-8.6	-8.7
379316N1211665W001	01N07E14J002	Central San Joaquin Water Conservation District	-49.9	176.0	44.0	-129.0	-93.9	-93.9	-49.9	-49.9
Not in CASGEM	Lodi City Well #2	City of Lodi	0.6	No Data	35.0	-56.3	-34.4	-34.4	0.6	0.6
Not in CASGEM	Manteca 18	City of Manteca	2.8	No Data	21.8	-58.2	-19.0	-19.0	2.8	9.1
380067N1213458W003	Swenson-3	City of Stockton	-19.3	204.0	7.3	-97.4	-26.6	-26.6	-19.3	-19.3
378163N1208321W001	01S10E26J001M	Eastside San Joaquin GSA	81.7	No Data	38.0	0.0	43.7	43.7	81.7	81.7
378846N1208816W001	01S10E04C001M	Eastside San Joaquin GSA	76.4	No Data	21.7	0.0	54.7	54.7	76.4	78.0
380206N1210943W001	02N08E15M002	Linden County Water District	-63.2	403.0	74.5	-124.1	-137.7	-124.1	-63.2	-63.2
Not in CASGEM	#3 Bear Creek	Lockeford Community Services District	-51.8	No Data	22.0	-122.9	-73.8	-73.8	-51.8	-49.3
381843N1212261W001	04N07E20H003M	North San Joaquin Water Conservation District	-35.5	180.0	45.0	-110.3	-80.5	-80.5	-35.5	-35.5
380909N1212153W001	03N07E21L003	North San Joaquin Water Conservation District	-51.5	No Data	42.5	-109.4	-94.0	-94.0	-51.5	-51.5
382345N1212261W001 - 06	NSJWCD-01	North San Joaquin Water Conservation District	NA	1255.0	NA	NA	NA	NA	NA	NA
Not in CASGEM	Hirschfeld (OID-8)	Oakdale Irrigation District	31.5	No Data	23.6	-11.5	7.9	7.9	31.5	31.5
377909N1208675W001	Burnett (OID-4)	Oakdale Irrigation District	79.7	249.0	18.9	28.2	60.8	60.8	79.7	79.7
377136N1212508W001	02S07E31N001	South Delta Water Agency	12.3	226.0	11.5	-62.5	0.8	0.8	12.3	13.8
377810N1211142W001	02S08E08A001	South San Joaquin GSA	24.0	180.0	23.4	-42.2	0.6	0.6	24.0	22.2
380578N1212017W001	02N07E03D001	Stockton East Water District	-61.7	484.0	52.0	-122.8	-113.7	-113.7	-61.7	-61.7
379661N1210011W001	01N09E05J001	Stockton East Water District	-22.6	750.0	120.2	-86.8	-142.8	-86.8	-22.6	-20.2
379976N1212308W001	02N07E29B001	Stockton East Water District	-80.4	202.0	60.6	-130.1	-141.0	-130.1	-80.4	-49.8
379794N1211083W001 - 05	SEWD-01	Stockton East Water District	NA	1650.0	NA	NA	NA	NA	NA	NA
381559N1213727W001	04N05E36H003	Woodbridge Irrigation District	-5.1	112.0	26.0	-63.9	-31.1	-31.1	-5.1	-5.1
381317N1213524W001	03N06E05N003	Woodbridge Irrigation District	-14.1	292.0	21.0	-55.3	-35.1	-35.1	-14.1	-14.1
381816N1213723W001	04N05E24J004	Woodbridge Irrigation District	-6.2	190.0	25.0	-65.5	-31.2	-31.2	-6.2	-6.2

*Data source for domestic and municipal well depths is the California DWR Online System for Well Completion Reports (OSWCR) N/A = Not Applicable

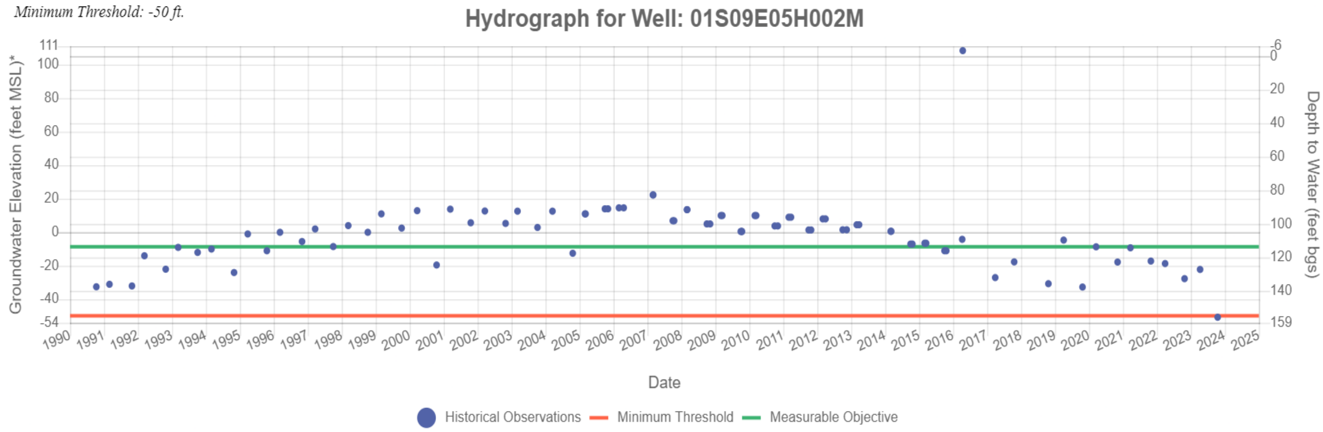
EASTERN SAN JOAQUIN GROUNDWATER AUTHORITY

ATTACHMENT 2

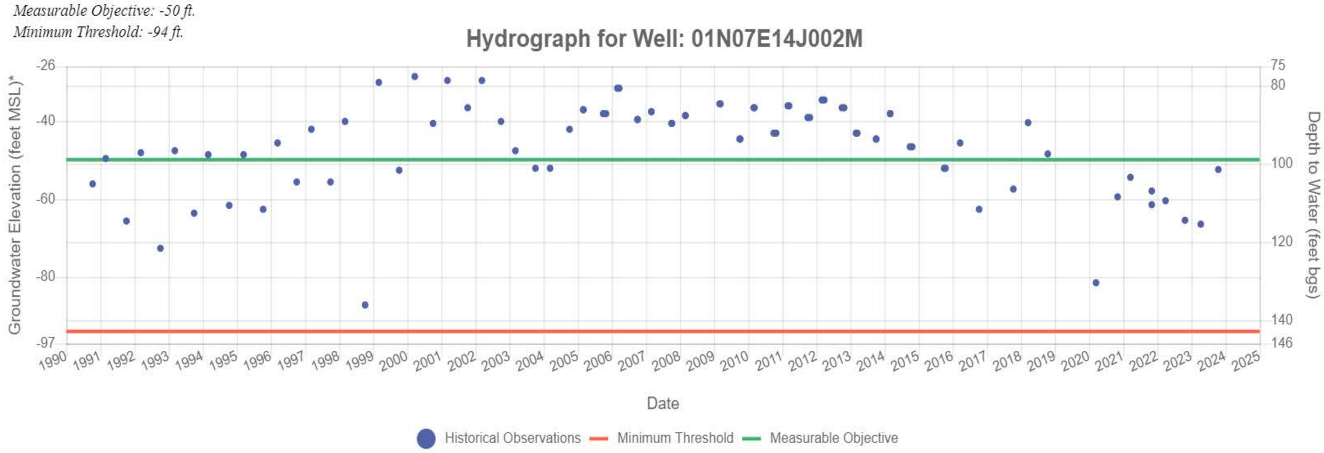
APPENDIX 3-I.
HYDROGRAPHS SHOWING GROUNDWATER MINIMUM THRESHOLDS AND MEASURABLE OBJECTIVES

ATTACHMENT 2

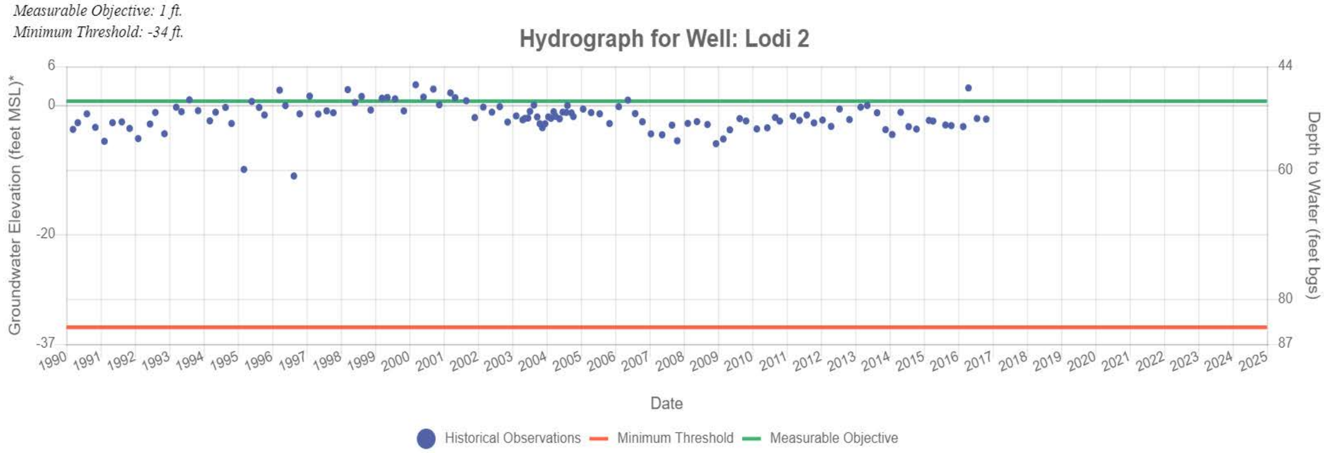
Ground Surface Elevation: 105 ft.
Measurable Objective: -9 ft.
Minimum Threshold: -50 ft.



Ground Surface Elevation: 50 ft.
Measurable Objective: -50 ft.
Minimum Threshold: -94 ft.

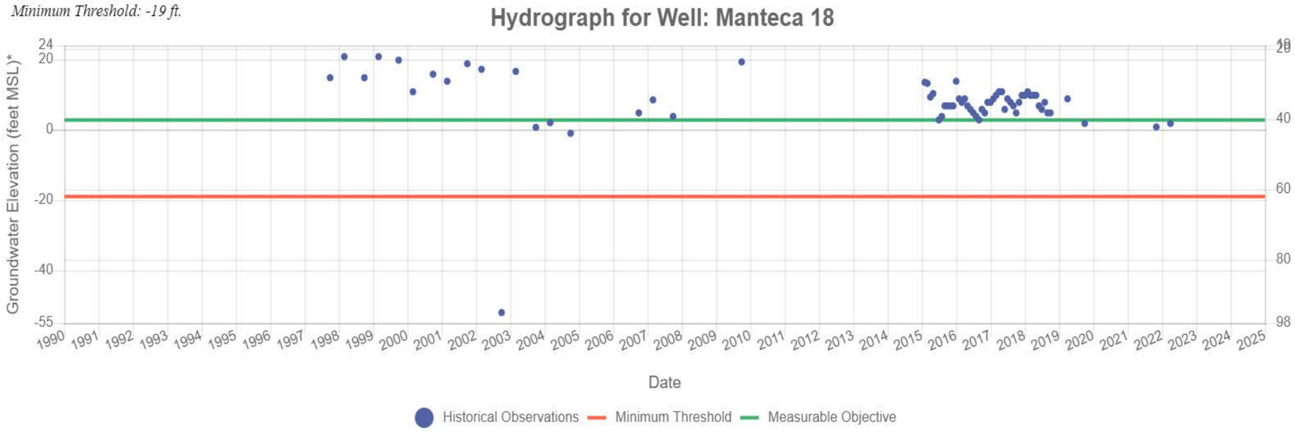


Ground Surface Elevation: 51 ft.
Measurable Objective: 1 ft.
Minimum Threshold: -34 ft.

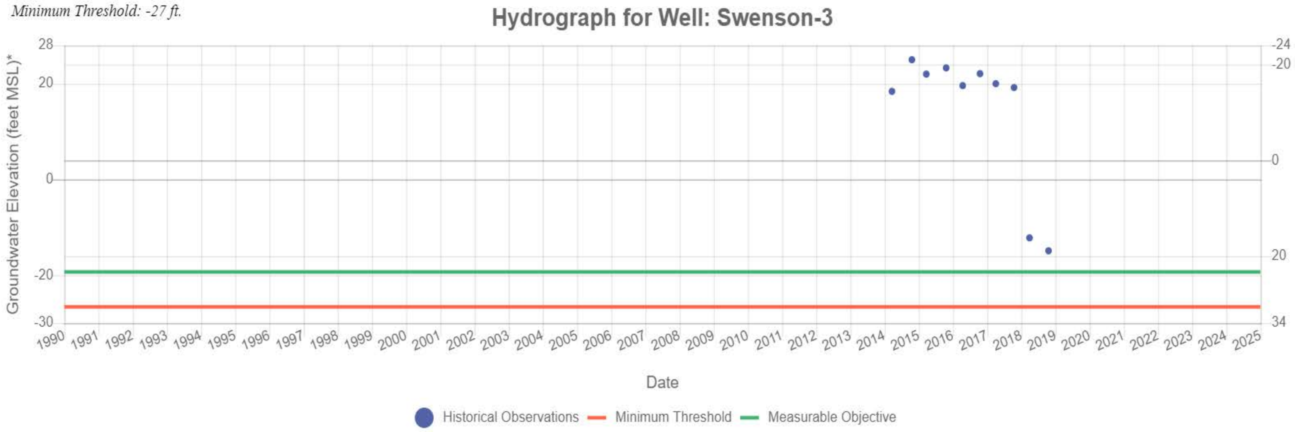


ATTACHMENT 2

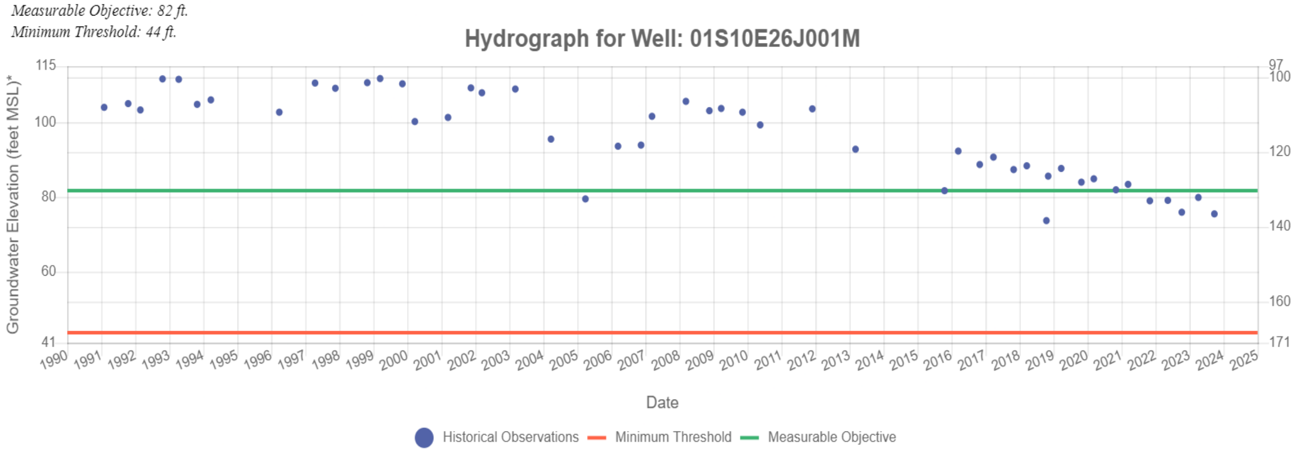
Ground Surface Elevation: 44 ft.
Measurable Objective: 3 ft.
Minimum Threshold: -19 ft.



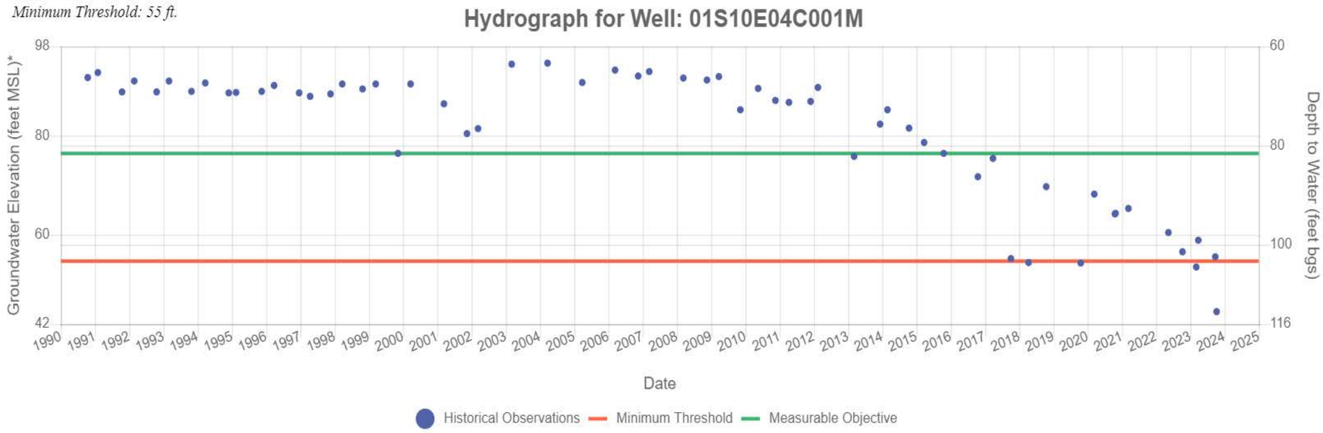
Ground Surface Elevation: 4 ft.
Measurable Objective: -19 ft.
Minimum Threshold: -27 ft.



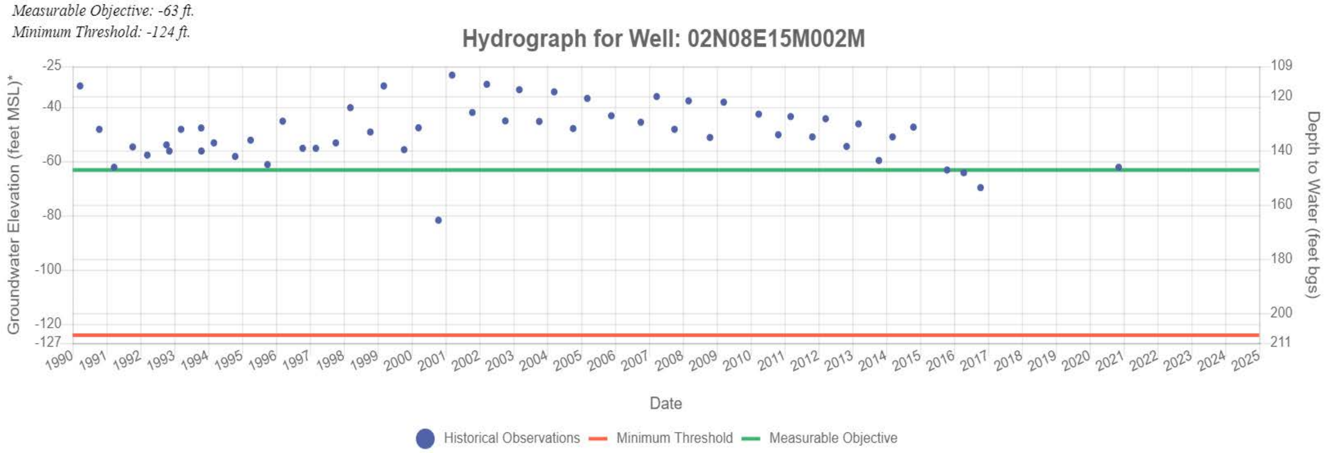
Ground Surface Elevation: 213 ft.
Measurable Objective: 82 ft.
Minimum Threshold: 44 ft.



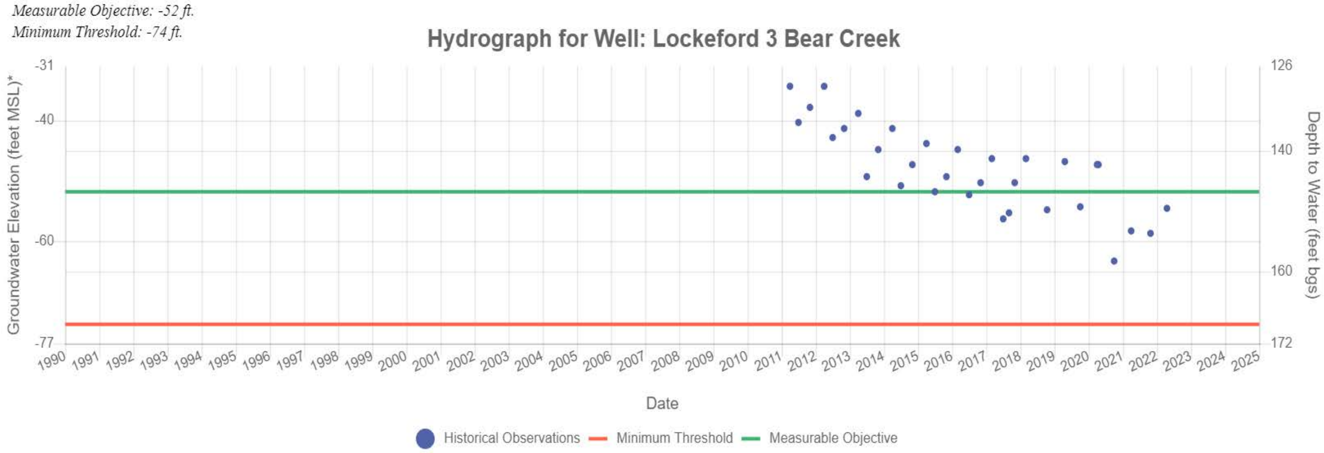
Ground Surface Elevation: 158 ft.
Measurable Objective: 76 ft.
Minimum Threshold: 55 ft.



Ground Surface Elevation: 85 ft.
Measurable Objective: -63 ft.
Minimum Threshold: -124 ft.

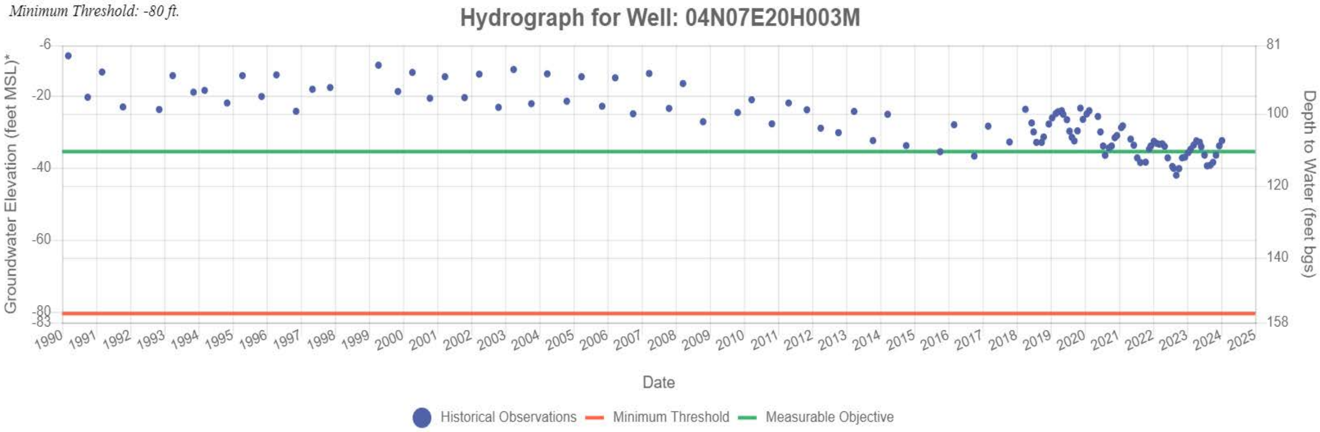


Ground Surface Elevation: 96 ft.
Measurable Objective: -52 ft.
Minimum Threshold: -74 ft.

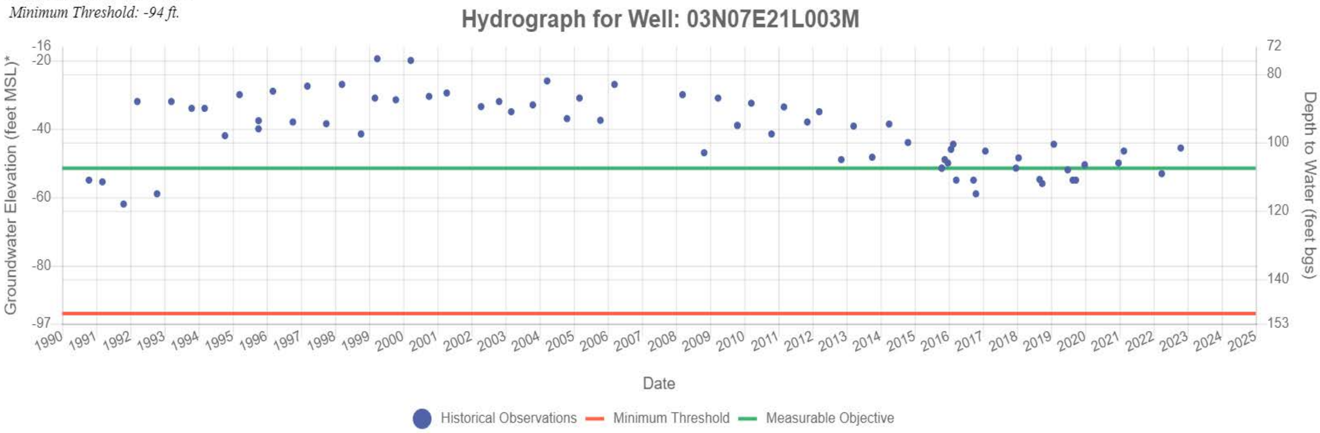


ATTACHMENT 2

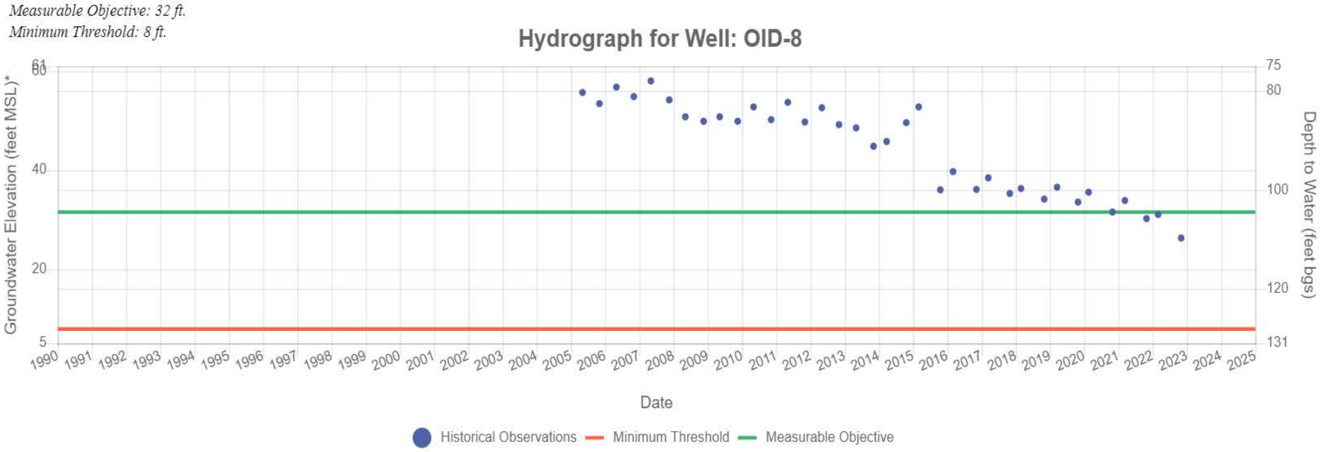
Ground Surface Elevation: 75 ft.
Measurable Objective: -35 ft.
Minimum Threshold: -80 ft.



Ground Surface Elevation: 57 ft.
Measurable Objective: -51 ft.
Minimum Threshold: -94 ft.



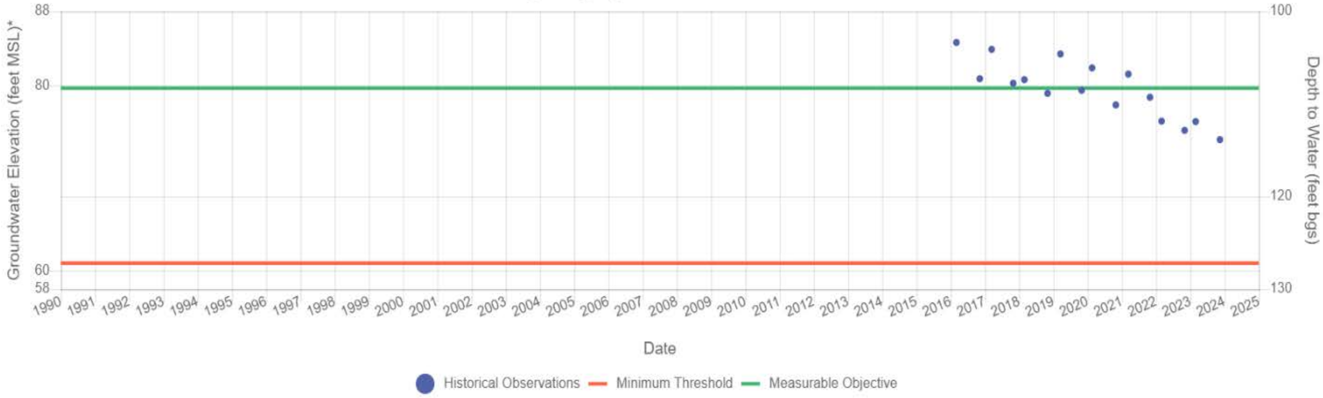
Ground Surface Elevation: 136 ft.
Measurable Objective: 32 ft.
Minimum Threshold: 8 ft.



ATTACHMENT 2

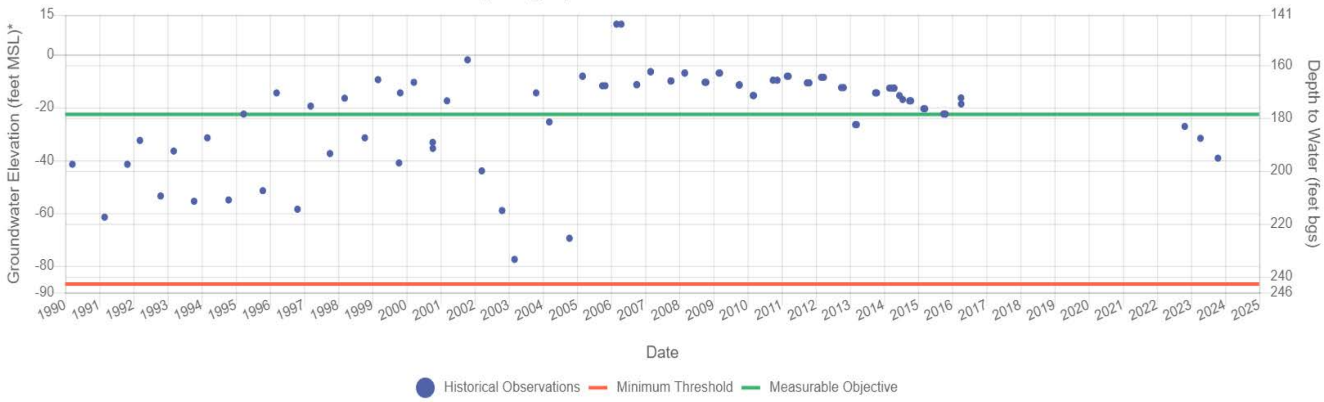
Ground Surface Elevation: 189 ft.
Measurable Objective: 80 ft.
Minimum Threshold: 61 ft.

Hydrograph for Well: OID-04



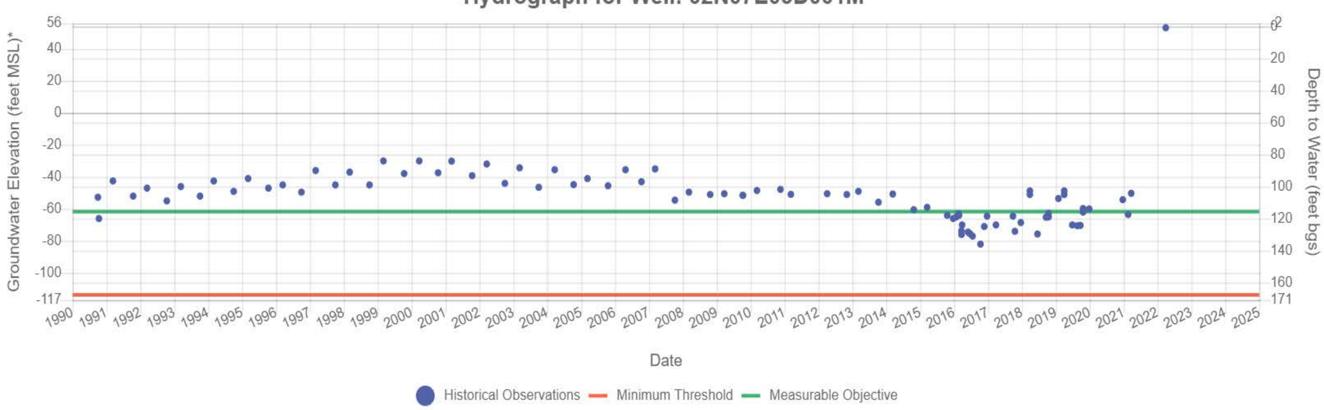
Ground Surface Elevation: 156 ft.
Measurable Objective: -23 ft.
Minimum Threshold: -87 ft.

Hydrograph for Well: 01N09E05J001M



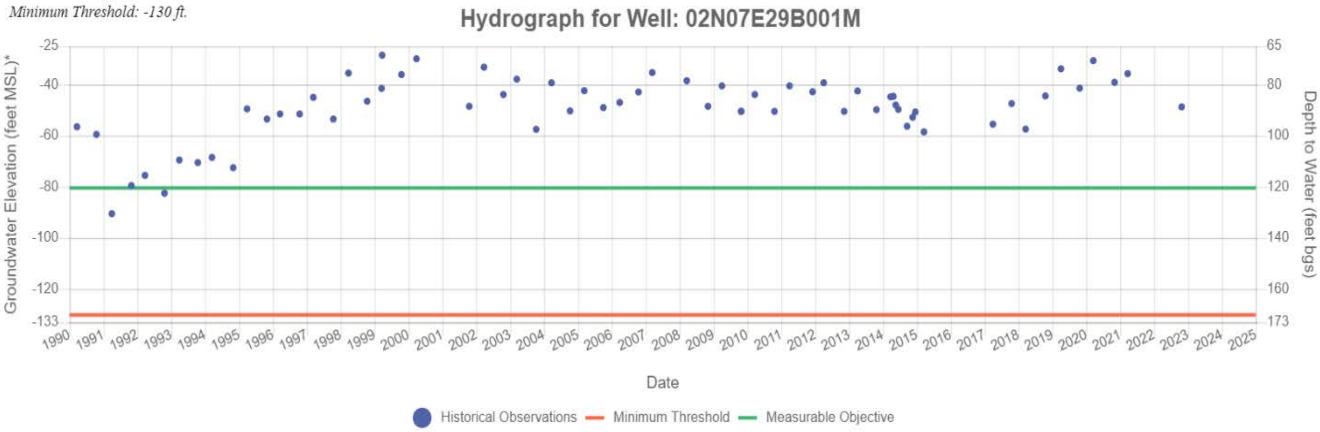
Ground Surface Elevation: 54 ft.
Measurable Objective: -62 ft.
Minimum Threshold: -114 ft.

Hydrograph for Well: 02N07E03D001M

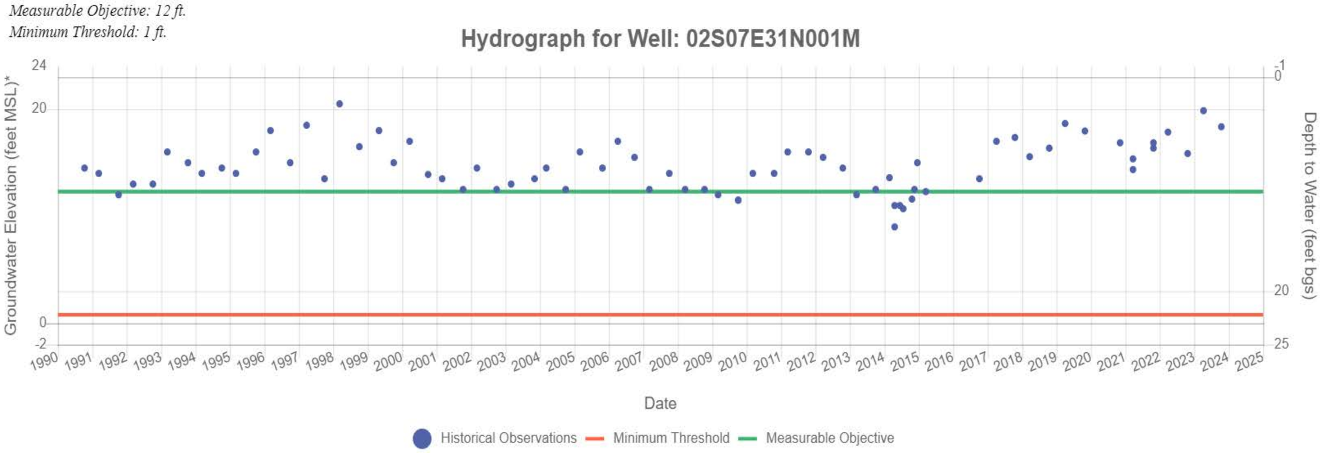


ATTACHMENT 2

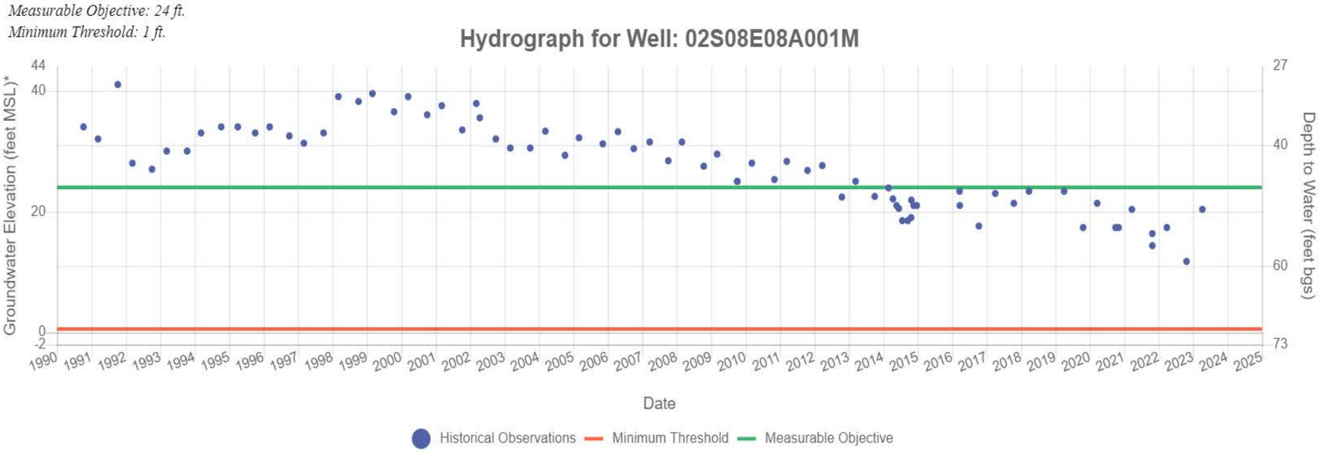
Ground Surface Elevation: 40 ft.
Measurable Objective: -80 ft.
Minimum Threshold: -130 ft.



Ground Surface Elevation: 23 ft.
Measurable Objective: 12 ft.
Minimum Threshold: 1 ft.

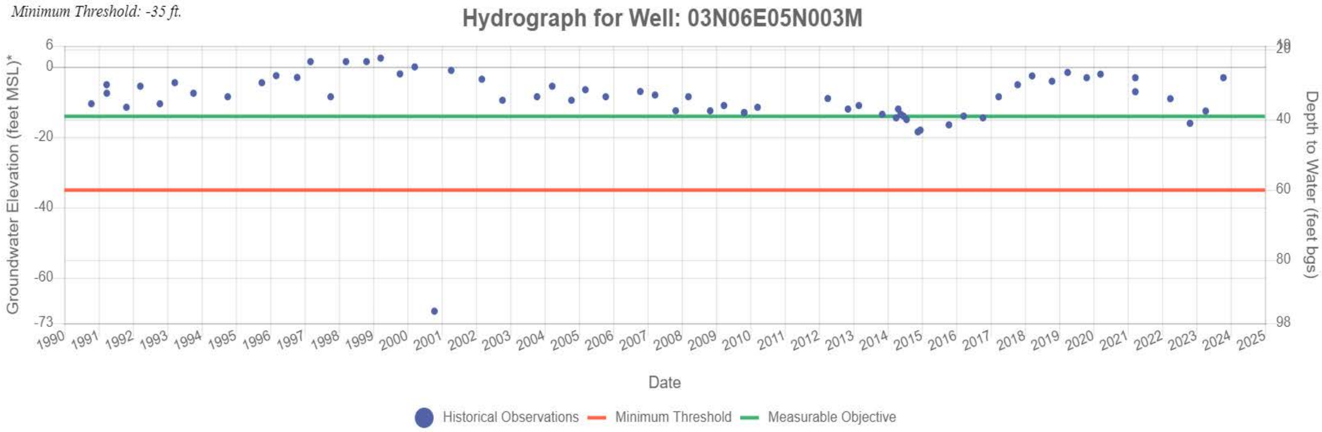


Ground Surface Elevation: 71 ft.
Measurable Objective: 24 ft.
Minimum Threshold: 1 ft.

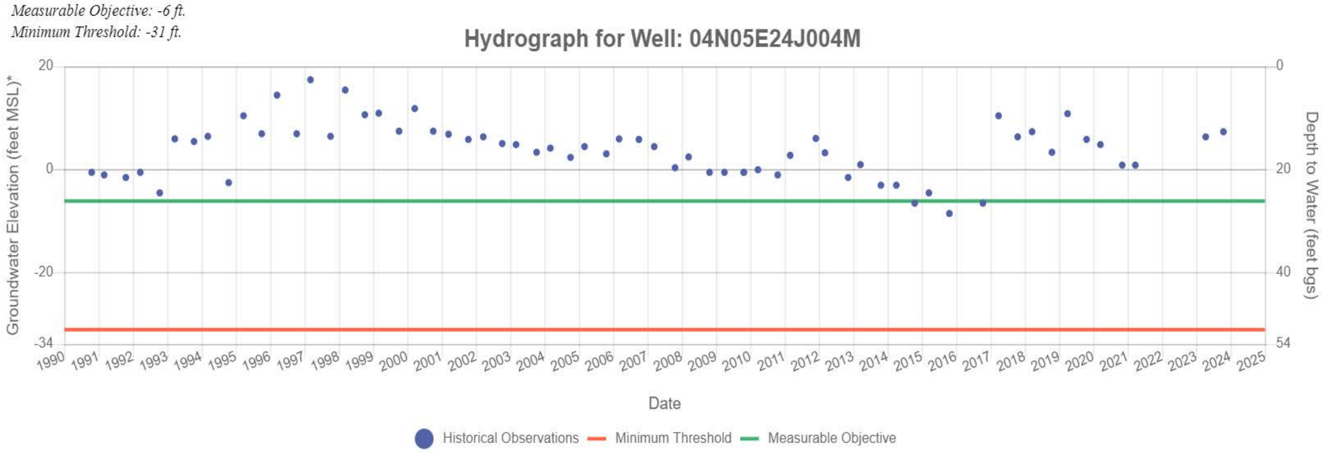


ATTACHMENT 2

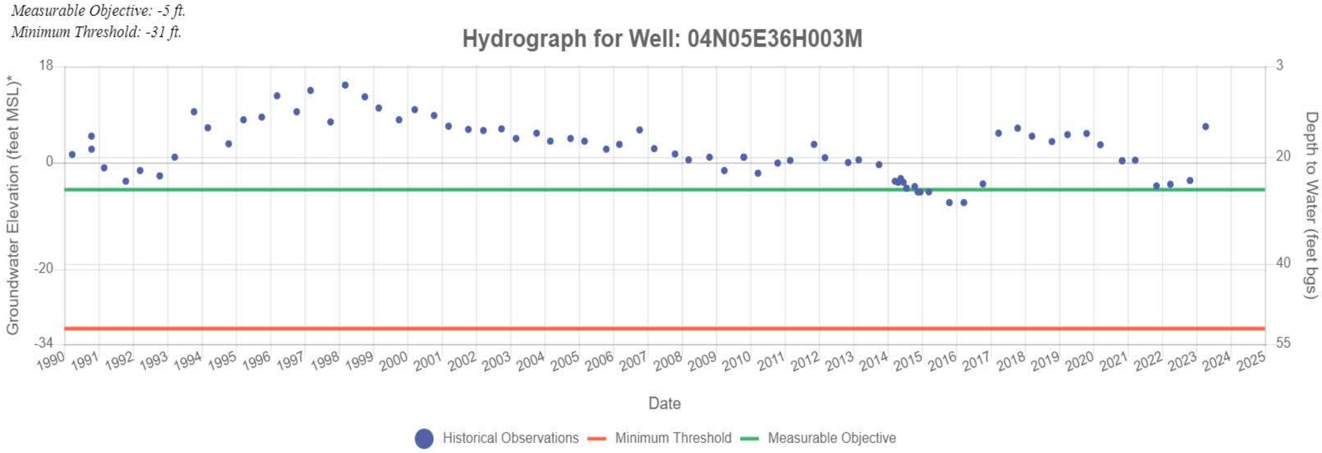
Ground Surface Elevation: 25 ft.
Measurable Objective: -14 ft.
Minimum Threshold: -35 ft.



Ground Surface Elevation: 20 ft.
Measurable Objective: -6 ft.
Minimum Threshold: -31 ft.



Ground Surface Elevation: 21 ft.
Measurable Objective: -5 ft.
Minimum Threshold: -31 ft.



APPENDIX 3-J.
DOMESTIC WELL MITIGATION PROGRAM

ATTACHMENT 2

**BEFORE THE BOARD OF DIRECTORS OF
THE EASTERN SAN JOAQUIN
GROUNDWATER AUTHORITY**

RESOLUTION R-24-02

ADOPTING PROGRAM FOR DRY DOMESTIC WELL MITIGATION

WHEREAS, the Eastern San Joaquin Groundwater Authority ("Authority") is a Joint Powers Authority created by the 16 Groundwater Sustainability Agencies ("GSAs") overlying the Eastern San Joaquin Subbasin to coordinate the Groundwater Sustainability Plan ("GSP") and activities thereunder as required by the Sustainable Groundwater Management Act ("SGMA").

WHEREAS, SGMA encourages GSAs to include in their GSP implementation measures that provide mitigation for undesirable results of overdraft, including the failure of domestic water supply wells due to overdraft pumping occurring after January 1, 2015;

WHEREAS, the GSA's in the Eastern San Joaquin Subbasin have not experienced significant dry well reports as reported by the State of California Dry Well Reporting System or as reported by individuals within the GSAs;

WHEREAS, nevertheless the GSA's desire to establish a single program, to be operated through the Authority, that can be used to provide emergency, interim and long-term mitigation assistance for owners and other persons who experience a failure of a domestic water supply well due to overdraft pumping within the subbasin;

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of the Authority that:

1. The attached Eastern San Joaquin Subbasin Program for Domestic Well Mitigation is hereby adopted and approved. The Program establishes the rules and procedures to be used by the Authority and its members to address mitigation for failure of domestic water supply wells caused by groundwater overdraft occurring after January 1, 2015.

2. The Program shall be implemented by the Authority and coordinated through the designated Authority Secretary.

3. The DRY WELL MITIGATION FUND (FUND) is hereby created with a funding target in the amount of TWO HUNDRED THOUSAND DOLLARS ($200,000.00). Initial funding shall be raised from GSA Member dues as part of the Authority's annual budget and apportioned to Member GSAs using the Authority's annual budget allocation formula.

4. Program activities and funding needs shall be reviewed annually and updated as needed with the understanding that this is an evolving situation and there is a need to establish an initial Program and then adjust as the GSA Members learn more about the needs of the community.

ATTACHMENT 2

PASSED AND ADOPTED this 11 day of September 2024, by the following vote of the Board of Directors of the Eastern San Joaquin Groundwater Authority, to wit:

AYES: Jason Colombini, Mike Henry, Robert Holmes, Dante Nomellini, Christy McKinnon, Keith Bussman, Mitchell Maidrand, Mel Panizza, John Herrick, Myron Blanton, Eric Thorburn, Alan Nakanishi, and David Breitenbucher.

NOES:

ABSTAIN:

ABSENT: George Biagi, Michael Blower, Paul Canepa, Anthony Carrasco, Kevin Jorgensen, Trais Kahrs, Mel Lytle, Scot Moody, Robert Rickman, Reid Roberts, Eric Schmid, Grant Thompson, Gary Tofanelli, Jose Valente, Andrew Watkins, and Dan Wright.

Robert Rickman
Chairman, Board of Directors
Eastern San Joaquin Groundwater
Authority

ATTEST: Fritz Buchman, C.E., P.E., CFM
Secretary, Board of Directors
Eastern San Joaquin Groundwater
Authority

ATTACHMENT 2

Eastern San Joaquin Subbasin Program for Domestic Well Mitigation

(draft 08/08/24, approved by the ESJGWA on __________)

1. **PURPOSE AND APPLICABILITY LIMITS:** This Program provides emergency, interim and financial mitigation for domestic water supply wells that have been determined to have failed due to groundwater overdraft conditions occurring since January 1, 2015.

2. **DRY WELL MITIGATION FUND:** The Authority shall establish a DRY WELL MITIGATION FUND (FUND) with a funding target in the amount of TWO HUNDRED THOUSAND DOLLARS ($200,000.00).

   2.01 Initial funding shall be raised from GSA Member dues as part of the Authority's annual budget and apportioned to Member GSAs using the Authority's annual budget allocation formula.

   2.02 By action of the Authority Bord of Directors, the Fund may be replenished by utilizing reserves or additional Member dues as part of the Authority's annual budgeting process or as a budget amendment.

   2.03 Should the Fund fall below ONE-HUNDRED THOUSAND DOLLARS ($100,000.00), GSA Members will meet and confer in good faith to determine the appropriate funding mechanism, replenishment amount, and GSA Member allocation methodology prior to Fund replenishment.

3. **PUBLIC OUTREACH AND CLAIMS ASSISTANCE:** Authority and GSA Members shall assign staff or representatives (collectively herein referred to as "staff") to engage in public outreach to give notice to domestic well owners and residents of their right to request assistance under this Program, and how to apply for assistance.

   3.01 Outreach: Staff will perform outreach to populations likely to require assistance under this Program and create fliers, social media posts and website links to publicize this Program. The above fliers shall be posted at appropriate locations such as County Environmental Health Departments, GSA offices, Farm Bureau locations, community organizations and City and County Public Works and Utility Offices. The Authority may also contract with non-governmental organizations to assist with outreach.

   3.02 Development of an Application for Assistance: Staff will develop a simple application from for residents applying for assistance under this Program. Pertinent information submitted with the application form may include contact information, location of the well, age of the well, well construction information such as total depth of the well, screen intervals, annular seal depth, and date the well first failed to produce water or meet water quality standards. Applicants will be strongly urged to provide evidence such as official lab results, declarations from a licensed well driller identifying the cause of the well failure (if available), and all other evidence in applicant's possession that the failure was caused by overdraft pumping (i.e. depth to water measurements, nearby wells, etc.).

3.03 Filing Applications for Assistance: Staff will assist residents with filing the request for assistance called for in this Program. The Authority may also contract with non-governmental organizations to assist residents with filing claims.

4. **CLAIMS PROCESS:**

4.01 Limitations Period: All claims brought under this Program must have accrued after January 1, 2015. Claims brought that accrued between January 1, 2015 and the adoption of this policy shall be brought within six months of the adoption of this policy. The limitations period for claims brought after the adoption of this policy shall be the limitations process and period provided by the California Government Tort Claims Act (Government Code Section 810 and following).

4.02 Technical Review Committee: A Technical Review Committee will be formed to review each application under this Policy. The Technical Review Committee shall consist of the following members:

4.02.1 The District Engineer for the GSA where the well is located.

4.02.2 A licensed hydrologist hired by the Authority on an eligibility list pre-approved by the ESJGWA Steering Committee.

4.02.3 A registered Environmental Health Specialist from the County Environmental Health Department in which the well is located.

4.02.4 The well owner, agent (i.e. well driller, independent consultant, attorney, or designated representative), or environmental justice advocate selected from a list compiled by the ESJGWA Steering Committee.

4.02.5 A technical representative designated by a Member GSA that is not the GSA for the area in where the well is located. The Steering Committee will vet and compile a list of names of eligible technical representatives from Member GSAs and assign a person from this list to serve on the Technical Review Committee on a rotating basis.

5. **Interim Remedies:** The Authority will work with county Office of Emergency Services where the well is located, other non-governmental agencies, or directly with vendors to ensure the applicant is provided an interim water supply to all applicants with a reasonable facial complaint for damages. An interim water supply consists of bottled water intended to meet drinking water and cooking needs while the claim is reviewed and processed. If the claim is approved, the Authority will ensure that an interim water supply will continue until the selected mitigation is complete.

6. **Claims Subject to Mitigation:** The following claims are eligible for mitigation assistance under this Program:

   6.01 Well Failures caused by declining water levels that were caused by overdraft pumping that occurred after January 1, 2015.

   6.02 Well Failures due to water quality problems caused by overdraft pumping that occurred after January 1, 2015. Water quality problems means well water that exceeds State or Federal maximum contaminant levels. Water quality problems that are not the result of overdraft pumping shall not be subject to mitigation under this Program. Eligibility for an alternative water supply such as bottled water may be available through CV-Salts.

   6.03 Well failure due to subsidence caused by overdraft pumping that occurred after January 1, 2015.

7. **Claim Administration:**

   7.01 Notice of Claim: Claims must be submitted in the form of a completed application to:

   Eastern San Joaquin Groundwater Authority
   Director of Public Works, San Joaquin County
   PO BOX 1810
   Stockton, CA 95201

   Or in-person:
   Eastern San Joaquin Groundwater Authority
   Director of Public Works, San Joaquin County
   1810 E. Hazelton Avenue
   Stockton, CA 95201

   7.02 The Secretary of the Authority is authorized to summarily reject any claim if and only if, the well failure can be remedied by replacing failed electrical or mechanical pump components without needing to re-drill the well.

   7.03 The Technical Review Committee shall have authority to conduct its own investigation of the evidence including contracting with hydrogeologists and well drillers, researching county well records and requesting records from the applicant.

   7.04 The Technical Review Committee will draft a written technical memorandum recommending how, whether and to what extent to mitigate a claim, if any, within 15 days of receipt of the application together with any additional information requested by the Technical Review Committee.

   7.05 The Technical Committee will forward its Technical Memorandum and Recommendation for funding/mitigation to the GWA Steering Committee. The

GWA Steering Committee will issue a final written decision on the Claim within 40 days of receipt of the Technical Review Committee's memorandum. The written decision will be provided to the Claimant via mail at the address located in the Application on the date it is issued.

7.06 The GWA Steering Committee may decide to provide complete or partial mitigation for a particular Claim based on the Committee's determination of the percentage of responsibility for the well failure related to groundwater pumping as opposed to other contributing factors, such as the age or construction of the well.

7.07 A Claimant may appeal a decision of the GWA Steering Committee by submitting a written appeal to the GWA Board Chair within 30 days of the mailing date of the GWA Steering Committee Decision. The appeal shall contain a copy of the original application, the Technical Memorandum and the Steering Committee Decision and state the basis for the appeal.

7.08 The GWA Board Chair shall agendize the appeal for the next quarterly GWA Board Meeting that is at least 15 days after receipt of the appeal and provide written notice and the agenda to the appellant.

7.09 The GWA Board of Directors shall act on the appeal and issue a written decision. The decision of the GWA Board of Directors shall be final.

APPENDIX 5-A.
LIST OF DMS DATA TYPES

ATTACHMENT 2

Data Type	Parameter	Unit
Groundwater Level	Depth to Groundwater	feet
Groundwater Level	Groundwater Elevation	feet
Groundwater Quality	1,1,1-Trichloroethane (111-TCA)	micrograms per liter
Groundwater Quality	1,2,3-Trichloropropane (123-TCP)	micrograms per liter
Groundwater Quality	Aggressiveness Index	-
Groundwater Quality	Aluminum	micrograms per liter
Groundwater Quality	Antimony	micrograms per liter
Groundwater Quality	Apparent Color	-
Groundwater Quality	Arsenic	micrograms per liter
Groundwater Quality	Arsenic	micrograms per liter
Groundwater Quality	Arsenic	picocuries per liter
Groundwater Quality	Barium	parts per billion
Groundwater Quality	Barium	micrograms per liter
Groundwater Quality	Benzene	micrograms per liter
Groundwater Quality	Beryllium	micrograms per liter
Groundwater Quality	Bicarbonate (HCO3)	milligrams per liter
Groundwater Quality	Boron	micrograms per liter
Groundwater Quality	Cadmium	micrograms per liter
Groundwater Quality	Calcium	parts permillion
Groundwater Quality	Calcium	milligrams per liter
Groundwater Quality	Carbonate (CO3)	milligrams per liter
Groundwater Quality	Chloride	milligrams per liter
Groundwater Quality	Chloride	milligrams per liter
Groundwater Quality	Chloride	parts permillion
Groundwater Quality	Chlorine	milligrams per liter
Groundwater Quality	Chromium	parts per billion
Groundwater Quality	Chromium	micrograms per liter
Groundwater Quality	Conductivity @ 25C	micromhos per centimeter
Groundwater Quality	Copper	parts per billion
Groundwater Quality	Copper	micrograms per liter
Groundwater Quality	Corrosivity	-
Groundwater Quality	Cyanide	micrograms per liter
Groundwater Quality	Dibromochloropropane (DBCP)	micrograms per liter
Groundwater Quality	Fluoride	parts permillion
Groundwater Quality	Fluoride	milligrams per liter
Groundwater Quality	Gross Alpha Activity	picocuries per liter
Groundwater Quality	Hardness	parts permillion
Groundwater Quality	Hexavalaent Chromium (CR6)	micrograms per liter
Groundwater Quality	Hexavalaent Chromium(CR6)	micrograms per liter
Groundwater Quality	Hydroxide (OH)	milligrams per liter

ATTACHMENT 2

Data Type	Parameter	Unit
Groundwater Quality	Iron	micrograms per liter
Groundwater Quality	Laboratory pH	-
Groundwater Quality	Laboratory Turbidity	nephelometric turbidity unit
Groundwater Quality	Lead	micrograms per liter
Groundwater Quality	Magensium	parts permillion
Groundwater Quality	Magnesium	milligrams per liter
Groundwater Quality	Manganese	micrograms per liter
Groundwater Quality	Mercury	micrograms per liter
Groundwater Quality	Methyl Tertiary Butyl Ether (MTBE)	micrograms per liter
Groundwater Quality	Methylene Active Blue Substances	milligrams per liter
Groundwater Quality	Nickel	micrograms per liter
Groundwater Quality	Nitrate (as N)	milligrams per liter
Groundwater Quality	Nitrate (as N)	parts permillion
Groundwater Quality	Nitrate (as N)	micrograms per liter
Groundwater Quality	Nitrate (as N)O4	milligrams per liter
Groundwater Quality	Nitrate (as N)O5	milligrams per liter
Groundwater Quality	Nitrate (as N)O6	milligrams per liter
Groundwater Quality	Nitrate (NO3)	milligrams per liter
Groundwater Quality	Odor Threshold (60'C)	-
Groundwater Quality	Perchlorate	micrograms per liter
Groundwater Quality	Perchlorate	micrograms per liter
Groundwater Quality	Potassium	parts permillion
Groundwater Quality	Potassium	milligrams per liter
Groundwater Quality	Selenium	micrograms per liter
Groundwater Quality	Silver	micrograms per liter
Groundwater Quality	Sodium	parts permillion
Groundwater Quality	Sodium	milligrams per liter
Groundwater Quality	Specific Conductance	microohmns
Groundwater Quality	Specific Conductance	micromhos per centimeter
Groundwater Quality	Specific Electrical Conductivity (SC)	UMHOS/CM
Groundwater Quality	Specific Electrical Conductivity (SC)	micromhos per centimeter
Groundwater Quality	Sulfate	parts permillion
Groundwater Quality	Sulfate	milligrams per liter
Groundwater Quality	Tetrachloroethylene (PCE)	micrograms per liter
Groundwater Quality	Thallium	micrograms per liter
Groundwater Quality	Total Alkalinity	parts permillion
Groundwater Quality	Total Alkalinity (CaCO3)	milligrams per liter
Groundwater Quality	Total ANIONS, meq/L	micromhos per centimeter

Data Type	Parameter	Unit
Groundwater Quality	Total ANIONS, meq/L	micromhos per centimeter
Groundwater Quality	Total ANIONS, meq/L	micromhos per centimeter
Groundwater Quality	Total CATIONS, meq/L	micromhos per centimeter
Groundwater Quality	Total CATIONS, meq/L	micromhos per centimeter
Groundwater Quality	Total Dissolved Solids (TDS)	milligrams per liter
Groundwater Quality	Total Dissolved Solids (TDS)	milligrams per liter
Groundwater Quality	Total Hardness (calc.)	milligrams per liter
Groundwater Quality	Total Trihalomethanes (TTHM)	parts per billion
Groundwater Quality	Trichloroethylene (TCE)	micrograms per liter
Groundwater Quality	Turbidity	-
Groundwater Quality	Uranium	picocuries per liter
Groundwater Quality	Vanadium	parts per billion
Groundwater Quality	Vanadium	micrograms per liter
Groundwater Quality	Zinc	micrograms per liter
Precipitation	Average Air Temperature	°F
Precipitation	Precipitation	inches
Precipitation	Reference Evapotranspiration (ETo)	Inches permonth
Streamflow	Streamflow	cubic feet per second
Surface Water Quality	(E)-Dimethomorph,water,filtered, recoverable	micrograms per liter
Surface Water Quality	(Z)-Dimethomorph,water,filtered, recoverable	micrograms per liter
Surface Water Quality	1,1,1-Trichloroethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	1,1,2,2-Tetrachloroethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	1,1,2-Trichloroethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	1,1-Dichloroethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	1,1-Dichloroethene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	1,2,4-Trichlorobenzene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	1,2-Dibromoethene, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	1,2-Dichlorobenzene, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	1,2-Dichlorobenzene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	1,2-Dichloroethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	1,2-Dichloropropane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	1,2-Dimethylnaphthalene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	1,3-Dichlorobenzene, water, unfiltered, recoverable, micrograms per liter	micrograms per liter
Surface Water Quality	1,3-Dichlorobenzene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	1,3-Dichloropropene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	1,4-Dichlorobenzene, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	1,4-Dichlorobenzene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	1,4-Naphthoquinone,water,filtered,recoverable	micrograms per liter
Surface Water Quality	1,6-Dimethylnaphthalene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	1-Methyl-9H-fluorene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	1-Methylphenanthrene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	1-Methylpyrene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	1-Naphthol,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	2-(4-tert-Butylphenoxy)-cyclohexanol,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2, 4-DB,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	2,2-Biquinoline,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2,3,6-Trimethylnaphthalene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2,4,5-T,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2,4,5-T,surrogate,Schedule 9060/2060, water, filtered	percent recovery
Surface Water Quality	2,4,5-T,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2,4,5-T,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	2,4-D,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2,4-D,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2,4-D,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	2,4-Dinitrotoluene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2,5-Dichloroaniline,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2,6-Diethylaniline,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	2,6-Dimethylnaphthalene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2,6-Dinitrotoluene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2-[(2-Ethyl-6-methylphenyl)amino]-1-propanol,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2-Amino-N-isopropylbenzamide,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2-Chloro-2 6-diethylacetanilide,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2-Chloro-4-isopropylamino-6-amino-s-triazine,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2-Chloro-6-ethylamino-4-amino-s-triazine,water,filtered,recoverable	micrograms per liter

Data Type	Parameter	Unit
Surface Water Quality	2-Chloroethyl vinyl ether,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	2-Chloronaphthalene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2-Chlorophenol,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2-Ethyl-6-methylaniline,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2-Ethylnaphthalene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	2-Fluorobiphenyl,surrogate,bed sediment smaller than 2 millimeters, wet sieved (native water), field	percent recovery
Surface Water Quality	2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine,water,filtered,recoverable	micrograms per liter
Surface Water Quality	2-Methyl-4,6-dinitrophenol,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	2-Methylanthracene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	3-(Trifluoromethyl)aniline,water,filtered,recoverable	micrograms per liter
Surface Water Quality	3,4-Dichloroaniline,water,filtered,recoverable	micrograms per liter
Surface Water Quality	3,5-Dichloroaniline,water,filtered,recoverable	micrograms per liter
Surface Water Quality	3,5-Dimethylphenol,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	3-Hydroxy carbofuran,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	3-Nitrotoluene,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	3-Phenoxybenzyl alcohol,water,filtered,recoverable	micrograms per liter
Surface Water Quality	4-(Hydroxymethyl) pendimethalin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	4,4-Dichlorobenzophenone,water,filtered,recoverable	micrograms per liter
Surface Water Quality	4-Bromophenyl phenyl ether,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	4-Chloro-2-methylphenol,water,filtered,recoverable	micrograms per liter
Surface Water Quality	4-Chloro-3-methylphenol,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	4-Chlorophenyl methyl sulfone,water,filtered,recoverable	micrograms per liter
Surface Water Quality	4-Chlorophenyl phenyl ether,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	4H-Cyclopenta[def]phenanthrene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	9,10-Anthraquinone,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	9H-Fluorene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Acenaphthene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Acenaphthylene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	Acetochlor oxanilic acid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Acetochlor sulfonic acid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Acetochlor,water,filtered, recoverable	micrograms per liter
Surface Water Quality	Acid neutralizing capacity,water,unfiltered, inflection-point titration method (incremental titration method)	milligrams per liter as calcium carbonate
Surface Water Quality	Acid neutralizing capacity,water,unfiltered,fixed endpoint (pH 4.5) titration	milligrams per liter as calcium carbonate
Surface Water Quality	Acid neutralizing capacity,water,unfiltered,fixed endpoint (pH 4.5) titration, laboratory	milligrams per liter as calcium carbonate
Surface Water Quality	Acifluorfen,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Acridine,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Agency analyzing sample	code
Surface Water Quality	Alachlor oxanilic acid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Alachlor sulfonic acid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Alachlor, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	Alachlor,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Aldicarb sulfone,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Aldicarb sulfoxide,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Aldicarb,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Aldrin,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Aldrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Aldrin,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Alkalinity,water,filtered, inflection-point titration method (incremental titration method), field	milligrams per liter as calcium carbonate
Surface Water Quality	Alkalinity,water,filtered,Gran titration, field	milligrams per liter as calcium carbonate
Surface Water Quality	Allethrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Allethrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	alpha-Endosulfan, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	alpha-Endosulfan,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	alpha-Endosulfan,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	alpha-Endosulfan,water,filtered,recoverable	micrograms per liter
Surface Water Quality	alpha-HCH,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	alpha-HCH,water,filtered,recoverable	micrograms per liter
Surface Water Quality	alpha-HCH-d6,surrogate,bed sediment smaller than 2 millimeters, wet sieved (native water), field	percent recovery
Surface Water Quality	alpha-HCH-d6,surrogate,Schedule 2002/9002,water,unfiltered	percent recovery
Surface Water Quality	alpha-HCH-d6,surrogate,Schedule 2003, water, filtered	percent recovery
Surface Water Quality	alpha-HCH-d6,surrogate,water,filtered (0.7 micron glass fiber filter)	percent recovery
Surface Water Quality	Aluminum,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	percent
Surface Water Quality	Aluminum,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Aluminum,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Aluminum,water,filtered	micrograms per liter
Surface Water Quality	Aluminum,water,recoverable, dry weight	micrograms per liter
Surface Water Quality	Ametryn,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Aminomethylphosphonic acid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Ammonia plus organic nitrogen,water,filtered	milligrams per liter as nitrogen
Surface Water Quality	Ammonia plus organic nitrogen,water,unfiltered	milligrams per liter as nitrogen
Surface Water Quality	Ammonia,water,filtered	milligrams per liter as nitrogen
Surface Water Quality	Ammonia,water,filtered	milligrams per liter as NH4
Surface Water Quality	Ammonia,water,unfiltered	milligrams per liter as nitrogen
Surface Water Quality	Ammonia,water,unfiltered	milligrams per liter as NH4
Surface Water Quality	Analytical reference number,Schedule 2501	
Surface Water Quality	Anthracene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Antimony,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Arsenic,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Arsenic,bed sediment,total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Arsenic,suspended sediment,total	micrograms per liter
Surface Water Quality	Arsenic,water,filtered	micrograms per liter
Surface Water Quality	Arsenic,water,unfiltered	micrograms per liter
Surface Water Quality	Atrazine,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Atrazine,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Azinphos-methyl oxygen analog,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Azinphos-methyl,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Azobenzene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	Barban,surrogate,Schedules 2060/9060, water, filtered	percent recovery
Surface Water Quality	Barium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Barium,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Barium,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Barium,water,filtered	micrograms per liter
Surface Water Quality	Barium,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Barometric pressure	millimeters ofmercury
Surface Water Quality	BDMC,surrogate,water, unfiltered	percent recovery
Surface Water Quality	Bed sediment,sieve diameter	percent smaller than 0.0625millimeters
Surface Water Quality	Bed sediment,sieve diameter	percent smaller than 0.125millimeters
Surface Water Quality	Bed sediment,sieve diameter	percent smaller than 0.25millimeters
Surface Water Quality	Bed sediment,sieve diameter	percent smaller than 0.5millimeters
Surface Water Quality	Bed sediment,sieve diameter	percent smaller than 1millimeter
Surface Water Quality	Bed sediment,sieve diameter	percent smaller than 2millimeters
Surface Water Quality	Bed sediment,sieve diameter	percent smaller than 4millimeters
Surface Water Quality	Bed sediment,sieve diameter	percent smaller than 8millimeters
Surface Water Quality	Bendiocarb,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Benfluralin,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Benomyl,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Bensulfuron-methyl,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Bentazon,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Benzene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Benzo[a]anthracene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Benzo[a]pyrene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Benzo[b]fluoranthene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Benzo[c]cinnoline,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Benzo[ghi]perylene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Benzo[k]fluoranthene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Benzyl n-butyl phthalate,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	Beryllium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Beryllium,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Beryllium,water,filtered	micrograms per liter
Surface Water Quality	Beryllium,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	beta-Endosulfan,water,filtered,recoverable	micrograms per liter
Surface Water Quality	beta-HCH,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Bicarbonate,water,filtered,inflection-point titration method (incremental titration method)	milligrams per liter
Surface Water Quality	Bicarbonate,water,unfiltered,fixed endpoint (pH 4.5) titration,field	milligrams per liter
Surface Water Quality	Bicarbonate,water,unfiltered,inflection-point titration method (incremental titration method)	milligrams per liter
Surface Water Quality	Bifenthrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Bifenthrin,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Bifenthrin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Biochemical oxygen demand, water, unfiltered, 5 days at 20 degrees Celsius	milligrams per liter
Surface Water Quality	Biomass,periphyton,ash free dry mass	grams per squaremeter
Surface Water Quality	Biomass,periphyton,ash weight	grams per squaremeter
Surface Water Quality	Biomass,periphyton,dry weight	grams per squaremeter
Surface Water Quality	Biomass,plankton,ash weight	milligrams per liter
Surface Water Quality	Biomass,plankton,dry weight	milligrams per liter
Surface Water Quality	Biomass/chlorophyll ratio,periphyton	number
Surface Water Quality	Biomass/chlorophyll ratio,plankton	number
Surface Water Quality	Bis(2-chloroethoxy)methane,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Bis(2-ethylhexyl) phthalate,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Bismuth,bed sediment smaller than 177 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Bismuth,water,filtered	micrograms per liter
Surface Water Quality	Boron,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Boron,water,filtered	micrograms per liter
Surface Water Quality	Boron,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Bromacil,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Bromide, water, filtered	milligrams per liter
Surface Water Quality	Bromodichloromethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Bromomethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Bromoxynil,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Butylate,water,filtered,recoverable	micrograms per liter
Surface Water Quality	C8-Alkylphenol,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	Cadmium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Cadmium,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Cadmium,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Cadmium,water,filtered	micrograms per liter
Surface Water Quality	Cadmium,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Caffeine,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Caffeine-13C,surrogate,Schedule 9060/2060, water, filtered	percent recovery
Surface Water Quality	Calcium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	percent
Surface Water Quality	Calcium,water,filtered	milligrams per liter
Surface Water Quality	Carbaryl,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Carbaryl,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Carbaryl,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Carbazole,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Carbofuran,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Carbofuran,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Carbon (inorganic plus organic), bed sediment, total, dry weight	grams per kilogram
Surface Water Quality	Carbon (inorganic plus organic),bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	grams per kilogram
Surface Water Quality	Carbon (inorganic plus organic),bed sediment smaller than 62.5 microns,wet sieved (native water), field,recoverable,dry weight	percent
Surface Water Quality	Carbon (inorganic plus organic),suspended sediment,total	milligrams per liter
Surface Water Quality	Carbon dioxide,water,unfiltered	milligrams per liter
Surface Water Quality	Carbonate,water,filtered,inflection-point titration method (incremental titration method)	milligrams per liter
Surface Water Quality	Carbonate,water,unfiltered,fixed endpoint (pH 8.3) titration,field	milligrams per liter
Surface Water Quality	Carbonate,water,unfiltered,inflection-point titration method (incremental titration method)	milligrams per liter
Surface Water Quality	Carbonate,water,unfiltered,inflection-point titration method (incremental titration method),field	milligrams per liter as calcium carbonate
Surface Water Quality	Carbophenothion,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Carbophenothion,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Cerium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Chemical oxygen demand, low level, water, unfiltered	milligrams per liter
Surface Water Quality	Chloramben methyl ester,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Chlordane (technical),bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Chlordane (technical),water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Chlordane plus degradates,bed sediment,recoverable,maximum summation, dry weight	micrograms per kilogram

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Data Type	Parameter	Unit
Surface Water Quality	Chloride,water,filtered	milligrams per liter
Surface Water Quality	Chlorimuron-ethyl,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Chlorobenzene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Chloroethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Chloromethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Chloroneb,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Chlorophyll a,periphyton,chromatographic-fluorometric method	milligrams per squaremeter
Surface Water Quality	Chlorophyll a,phytoplankton,chromatographic-fluorometric method	micrograms per liter
Surface Water Quality	Chlorophyll b,phytoplankton,chromatographic-fluorometric method	micrograms per liter
Surface Water Quality	Chlorothalonil,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Chlorpyrifos oxygen analog,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Chlorpyrifos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Chlorpyrifos,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Chromium(VI),water,filtered	micrograms per liter
Surface Water Quality	Chromium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Chromium,bed sediment,recoverable	milligrams per kilogram
Surface Water Quality	Chromium,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Chromium,water,filtered	micrograms per liter
Surface Water Quality	Chromium,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Chrysene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	cis-1,3-Dichloropropene, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	cis-Chlordane,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	cis-Nonachlor,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	cis-Permethrin,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	cis-Permethrin,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	cis-Propiconazole,water,filtered, recoverable	micrograms per liter
Surface Water Quality	Clopyralid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Cobalt,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Cobalt,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Cobalt,water,filtered	micrograms per liter
Surface Water Quality	Cobalt,water,unfiltered, recoverable	micrograms per liter
Surface Water Quality	Copper,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Copper,bed sediment,recoverable, dry weight	milligrams per kilogram

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Data Type	Parameter	Unit
Surface Water Quality	Copper,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Copper,water,filtered	micrograms per liter
Surface Water Quality	Copper,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Cyanazine,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Cyanazine,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Cycloate,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Cyfluthrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Cyfluthrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Cyfluthrin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Cypermethrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Cypermethrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Cypermethrin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	DCPA monoacid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	DCPA,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	DCPA,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	DDT plus degradates,bed sediment smaller than 2 millimeters,wet sieved (native water),recoverable,minimum summation, dry weight	micrograms per kilogram
Surface Water Quality	DDT plus degradates,bed sediment smaller than 2 millimeters,wet sieved (native water),recoverable,minimum summation, dry weight	micrograms per kilogram
Surface Water Quality	Deltamethrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Deltamethrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Desulfinylfipronil amide,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Desulfinylfipronil,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Diazinon,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Diazinon,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Diazinon,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Diazinon-d10,surrogate,Schedule 2002/9002,water,unfiltered	percent recovery
Surface Water Quality	Diazinon-d10,surrogate,Schedule 2003, water, filtered	percent recovery
Surface Water Quality	Diazinon-d10,surrogate,water,filtered (0.7 micron glass fiber filter)	percent recovery
Surface Water Quality	Diazoxon,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Dibenzo[a,h]anthracene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Dibenzothiophene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Dibromochloromethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Dicamba,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter

Data Type	Parameter	Unit
Surface Water Quality	Dicamba,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Dichlobenil,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Dichlorodifluoromethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Dichloromethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Dichlorprop,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Dichlorprop,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Dichlorvos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Dicrotophos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Dieldrin,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Dieldrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Dieldrin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Dieldrin,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Diethyl phthalate,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Dimethenamid oxanilic acid,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Dimethenamid sulfonic acid,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Dimethoate,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Dimethyl phthalate,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Di-n-butyl phthalate,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Di-n-octyl phthalate,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Dinoseb,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Diphenamid,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Discharge	cubic feet per second
Surface Water Quality	Discharge	cubicmeters per second
Surface Water Quality	Discharge,instantaneous	cubic feet per second
Surface Water Quality	Discharge,instantaneous	cubicmeters per second
Surface Water Quality	Dissolved oxygen,water,unfiltered	milligrams per liter
Surface Water Quality	Dissolved oxygen,water,unfiltered	percent of saturation
Surface Water Quality	Dissolved solids dried at 180 degrees Celsius,water,filtered	milligrams per liter
Surface Water Quality	Dissolved solids,water	tons per day
Surface Water Quality	Dissolved solids,water,filtered	tons per acre-foot
Surface Water Quality	Dissolved solids,water,filtered,sum of constituents	milligrams per liter
Surface Water Quality	Disulfoton sulfone,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Disulfoton sulfoxide,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Disulfoton,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Diuron,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Endosulfan ether,water,filtered,recoverable	micrograms per liter

Data Type	Parameter	Unit
Surface Water Quality	Endosulfan sulfate,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Endrin,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Endrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Endrin,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	EPTC,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Esfenvalerate,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Esfenvalerate,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Esfenvalerate,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Ethalfluralin,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Ethion monoxon,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Ethion,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Ethion,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Ethion,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Ethoprop,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Ethylbenzene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Europium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Fenamiphos sulfone,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fenamiphos sulfoxide,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fenamiphos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fenpropathrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Fenpropathrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Fenthion sulfoxide,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fenthion,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fenuron,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Fipronil sulfide,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fipronil sulfone,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fipronil,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Flufenacet oxanilic acid,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Flufenacet sulfonic acid,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Flumetralin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Flumetsulam,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fluometuron,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Fluoranthene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	Fluoride,water,filtered	milligrams per liter
Surface Water Quality	Fonofos oxygen analog,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fonofos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Fonofos,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Gage height	feet
Surface Water Quality	Gage height,above datum	meters
Surface Water Quality	Gallium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Gallium,water,filtered	micrograms per liter
Surface Water Quality	Germanium,water,filtered	micrograms per liter
Surface Water Quality	Glufosinate,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Glyphosate,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Gold,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Hardness,water	milligrams per liter as calcium carbonate
Surface Water Quality	Heptachlor epoxide,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Heptachlor epoxide,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Heptachlor epoxide,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Heptachlor,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Heptachlor,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Heptachlor,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Hexachlorobenzene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Hexazinone,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Holmium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Hydrogen ion,water,unfiltered	milligrams per liter
Surface Water Quality	Imazaquin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Imazethapyr,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Imidacloprid,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Indeno[1,2,3-cd]pyrene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Inorganic carbon, bed sediment, total, dry weight	grams per kilogram
Surface Water Quality	Inorganic carbon,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	grams per kilogram
Surface Water Quality	Inorganic carbon,bed sediment smaller than 62.5 microns,wet sieved (native water), field,recoverable,dry weight	percent
Surface Water Quality	Inorganic carbon,suspended sediment,total	milligrams per liter
Surface Water Quality	Iprodione,water,filtered,recoverable	micrograms per liter

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Data Type	Parameter	Unit
Surface Water Quality	Iron, water, unfiltered, micrograms per liter	micrograms per liter
Surface Water Quality	Iron,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	percent
Surface Water Quality	Iron,bed sediment,total digestion,dry weight	milligrams per kilogram
Surface Water Quality	Iron,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Iron,water,filtered	micrograms per liter
Surface Water Quality	Iron,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Isodrin,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Isofenphos,surrogate,Schedule 1319, water, unfiltered	percent recovery
Surface Water Quality	Isofenphos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Isophorone,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Isoquinoline,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	lambda-Cyhalothrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	lambda-Cyhalothrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	lambda-Cyhalothrin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Lanthanum,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Lead,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Lead,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Lead,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Lead,water,filtered	micrograms per liter
Surface Water Quality	Lead,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Lindane,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Lindane,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Lindane,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Lindane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Linuron,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Linuron,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Lithium, suspended sediment, recoverable	micrograms per liter
Surface Water Quality	Lithium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Lithium,bed sediment,dry weight	milligrams per kilogram
Surface Water Quality	Lithium,water,filtered	micrograms per liter
Surface Water Quality	Lithium,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Loss on ignition of suspended solids, water, unfiltered	milligrams per liter

Data Type	Parameter	Unit
Surface Water Quality	Magnesium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	percent
Surface Water Quality	Magnesium,water,filtered	milligrams per liter
Surface Water Quality	Malaoxon,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Malathion,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Malathion,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Malathion,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Manganese,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Manganese,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Manganese,bulk atmospheric deposition,suspended,micrograms per liter	micrograms per liter
Surface Water Quality	Manganese,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Manganese,water,filtered	micrograms per liter
Surface Water Quality	Manganese,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	MCPA,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	MCPB,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Mercury,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Mercury,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Mercury,biota,tissue,recoverable,dry weight	milligrams per kilogram
Surface Water Quality	Mercury,solids,total,dry weight	micrograms per kilogram
Surface Water Quality	Mercury,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Mercury,suspended sediment,total	nanograms per liter
Surface Water Quality	Mercury,water,filtered	nanograms per liter
Surface Water Quality	Mercury,water,filtered	micrograms per liter
Surface Water Quality	Mercury,water,unfiltered, recoverable	micrograms per liter
Surface Water Quality	Metalaxyl,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Metalaxyl,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Methidathion,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Methiocarb,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Methomyl,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Methomyl,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Methyl cis-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane-1-carboxylate,water,filtered, recoverable	micrograms per liter
Surface Water Quality	Methyl paraoxon,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Methyl parathion,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Methyl parathion,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Methyl parathion,water,unfiltered,recoverable	micrograms per liter

Data Type	Parameter	Unit
Surface Water Quality	Methyl trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane-1-carboxylate,water,filtered, recoverable	micrograms per liter
Surface Water Quality	Methyl trithion,bed sediment,dry weight,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Methyl trithion,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Methylene blue active substances, water, unfiltered, recoverable	milligrams per liter
Surface Water Quality	Methylmercury,solids,total,dry weight	micrograms per kilogram
Surface Water Quality	Methylmercury,suspended sediment,total	nanograms per liter
Surface Water Quality	Methylmercury,water,filtered, recoverable	nanograms per liter
Surface Water Quality	Metolachlor oxanilic acid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Metolachlor sulfonic acid,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Metolachlor, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	Metolachlor,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Metribuzin, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	Metribuzin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Metsulfuron-methyl,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Mirex,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Mirex,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Mirex,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Molinate,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Molybdenum,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Molybdenum,suspended sediment,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Molybdenum,water,filtered	micrograms per liter
Surface Water Quality	Molybdenum,water,unfiltered	micrograms per liter
Surface Water Quality	Myclobutanil,water,filtered,recoverable	micrograms per liter
Surface Water Quality	N-(4-Chlorophenyl)-N-methylurea,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Naphthalene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Napropamide,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Neburon,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Neodymium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Nickel,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Nickel,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Nickel,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Nickel,water,filtered	micrograms per liter

Data Type	Parameter	Unit
Surface Water Quality	Nickel,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Nicosulfuron,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Niobium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Nitrate plus nitrite,water,filtered	milligrams per liter as nitrogen
Surface Water Quality	Nitrate plus nitrite,water,unfiltered	milligrams per liter as nitrogen
Surface Water Quality	Nitrate,water,filtered	milligrams per liter as nitrogen
Surface Water Quality	Nitrate,water,filtered	milligrams per liter
Surface Water Quality	Nitrite,water,filtered	milligrams per liter as nitrogen
Surface Water Quality	Nitrite,water,filtered	milligrams per liter
Surface Water Quality	Nitrobenzene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Nitrobenzene-d5,surrogate,bed sediment smaller than 2 millimeters, wet sieved (native water), field	percent recovery
Surface Water Quality	N-Nitrosodi-n-propylamine,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	N-Nitrosodiphenylamine,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Noncarbonate hardness,water,filtered	milligrams per liter as calcium carbonate
Surface Water Quality	Noncarbonate hardness,water,unfiltered	milligrams per liter as calcium carbonate
Surface Water Quality	Norflurazon,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	o, p-DDD,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable, dry weight	micrograms per kilogram
Surface Water Quality	o, p-DDE,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable, dry weight	micrograms per kilogram
Surface Water Quality	o, p-DDT,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable, dry weight	micrograms per kilogram
Surface Water Quality	o, p-Methoxychlor,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	O-Ethyl-O-methyl-S-propylphosphorothioate,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Organic carbon, bed sediment, total, dry weight	grams per kilogram
Surface Water Quality	Organic carbon,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	grams per kilogram
Surface Water Quality	Organic carbon,bed sediment smaller than 62.5 microns,wet sieved (native water), field,recoverable,dry weight	percent
Surface Water Quality	Organic carbon,suspended sediment,total	milligrams per liter
Surface Water Quality	Organic carbon,water,filtered	milligrams per liter
Surface Water Quality	Organic carbon,water,unfiltered	milligrams per liter
Surface Water Quality	Organic nitrogen,water,filtered	milligrams per liter
Surface Water Quality	Organic nitrogen,water,unfiltered	milligrams per liter

Data Type	Parameter	Unit
Surface Water Quality	Orthophosphate,water,filtered	milligrams per liter
Surface Water Quality	Orthophosphate,water,filtered	milligrams per liter as phosphorus
Surface Water Quality	Oryzalin,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Oxamyl,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Oxychlordane,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Oxyfluorfen,water,filtered,recoverable	micrograms per liter
Surface Water Quality	p, p-DDD,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable, dry weight	micrograms per kilogram
Surface Water Quality	p, p-DDD,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	p, p-DDD,water,unfiltered, recoverable	micrograms per liter
Surface Water Quality	p, p-DDE,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable, dry weight	micrograms per kilogram
Surface Water Quality	p, p-DDE,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	p, p-DDE,water,filtered,recoverable	micrograms per liter
Surface Water Quality	p, p-DDE,water,unfiltered, recoverable	micrograms per liter
Surface Water Quality	p, p-DDT,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable, dry weight	micrograms per kilogram
Surface Water Quality	p, p-DDT,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	p, p-DDT,water,unfiltered, recoverable	micrograms per liter
Surface Water Quality	p, p-Methoxychlor,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	p, p-Methoxychlor,unfiltered,recoverable	micrograms per liter
Surface Water Quality	p, p-Methoxychlor,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	p,p-Ethyl-DDD, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	p,p-Ethyl-DDD,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Paraoxon,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Parathion,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Parathion,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Parathion,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Particulate nitrogen,suspended in water	milligrams per liter
Surface Water Quality	PCB congener 14,surrogate,bed sediment smaller than 2 millimeters, wet sieved (native water), field	percent recovery
Surface Water Quality	PCB congener 204,surrogate,bed sediment smaller than 2 millimeters, wet sieved (native water), field	percent recovery
Surface Water Quality	PCBs,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	PCBs,bed sediment,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	PCBs,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	p-Cresol,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Pebulate,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Pendimethalin,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Pentachloroanisole,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Pentachloronitrobenzene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Permethrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Permethrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	pH,water,unfiltered, field	standard units
Surface Water Quality	pH,water,unfiltered., laboratory	standard units
Surface Water Quality	Phenanthrene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Phenanthridine,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Phenol,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Phenothrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Phenothrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Pheophytin a,periphyton	milligrams per squaremeter
Surface Water Quality	Phorate oxygen analog,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Phorate,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Phorate,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Phosmet oxygen analog,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Phosmet,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Phosphate,water,unfiltered	milligrams per liter
Surface Water Quality	Phosphorus,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	percent
Surface Water Quality	Phosphorus,water,filtered	milligrams per liter as phosphorus
Surface Water Quality	Phosphorus,water,unfiltered	milligrams per liter as phosphorus
Surface Water Quality	Phosphorus,water,unfiltered	milligrams per liter as phosphate
Surface Water Quality	Picloram,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Picloram,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Polychlorinated naphthalenes,bed sediment,recoverable,dry weight	micrograms per kilogram

Data Type	Parameter	Unit
Surface Water Quality	Polychlorinated naphthalenes,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Potassium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	percent
Surface Water Quality	Potassium,water,filtered	milligrams per liter
Surface Water Quality	Profenofos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Prometon,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Prometon,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Prometryn,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Prometryn,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Propachlor,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Propanil,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Propargite,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Propazine,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Propetamphos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Propham,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Propham,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Propiconazole,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Propoxur,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Propyzamide,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	p-Terphenyl-d14,surrogate,bed sediment smaller than 2 millimeters, wet sieved (native water), field	percent recovery
Surface Water Quality	Pyrene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Quinoline,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Ratio of particulate nitrogen to particulate organic carbon	number
Surface Water Quality	Resmethrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Resmethrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Sample purpose	code
Surface Water Quality	Sample source	code
Surface Water Quality	Sample volume,Schedule 1319	milliliters
Surface Water Quality	Sample volume,Schedule 2001	milliliters
Surface Water Quality	Sample volume,Schedule 2003	milliliters
Surface Water Quality	Sample volume,Schedule 2010	milliliters
Surface Water Quality	Sample volume,Schedule 2050	milliliters
Surface Water Quality	Sample volume,Schedule 2051	milliliters
Surface Water Quality	Sample volume,Schedules 2002 and 9002	milliliters
Surface Water Quality	Sample volume,Schedules 2060 and 9060	milliliters
Surface Water Quality	Sample weight,Schedule 2501	grams
Surface Water Quality	Sampler type	code

Data Type	Parameter	Unit
Surface Water Quality	Sampling condition	code
Surface Water Quality	Sampling method	code
Surface Water Quality	Scandium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Selenium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Selenium,bed sediment,total digestion,dry weight	milligrams per kilogram
Surface Water Quality	Selenium,suspended sediment,total	micrograms per liter
Surface Water Quality	Selenium,water,filtered	micrograms per liter
Surface Water Quality	Selenium,water,unfiltered	micrograms per liter
Surface Water Quality	Set number	lab code 0113
Surface Water Quality	Set number	lab code 0114
Surface Water Quality	Set number	Schedule 2001
Surface Water Quality	Set number	Schedule 2010
Surface Water Quality	Set number	Schedule 2050
Surface Water Quality	Set number	Schedule 2051
Surface Water Quality	Set number	Schedule 2002
Surface Water Quality	Set number,Schedule 1319	code
Surface Water Quality	Set number,Schedule 2060	lab code 9060
Surface Water Quality	Set number,Schedule 2502	
Surface Water Quality	Siduron,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Silica,water,filtered	milligrams per liter as SiO2
Surface Water Quality	Silver,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Silver,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Silver,water,filtered	micrograms per liter
Surface Water Quality	Silver,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Silvex,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Silvex,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Silvex,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Simazine,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Simazine,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Simetryn,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Site visit purpose	code
Surface Water Quality	Sodium adsorption ratio,water	number
Surface Water Quality	Sodium fraction of cations,water	percent in equivalents ofmajor cations
Surface Water Quality	Sodium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	percent
Surface Water Quality	Sodium,water,filtered	milligrams per liter

Data Type	Parameter	Unit
Surface Water Quality	Specific conductance,water,unfiltered	microsiemens per centimeter at 25 degrees Celsius
Surface Water Quality	Specific conductance,water,unfiltered, laboratory	microsiemens per centimeter at 25 degrees Celsius
Surface Water Quality	Strontium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Styrene, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	Sulfate,water,filtered	milligrams per liter
Surface Water Quality	Sulfometuron-methyl,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Sulfotepp,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Sulfur,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	percent
Surface Water Quality	Sulprofos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Suspended sediment concentration	milligrams per liter
Surface Water Quality	Suspended sediment discharge	tons per day
Surface Water Quality	Suspended sediment,sieve diameter	percent smaller than 0.0625millimeters
Surface Water Quality	Suspended solids remaining after ignition, water, unfiltered	milligrams per liter
Surface Water Quality	Suspended solids, water, unfiltered	milligrams per liter
Surface Water Quality	Tantalum,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	tau-Fluvalinate,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	tau-Fluvalinate,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Tebupirimfos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Tebupirimphos oxygen analog,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Tebuthiuron,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Tefluthrin acid benzyl ester,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Tefluthrin acid pentafluorobenzyl ester,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Tefluthrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Tefluthrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Tefluthrin,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Temephos,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Temperature,air	degrees Celsius
Surface Water Quality	Temperature,water	degrees Celsius
Surface Water Quality	Terbacil,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Terbacil,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Terbufos oxygen analog sulfone,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Terbufos,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter

Data Type	Parameter	Unit
Surface Water Quality	Terbuthylazine,surrogate,water,filtered (0.7 micron glass fiber filter)	percent recovery
Surface Water Quality	Terbuthylazine,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Tetrachloroethene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Tetrachloromethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Tetramethrin,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Tetramethrin,suspended sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Thiobencarb,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Thorium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Tin,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Titanium,bed sediment smaller than 62.5 microns,wet sieved (native water), field,recoverable,dry weight	percent
Surface Water Quality	Titanium,water,filtered	micrograms per liter
Surface Water Quality	Toluene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Topical quality-control data purpose	code
Surface Water Quality	Total nitrogen (nitrate + nitrite + ammonia + organic-N),water,filtered,analytically determined	milligrams per liter
Surface Water Quality	Total nitrogen (nitrate + nitrite + ammonia + organic-N),water,unfiltered,analytically determined	milligrams per liter
Surface Water Quality	Total nitrogen,bed sediment,total, dry weight	milligrams per kilogram
Surface Water Quality	Total nitrogen,water,filtered	milligrams per liter
Surface Water Quality	Total nitrogen,water,unfiltered	milligrams per liter
Surface Water Quality	Total nitrogen,water,unfiltered	milligrams per liter as nitrate
Surface Water Quality	Toxaphene,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Toxaphene,bed sediment,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	Toxaphene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	trans-1,2-Dichloroethene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	trans-1,3-Dichloropropene, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	trans-Chlordane,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	trans-Nonachlor,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	trans-Permethrin,bed sediment smaller than 2 millimeters,wet sieved (native water),field,recoverable,dry weight	micrograms per kilogram
Surface Water Quality	trans-Propiconazole,water,filtered, recoverable	micrograms per liter
Surface Water Quality	Triallate,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Tribenuron-methyl,water,filtered,recoverable	micrograms per liter
Surface Water Quality	Tribromomethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Tribuphos,water,filtered,recoverable	micrograms per liter

Data Type	Parameter	Unit
Surface Water Quality	Tribuphos,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Trichloroethene,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Trichlorofluoromethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Trichloromethane,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Triclopyr,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Trifluralin, water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	Trifluralin,water,filtered (0.7 micron glass fiber filter),recoverable	micrograms per liter
Surface Water Quality	Trihalomethanes,water,unfiltered,maximum summation	micrograms per liter
Surface Water Quality	Turbidity, water, unfiltered	nephelometric turbidity units
Surface Water Quality	Turbidity,water,unfiltered	Jackson Turbidity Units
Surface Water Quality	Type of quality assurance data associated with sample	code
Surface Water Quality	Type of replicate	code
Surface Water Quality	Uranium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Vanadium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Vanadium,water,filtered	micrograms per liter
Surface Water Quality	Vinyl chloride,water,unfiltered,recoverable	micrograms per liter
Surface Water Quality	Water present,biota,tissue, recoverable, dry weight	percent
Surface Water Quality	Xylene (all isomers), water, unfiltered, recoverable	micrograms per liter
Surface Water Quality	Ytterbium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Yttrium,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Zinc,bed sediment smaller than 62.5 microns,wet sieved, filed, total digestion, dry weight	milligrams per kilogram
Surface Water Quality	Zinc,bed sediment,recoverable, dry weight	milligrams per kilogram
Surface Water Quality	Zinc,suspended sediment,recoverable	micrograms per liter
Surface Water Quality	Zinc,water,filtered	micrograms per liter
Surface Water Quality	Zinc,water,unfiltered,recoverable	micrograms per liter

APPENDIX 6-A. ADDITIONAL PROJECT AND MANAGEMENT ACTION PROJECTS

ATTACHMENT 2

This appendix includes projects and management actions that were approved by the ESJGSA Board of Directors at their September 11, 2024 meeting. At the meeting, the Board approved by resolution the addition of 5 projects to the GSP. These projects include:

- Mariposa Drain Water Delivery Improvement Project – Central San Joaquin Water Conservation District GSA
- South System Pipeline Phase 4 Improvement Project – North San Joaquin Water Conservation District GSA
- Q/Qc Conjunctive Use Project – South San Joaquin GSA
- SSJID Advanced Metering Infrastructure Project – South San Joaquin GSA
- Clements Road Pipeline Project – Stockton East Water District

The South System Pipeline Phase 4 Improvement Project is already included in the 42 projects listed in Table 6-1 and is discussed in Section 6.2.4.5 of the GSP. The other four projects are new additions that are not included in Table 6-1, nor in the writeups in the GSP, but are summarized below.

The addition of these four Category B projects have the potential to bring an additional 9,781 AF/year of recharge benefit to the Eastern San Joaquin subbasin. Combined with the 42 Category B projects already identified in Table 6-1, these 46 projects result in a total maximum benefit of 531,766 AF/year in groundwater offset/recharge/conservation that could potentially be made available to the Subbasin if funding and water rights are secured.

ATTACHMENT 2

Project Name	Project Type	Project Proponent	Measurable Objective Expected to Benefit	Current Status	Time-table (initiation and completion)	Estimated Costs		Required Permitting and Regulatory Process[1]	Maximum Recharge Benefit (AF/year)
						Capital	Annual O&M		
Additional Category B Projects - projects that are not anticipated to advance in the next five years, but may be implemented in the future, particularly if Category A projects do not fully achieve stated recharge and/or offset targets or do not produce a response as simulated in the model.									
Mariposa Drain Water Delivery Project	In-lieu Recharge	CSJWCD	Groundwater levels	Planning	To Be Determined	$300,000	To Be Determined	Not determined	5,000
Q/Qc Conjunctive Use Project	In-lieu Recharge	SSJ GSA	Groundwater levels	Design	2025	$4.5 million	To Be Determined	CEQA/NEPA (MND/ISMND), Power (Modesto Irrigation District), Road Encroachment Permits, SWPPP	1,081
SSJID Advanced Metering Infrastructure Project	In-lieu Recharge and Water Use Efficiency	SSJ GSA	Groundwater levels	Late Planning	2025	$5 million	$350,000	Not determined	2,500
Clements Road Pipeline Project	In-Lieu Recharge	SEWD	Groundwater levels	Planning	2025	$2.5 million	To Be Determined	Not determined	1,200
Total Additional Category B Projects									*9,781*
Total Category B Projects (including 4 new projects)									*531,766*

Mariposa Drain Water Delivery Project

CSJWCD receives federal contract water from New Melones Dam on the Stanislaus River. This water is released to SEWD via Goodwin Tunnel and then to Farmington Dam. Stored water from the dam is then released to Rock Creek which flows to Little Johns Creek, and then into Temple and Duck Creek. Water is pumped from these three creeks to serve farms via both developed and non-developed facilities of CSJWCD at each pump site. One such system is the 6.6-mile-long Mariposa Drain Delivery System. Currently, there are four fixed-speed pumps used to lift water from Little Johns Creek into the Mariposa Drain Delivery System for water deliveries. Downstream demands are impossible to meet with four fixed speed pumping systems, unless over-pumping is performed, which is nearly always the case. Such over delivery is an inefficient use of both electricity and water as unused water is lost at the end of the delivery system.

This project would convert two of these pumps to variable speed drive pumps and automate the first downstream gate structure to communicate with the newly converted pumps. These changes will help better regulate flows to more closely match downstream demands, thereby reducing over-commitment of water and improving service to customers. To better match downstream demand with flow will free up ditch capacity that will then be used to serve additional agricultural land, further offsetting groundwater use with surface water deliveries. Future phases of this project would include the automation of the other check structures and two downstream lift stations in the Mariposa Delivery system to further enhance water control and conservation of both water and electricity.

Project Summary	
Submitting GSA:	Central San Joaquin Water Conservation District
Project Type:	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	5,000 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: The project is still in the initial planning stages and will move forward as funding becomes available. CSJWCD is applying for a WaterSmart Grant to fund the first phase of this project.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation and completion dates for this project are currently unknown.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 5,000 AF/year in groundwater pumping in CSJWCD. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project relies on this use of surface water from the New Melones Unit Central Valley Project. The surface water source is based upon a contract with the United States for delivery of surface water from the New Melones Unit of the Central Valley Project. The contract is long-term; however, water availability is subject to drought conditions. This is an existing water right.

Legal Authority: The Water Code, Division 21 §74000 et seq. authorizes CSJWCD to acquire, sell, and distribute water and fix rates for service throughout the District.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $300,000 in capital costs. Annual operations and maintenance costs are unknown at this time. Costs for this project would be met by grant funding.

Circumstances for Implementation: This project is a Category B project and may move forward as funding becomes available. Category B projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects. As scenarios change, the project can come online to bring additional resources for adaptive management. Circumstances for implementation include securing funding. Project may be implemented on a smaller scale depending on use of water by other projects in the District.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on funding availability.

Q/Qc Conjunctive Use Project

SSJID has identified several projects aimed at enhancing irrigation service demand, capacity, and the cost-effectiveness of implementation. One high-priority project is the construction of a regulating basin at the District's Lateral Q and Lateral Qc junction. The project involves the construction of a new 18.4-acre lined operating regulating basin with a storage capacity of 60 acre-feet, a new water service turnout, and a Q-Qc lateral interconnection. The project will be equipped with SCADA technology to provide better measurement and control to ensure supply matches demand.

The Project will enable the delivery of surface water to areas currently reliant on groundwater. The project would reduce operational spills by 650 AF/year, reduce agricultural demands by 40 AF/year, and replace 1,081 AF/year of groundwater use with surface water, thereby conserving groundwater for drought periods. The total water supply benefits will be 1,771 AF/year. The project will benefit agricultural, rural and urban water users.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	1,081 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: The project is at the 70% design stage. The initial study was completed in 2023, and SSJ GSA has executed a Property Purchase Agreement with the local landowner.

Required Permitting and Regulatory Process: CEQA/NEPA - MND/ISMND, Power through Modesto Irrigation District, roads encroachment permits through San Joaquin County, SWPPP

Time-table for Initiation and Completion: Construction on this project is expected to begin as soon as Fall of 2025.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 1,081 AF/year in groundwater pumping in the District's extent. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: SSJID holds pre- and post-1914 water rights on the Stanislaus River. These are existing water rights.

Legal Authority: SSJID is an irrigation district formed in accordance with State law. SSJID has an executed land purchase agreement to buy the property required for the project.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $4.5 million in capital costs. Annual operations and maintenance costs are unknown at this time. Costs for this project would be met by grant funding, district capital reserves, and through rate payers.

Circumstances for Implementation: This project is a Category B project and may move forward as funding becomes available. Category B projects represent a "menu of options" for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects. As scenarios change, the project can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on bids received, and final award by the Board of Directors.

SSJID Advanced Metering Infrastructure Project

SSJID is proposing the use of real-time flower meters, equipped with telemetry, on more than 400 service connections. This installation would improve on-farm water management and reporting of water use to the District. This would allow for higher accuracy and precision for surface water deliveries made to District customers. Additionally, the District would make this information available to the customers, allowing for customers to see near-real time pumping volumes. This improvement is anticipated to provide 5-6% of water savings to customers, resulting in 2,500 AF of groundwater offset annually.

Project Summary	
Submitting GSA:	South San Joaquin GSA
Project Type:	In-Lieu Recharge and Water Use Efficiency
Estimated Groundwater Offset and/or Recharge:	2,500 AF/year

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities by improving water use efficiency.

Project Status: The project is in the late planning stages. SSJ GSA is finalizing the equipment specifications and cost estimates.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: Equipment procurement for this project is expected in Fall 2025.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset up to 2,500 AF/year in groundwater pumping by improving water use efficiency. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: This project will improve water use efficiency of existing water. The District will use the Irrigation Operations and SCADA work force to install.

Legal Authority: SSJID is an irrigation district formed in accordance with State law. SSJID has executed Right to Enter Agreements with customers.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $5 million in capital costs. Annual operations and maintenance costs are estimated at $350,000. Costs for this project would be met by grant funding, district capital reserves, and through rate payers.

Circumstances for Implementation: This project is a Category B project and may move forward as funding becomes available. Category B projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects. As scenarios change, the project can come online to bring additional resources for adaptive management.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on approval by the Board of Directors.

Clements Road Pipeline Project

This project is a continuation of the Water Supply Enhancement Project which aims to enhance water supply accessibility for on-farm in-lieu recharge by distributing surface through the proposed Clements Gravity Pipeline. By providing surface water to farmers who currently lack access, the project will reduce groundwater overdraft in these regions. Additionally, this project will provide a more resilient water delivery to urban customers in drought periods by providing surface water in addition to groundwater for conjunctive use. The estimated water offset is 1,200 acre-feet per year, depending on the water year type.

Project Summary	
Submitting GSA:	Stockton East Water District
Project Type:	In-Lieu Recharge
Estimated Groundwater Offset and/or Recharge:	1,200 AF/yr

Measurable Objective Expected to Benefit: This project addresses chronic lowering of groundwater levels in the Subbasin by enhancing in-lieu recharge opportunities.

Project Status: The project is still in the initial planning stages and will move forward as funding becomes available. SEWD is applying for a WaterSmart Grant to fund this project.

Required Permitting and Regulatory Process: The required permitting and regulatory process for this project has not been determined.

Time-table for Initiation and Completion: The initiation and completion dates for this project are currently unknown.

Expected Benefits and Evaluation: Groundwater Subbasin recharge through the in-lieu use of alternate water supply will be an important component of the GSP and will be critical to establishing long-term Subbasin sustainability. This project is anticipated to offset additional groundwater pumping in the SEWD service area. Benefits to groundwater levels will be evaluated through ESJWRM model simulations.

How Project Will Be Accomplished/Evaluation of Water Source: The identification of water source will occur as project develops.

Legal Authority: SEWD is a local agency with its own enabling legislation established to serve water for agricultural and municipal demands. SEWD is also a GSA with authority on groundwater pumping.

Estimated Costs and Plans to Meet Costs: The estimated costs for this project include $2.5 million in capital costs. Annual operations and maintenance costs are unknown at this time. Costs for this project would be met by grant funding, and District funds.

Circumstances for Implementation: This project is a Category B project and may move forward as funding becomes available. Category B projects represent a “menu of options” for the Subbasin to achieve long-term sustainability and offset the remaining imbalance above and beyond implementation of the Category A projects. As scenarios change, the project can come online to bring additional resources for adaptive management. Circumstances for implementation include securing funding. Project may be implemented on a smaller scale depending on use of water by other projects in the District.

Trigger for Implementation and Termination: Not applicable.

Process for Determining Conditions Requiring the Project have Occurred: Implementation of this project will be based on funding availability.

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APPENDIX 6-B.
TECHNICAL MEMORANDUM NO.6 – DEMAND MANAGEMENT PROGRAM

TECHNICAL MEMORANDUM NO. 6 – DEMAND MANAGEMENT PROGRAM

TO: Paul Gosselin, California Department of Water Resources, Deputy Director

CC: Ashley Couch, on behalf of the Eastern San Joaquin Groundwater Authority

PREPARED BY: GSA Legal Representation & Emily Honn, Woodard & Curran

REVIEWED BY: Katie Cole and Leslie Dumas, Woodard & Curran

DATE: November 2024

RE: Demand Management Program in Eastern San Joaquin Subbasin

1. PURPOSE

The California Department of Water Resources (DWR) and the State Water Resources Control Board (SWRCB) are directing groundwater basins to include a "Demand Management Program" in their Groundwater Sustainability Plans (GSPs) as a backstop to achieving the basin's sustainability goal. Their reasoning is that surface water availability and the funding and actual completion of projects and management actions (PMAs) to use more surface water (in-lieu of groundwater) are uncertain. The State wants to see that each basin has a detailed plan in place to allocate and impose pumping restrictions if needed to prevent undesirable results.

The 2020 Eastern San Joaquin (ESJ) Subbasin GSP noted that "…if the projects do not progress, or if monitoring efforts demonstrate that the projects are not effective in achieving stated recharge and/or offset targets, the GWA will convene a working group to evaluate supply-side and demand-side management actions such as the implementation of groundwater pumping curtailments, land fallowing, etc." And it was subsequently identified in the 2022 Revised GSP that mandatory demand reductions may be considered as an adaptive management strategy for the ESJ Subbasin. In the 2024 Plan Amendment, a new management action is being added to describe the development of a demand management program that can be used as a backstop, if necessary, to achieve and/or maintain the Subbasin's sustainability goal.

It is the still the overall theme and goal of the ESJ GSP to first implement supply projects to manage overdraft and reach basin sustainability. The Demand Management Program is a management action intended to respond to direction provided by the State and outline the demand side actions that would be taken if supply side actions are not effective in meeting overall basin sustainability goals.

1.1 Strategies to Reduce Groundwater Use

There are two principal ways to reduce reliance on groundwater as the GSP is implemented:

1. Decrease demand
2. Increase supply

Reducing groundwater demand can be done through a variety of different strategies, including changes to cropping, land fallowing, land repurposing, and conservation. Strategies to increase supply have been identified by the GSAs and are included in Chapter 6 of the GSP as projects. These projects either directly recharge groundwater with surface water or provide surface water to meet groundwater demand so that groundwater pumping is reduced without changing the land use or total water demand (in-lieu recharge). To date, the Eastern San Joaquin Subbasin GSP has focused on implementing projects to address overdraft.

For the ESJ Subbasin, the schedule of implementation, source, and timing of the funding, design, and ultimately construction of some of the PMAs, poses uncertainties in terms of realizing the benefits of those projects in the expected timeline. For this reason, the GSAs are developing a demand management program as a backstop. The GSAs can adjust the demand management program as the projects are implemented.

2. GROUNDWATER DEMAND REDUCTION TARGET

Without consideration to the possible (and uncertain) impacts of climate change, the Eastern San Joaquin Water Resources Model (ESJWRM) Version 3.0 indicates that the Subbasin needs to reduce groundwater use by approximately 95,000 acre-feet per year (AFY) in order to achieve an annual 0 AF change in storage. In other words, to halt the continued downward decline in groundwater storage, 95,000 AFY of groundwater offset is estimated to be required. Given the inherent uncertainties with groundwater models and other factors (cropping patterns, hydrology, etc.), the GSAs are using 95,000 AFY as an initial demand management target for planning purposes, using results from ESJWRM Version 3.0. The 2024 Model Documentation TM, included in Appendix 2-C to the 2024 GSP Amendment, provides additional detail on the model assumptions used to derive this targeted reduction value.

Notably, the ESJWRM estimates that the annual overdraft in the basin is approximately 30,000 AFY, which is approximately one-third of the estimated pumping reduction required to achieve a 0 AF change in storage. The relationship between annual basin overdraft and annual pumping reduction is not a one-to-one relationship in numerical modeling. This is because pumping (or lack of pumping) may cause changes in groundwater levels that impact head gradients in other inflows or outflows in the model. Less pumping near a stream, for example, would raise groundwater levels and may induce additional outflow to the stream. More pumping on the edge of the Subbasin might lower groundwater levels and induce additional inflow from surrounding subbasins. Iterating across a variety of different demand reduction scenarios demonstrates the simulated relationship between pumping reduction and resulting change in storage within the Subbasin. Figure 1 shows the results of these iterations plotted on a single graph.

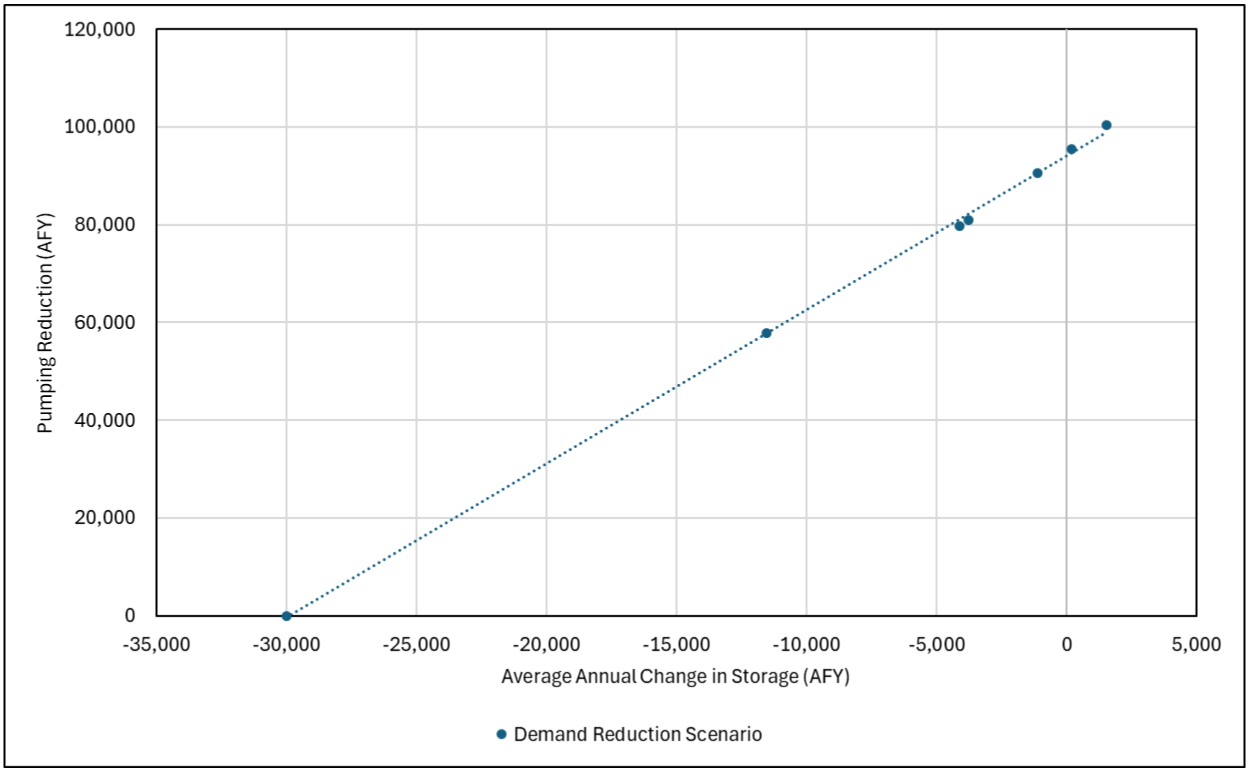

FIGURE 1: AVERAGE ANNUAL CHANGE IN STORAGE UNDER VARIOUS LEVELS OF DEMAND REDUCTION

Figure 1 assumes a future Baseline condition of pumping projected from DWR's 2022 land use map-derived cropping patterns and urban pumping records. The simulations used to estimate the average annual change in storage associated with each pumping reduction level assume no Category A project has been implemented.

Groundwater recharge associated with the implementation of Category A projects would be credited towards the 95,000 AFY reduction target. This includes projects contained in the 2024 GSP Amendment, and any new project that would be added to the Category A PMA list in the future. ESJWRM currently assumes that the Subbasin will implement the Category A projects listed in the 2024 GSP in the next five years.

Projects are comprised of both in-lieu recharge projects and direct recharge projects. Projects identified as Category A projects[1] in the 2024 GSP Amendment are expected to have a large range of groundwater storage contributions based on future hydrology assumed between 2025 and 2030. On average, across all

[1] Category A projects are defined as those that are likely to advance by 2030, and have secured necessary water rights, permits, or contracts.

year types, the Category A projects are expected to contribute 67,000 AFY of surface water to the basin, either directly or via in-lieu use of surface water. Table 1 shows the expected average contribution to groundwater storage to be achieved Category A projects, by project type and by water year type, in acre-feet per year.

TABLE 1: ANTICIPATED BENEFITS OF CATEGORY A PROJECTS

Project Type	Water Year Type	Average Contributions to Groundwater Storage (AFY)
In-Lieu Recharge	Drought	30,000
	Dry	36,000
	Normal	65,000
	Wet	69,000
	Average	50,000
Direct Recharge	Drought	7,000
	Dry	10,000
	Normal	24,000
	Wet	27,000
	Average	17,000

Over 55 years of hydrology simulated in ESJWRM Version 3.0, it is expected that, on average, the Category A projects recharging 67,000 AFY of surface water into the ESJ Subbasin will result in 33,000 AFY of annual demand offset after accounting for recharged water lost to other subbasins and streams. This remaining water in storage will offset pumping and would be directly credited against the total 95,000 AFY deficit.

The Demand Management Program will lay out how the Subbasin will make up the difference between the expected average annual 33,000 AFY of demand offset resulting from Category A project implementation and the estimated 95,000 AFY of total demand reduction currently estimated to be necessary to achieve zero AFY change in storage. Generally, the GSAs have agreed to allocated between themselves the responsibility for reducing groundwater demands in the Subbasin by 56,000 AFY, or the amount of pumping reduction needed to address the -13,000 AFY average annual change in storage. . The remaining 6,000 AFY of pumping reductions represents an approximate margin of error due to modeling. This difference could be met with more demand reduction or more direct or in-lieu recharge from projects. Figure 2 shows a visualization of how the 95,000 AFY of groundwater demand reduction would generally be addressed.

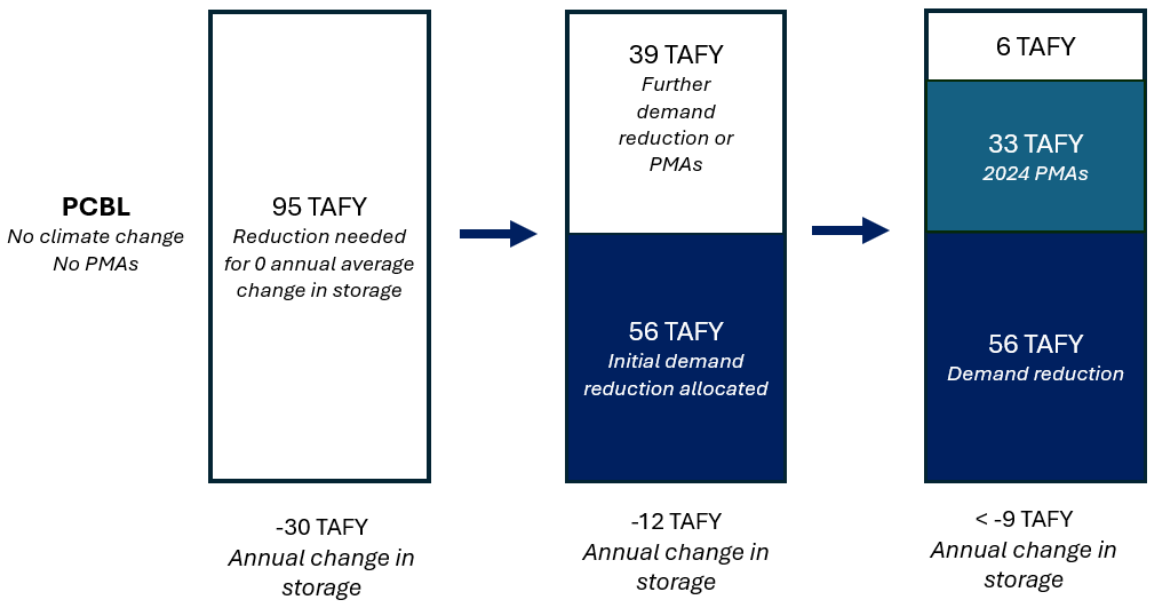

FIGURE 2: PORTION OF STORAGE DEFICIT MET BY PMAS OR DEMAND REDUCTION

3. DEMAND MANAGEMENT PROGRAM FRAMEWORK

3.1 Overview

The GSAs and ESJGWA have committed to adopting a Demand Management Program (DM Program) by December 31, 2027. The Program will have the following elements:

- Stated goal of total demand reduction to achieve a modeled zero change in groundwater storage conditions by 2040, implemented either by PMAs that directly recharge groundwater or provide surface water to meet groundwater demand so that pumping is reduced without changing the land use; or reducing pumping through changes in cultivated agriculture, land fallowing or land repurposing that reduces the total demand for water, or a combination of both.

- The DM Program will include strict timelines for phased implementation so that if deadlines for PMA implementation are not met, the GSA will immediately implement the adopted reduced pumping requirements.

- The Demand Management goal will be imposed upon individual GSAs on a pro-rata basis in relation to their contribution to the identified basin overdraft at the time the program is implemented.

- The Demand reduction goal will be updated annually based on model runs and updated data and assumptions.

- The GSAs will agree on an initial allocation of responsibility for reducing demand within their GSA areas by December 31, 2026.
  - The GSAs agree that this allocation of responsibility is not a determination of rights to pump or rights to specific types of groundwater, is not an admission by any party, and is for planning purposes only.
  - At the same time, this initial allocation agreement shall also include an agreement on a process to track GSA water budgets consistently across the Subbasin, with actual data reported annually that is shared with all GSAs in the subbasin.
- Each GSA with allocated responsibility must adopt an enforceable demand management program within their GSA by December 31, 2027 and begin implementation by December 31, 2028. Failure to do so may result in referral to a dispute resolution process, creation of a management area, or other action by the other GSAs for legal or equitable remedy.

3.2 Adaptive Management Approach

Adaptive management is a key component of the DM Program. A program that is flexible and developed to adapt to changing conditions will be the most effective. The unknown factors in meeting the demand management goals may include, but are not limited to, the following:

- <u>Hydrology of the next five years:</u> The benefits (recharge) accrued from PMAs vary based on the availability of surface and storm water over the next few years, as shown in Table 1. Projects that rely on excess surface water to be implemented will not produce benefits in drought years.
- <u>Implementation schedule of identified PMAs:</u> It is unknown what legal, financial, or environmental hurdles could delay the implementation of PMAs. These delays could be specific to a GSA, or the Subbasin as a whole. For example, the Covid-19 pandemic caused significant delays in project implementation that were not anticipated at the time that the 2020 GSP was developed.
- <u>Estimation of PMA Contributions:</u> Not all projects may be able, once implemented, to produce the anticipated benefits estimated during the planning process, even without project delays.
- <u>Model Uncertainty:</u> Through future monitoring, the GSAs will be able to assess model uncertainty and improve model estimations as new data becomes available.

Given these unknowns, the DM Program will be adapted on an annual basis. Each year, the hydrologic conditions will be evaluated through the existing annual report process. Progress toward reaching PMA goals will be reported by GSAs as well. The ESJWRM flow model will be updated annually to incorporate the latest hydrologic conditions and demand assumptions. It will then be used to calculate a new demand reduction target. Through this iterative approach the Subbasin will be able to adjust the approach to the natural conditions and accommodate any project delays.

3.3 Schedule

In anticipation of reaching sustainability by 2040, Table 2 shows the proposed schedule of the DM Program over the next 15 years, organized by obligations on the part of the GWA and individual GSAs.

TABLE 2: ANTICIPATED SCHEDULE OF PROGRAM IMPLEMENTATION

Year	Eastern San Joaquin GWA	Individual GSAs
2025	• Refine model as part of, or just following, the development of the annual report. • Develop process for recalculating target pumping reduction annually. • Develop approach for annual allocation of reduction among GSAs based on hydrology, PMA implementation, and other ongoing groundwater demand management efforts.	• Monitor and report groundwater conditions, as required. • Implement PMAs and track benefits.
2026	• Refine model, if needed, and recalculate target pumping reduction. • Test and refine annual process for recalculating target pumping reduction. • Test and refine approach for annual allocation of reduction among GSAs.	• Monitor and report groundwater conditions, as required. • GSAs agree on initial allocation of responsibility by December 31, 2026. • GSAs implement PMAs and track benefits.
2027		• Monitor and report groundwater conditions, as required. • Each GSA with allocated responsibility must adopt an enforceable DM Program within their GSA by December 31, 2027. • GSAs implement PMAs and track benefits.
2028	• Subbasin will initiate the 2030 GSP Update.	• Monitor and report groundwater conditions, as required. • GSAs implement DM Program by December 31, 2028. • GSAs implement PMAs and track benefits.

Year	Eastern San Joaquin GWA	Individual GSAs
2029	• Develop the 2030 GSP Periodic Evaluation and GSP Amendment (if needed), including detailed description of the implemented DM Program.	• Monitor and report groundwater conditions, as required. • First year of DM Program implementation, if needed. • GSAs implement PMAs and track benefits.
2030	• Submit 2030 GSP Periodic Evaluation and GSP Amendment (if needed) to DWR.	• Monitor and report groundwater conditions, as required. • GSAs implement PMAs and track benefits.
2031-2039	• Evaluate progress toward sustainability in 2035 GSP Periodic Evaluation and determine prescriptive plan for addressing remaining overdraft by 2040.	• Monitor and report groundwater conditions, as required. • Continue to implement DM Program and adapt as necessary each year. • GSAs implement PMAs and track benefits.
2040	Subbasin reaches sustainability.	