

**FINAL REPORT**

South American Subbasin Groundwater Sustainability Plan



South American  
**SUBBASIN**



**RECLAMATION DISTRICT 551**

# **SOUTH AMERICAN SUBBASIN GROUNDWATER SUSTAINABILITY PLAN**

**FINAL**

## **ACKNOWLEDGEMENTS**



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**Contributing GSAs**

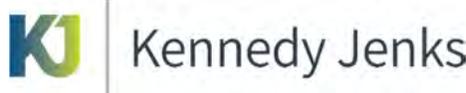
South American  
**SUBBASIN**



**RECLAMATION DISTRICT 551**

Northern Delta Groundwater Sustainability Agency, Omochumne – Hartnell Water District, Reclamation District 551, Sacramento Central Groundwater Authority, Sacramento County, and Sloughhouse Resource Conservation District contributed to the development of the South American Subbasin Groundwater Sustainability Plan.

**South American Subbasin Consulting Team**



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Also, staff of SCGA have contributed to the development of the South American Subbasin Groundwater Sustainability Plan, as has The Freshwater Trust, who performed technical services as in-kind contribution for the Northern Delta GSA.



LARRY WALKER ASSOCIATES

**South American Subbasin  
Groundwater Sustainability Plan**

Northern Delta Groundwater Sustainability Agency  
Omochumne-Hartnell Water District  
Reclamation District 551  
Sacramento Central Groundwater Authority  
Sacramento County  
Sloughouse Resource Conservation District

October 29, 2021

This report was prepared by the staff and subconsultants of Larry Walker Associates under the supervision of the Engineer(s) and/or Geologist(s) whose seal(s) and signature(s) appear hereon.

The findings, recommendations, specifications, or professional opinions are presented within the limits described by the client, in accordance with generally accepted professional engineering and geologic practice. No warranty is expressed or implied.



Date Signed: 10/29/21



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## Glossary

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Basin Management Objectives	Five objectives defined by the Central Sacramento County Groundwater Management Plan to help ensure viable groundwater resources for beneficial uses. The BMOs serve as a starting point for the development of the Sustainable Management Criteria. The five BMOs are to maintain the long-term average groundwater extraction rate at or below 273,000 acre-feet per year (AF/year); maintain specific groundwater elevations within all areas of the groundwater basin consistent with agreements in the WFA; protect against any potential inelastic land surface subsidence by limiting subsidence to no more than 0.007 feet per 1 foot of drawdown in the groundwater basin; protect against any adverse impacts to surface water flows in the American, Cosumnes, and Sacramento Rivers; and attain adopted water quality objectives.
Central Basin	The locally-defined Sacramento Central Groundwater Basin (SCGA's jurisdiction)
CoSANA Model	Cosumnes, South American, North American (Subbasins) Integrated Hydrological Model
Groundwater Dependent Ecosystems	Beneficial user of groundwater that rely on a connection to shallow groundwater, typically characterized by the depth to groundwater and the vegetation rooting depth.
Groundwater Sustainability Agency	A local agency or combination of local agencies with water supply, water management, or land use responsibilities may establish a Groundwater Sustainability Agency. It is the GSA's responsibility to develop and implement a groundwater sustainability plan that considers all beneficial uses and users of groundwater in the basin/subbasin.
Groundwater Sustainability Plan (GSP)	GSAs must develop GSPs in accordance with the requirements of the California Department of Water Resources' GSP Regulations. The GSP(s) must include management criteria (minimum thresholds, measurable objectives and interim milestones) that ensure basin sustainability within 20 years of GSP adoption. A basin may be managed by a single GSP or multiple coordinated GSPs.
Groundwater Sustainability Plan Working Group	A GSP Working Group was established per a Memorandum of Understanding to provide recommendations related to development of the GSP. This GSPWG is comprised of representatives from five of the six GSAs within the Subbasin and follows a consensus-based decision-making structure, where each GSA representative receives an equal voice. The GSPWG conducts regular coordination meetings to discuss GSP technical development and public outreach and engagement activities in order to prepare a GSP for ultimate adoption by the respective GSA Boards and submittal to DWR by January 31, 2022.

Hydrogeologic Conceptual Model	Complies geologic, hydrologic, hydraulic, chemical, environmental and other information into an integrated understanding of surface and subsurface conditions in which water is flowing through in the Basin
Measurable Objective	Specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted GSP to achieve the sustainability goal for the basin.
Minimum Thresholds	Numeric values that define the lowest acceptable level above which undesirable results do not occur at each monitoring location for each sustainability indicator.
Monitoring Network	A network comprised of monitoring points that track sustainability indicators. Each point has a minimum threshold and a measurable objective. Adequate spatial and temporal coverage are required for the subbasin in order to properly chart progress toward sustainable management of the groundwater resources.
Plan Area	Describes the Basin, including major streams and creeks, institutional entities, land uses, and locations of production wells
South American Subbasin	The South American Subbasin (SASb) (DWR Bulletin 118, 5- 21.65) is a high priority subbasin within the larger Sacramento Valley Groundwater Basin. A majority of the SASb is surrounded by rivers including the American River on the northern boundary, the Cosumnes and Mokelumne Rivers on the south, and the Sacramento River on the western boundary. The eastern boundary is not bounded by a river, but is located at the transition between alluvial sediments of the groundwater basin and the foothills of the Sierra Nevada. The SASb shares boundaries with five adjacent subbasins: the Yolo Subbasin to the northwest, Solano Subbasin to the west, North American Subbasin to the north, and the Eastern San Joaquin and Cosumnes Subbasins to the south.
South American Subbasin Groundwater Sustainability Agencies	County of Sacramento, Northern Delta, Reclamation District #551, Omochumne-Hartnell Water District, Sacramento Central Groundwater Authority, and Sloughouse Resource Conservation District
Sacramento Central Groundwater Authority	SCGA is a Joint Powers Authority composed of the County of Sacramento and the cities of Elk Grove, Folsom, Rancho Cordova and Sacramento. The SCGA is responsible for groundwater management in the locally-defined Central Basin. The Central Basin overlaps considerably with the South American Subbasin.

Sustainable Groundwater Management Act	A California Law, comprised of three bills (AB 1739, SB 1168, and SB 1319), that provides local agencies with a framework for managing groundwater basins/subbasins in a sustainable manner. Recognizing that groundwater is most effectively managed at the local level, SGMA empowers local agencies by providing them with the authority, the technical and the financial means necessary to achieve sustainability within 20 years.
Sustainability Goal	Goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline.
Sustainability Indicators	Any of the effects caused by groundwater conditions occurring throughout the basin that, when significant and unreasonable, cause undesirable results. These indicators include: chronic lowering of groundwater levels, reduction of groundwater storage, seawater intrusion, degraded water quality, land subsidence, and depletion of interconnected surface waters.
Sustainable Management Criteria	Developed by the GSA(s) to define undesirable results, based on minimum thresholds, measurable objectives and interim milestones for each monitoring point for each applicable sustainability indicator.
Undesirable Results	Significant and unreasonable occurrence of any of the six sustainability indicators constitutes an undesirable result.
Water Budget	Quantification of water entering and leaving a basin for historical, current, and projected time periods

## Acronyms and Abbreviations

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AB	Assembly Bill
Aerojet	Aerojet-General Corporation
AF	Acre-feet
AF/Year	Acre-Feet per Year
AFB	Air Force Base
AGLAND	Irrigated Agricultural Land Waiver
Ag-Res	Agricultural Residential
Alternative	Alternative Submittal for GSP
AMSL	Above Mean Sea Level
bgs	Below Ground Surface
BMO	Basin Management Objective
BMP	Best Management Practices
Board	Board of Directors for Sacramento Central Groundwater Authority
C&E Plan	Communication and Engagement Plan
C2VSimCG	California Central Valley Groundwater-Surface Water Simulation Model Coarse Grid
CASGEM	California Statewide Groundwater Elevation Monitoring
CCR	California Code of Regulations
CDEC	California Data Exchange Center
cfs	Cubic Feet per Second
CGPS	Continuous Global Positioning System
CI	Commercial and Industrial
CNRA	California Natural Resources Agency
COSb	Consumnes Subbasin
CoSANA Model	Cosumnes, South American, North American Subbasins Integrated Hydrological Model
CSCGF	Central Sacramento County Groundwater Forum
CSCGMP	Central Sacramento County Groundwater Management Plan
CVGSM	Central Valley Integrated Groundwater Surface Water Model
CVRWQCB, Central Valley Water Board	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWC	California Water Code
DA	Decline Area
DAC	Disadvantaged Communities
Delta	Sacramento-San Joaquin Delta
DDW	Division of Drinking Water
DPR	California Department of Pesticide Regulation

DTW	Depth to Water
DWR	California Department of Water Resources
EDF	Electronic Deliverable Format
EIR	Environmental Impact Report
ELAP	California Environmental Laboratory Accreditation Program
EPA	Environmental Protection Agency (United States)
ET	Evapotranspiration
Flood-MAR	Flood Managed Aquifer Recharge
GAMA	Groundwater Ambient Monitoring and Assessment Program
GDE	Groundwater Dependent Ecosystems
GIS	Geographic Information System
GMP	Groundwater Management Plan
GSA	Groundwater Sustainability Agency
GSP, Plan	Groundwater Sustainability Plan
GSPWG	Groundwater Sustainability Plan Working Group
GWE	Groundwater Elevation
GW-SW	Groundwater-Surface Water
HCM	Hydrogeologic Conceptual Model
IDW	Inverse Distance Weighted
IM	Interim Milestone
InSAR	Interferometric Synthetic Aperture Radar (USGS)
IRCT	McDonnell Douglas (Boeing) Inactive Rancho Cordova Test Site
ISW	Interconnected Surface Water
JPA	Joint Powers Authority
LFG	Landfill gas
LCRS	Leachate collections and removal systems
m	Meter
Mather AFB	Mather Air Force Base
McClellan AFB	McClellan Air Force Base
MCL	Maximum Contaminant Level
µg/L	Micrograms per Liter
mg/L	Milligrams per Liter
MGD	Million Gallons per Day
MO	Measurable Objective
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MT	Minimum Threshold
NASb	North American Subbasin
NDGSA	Northern Delta Groundwater Sustainability Agency
NDMA	Nitrosodimethylamine
NDWI	Normalized Difference Water Index
NGVD 29	National Geodetic Vertical Datum of 1929

NRCS	Natural Resources Conservation Service
NSSDA	National Standard for Spatial Data Accuracy
OHWD	Omochumne-Hartnell Water District
PDF	Portable Document Format
PFAS	Polyfluoroalkyl Substances
PMA	Potential Management Actions
PWS	Public Water Supply
RA	Recharge Area
RD	Reclamation District
RMP	Representative Monitoring Point
RP	Reference Point
RPE	Reference Point Elevation
RWA	Regional Water Authority
SacIGSM	Sacramento Integrated Groundwater Surface Water Model
SAFCA	Sacramento Area Flood Control Agency
SAGBI	Soil Agricultural Banking Index
SASb, Basin	South American Subbasin
SB	Senate Bill
SCADA	Supervisory control and data acquisition
SCGA	Sacramento Central Groundwater Authority
SCWA	Sacramento County Water Agency
SGMA	Sustainable Groundwater Management Act
SMC	Sustainable Management Criteria
SMCL	Secondary Maximum Contaminant Level
SMWP	State Monitoring Well Program
SRCD	Sloughouse Resource Conservation District
CSUS	California State University - Sacramento
Staff Report	Sustainable Groundwater Management Program Alternative Assessment Staff Report – South American Subbasin
State Water Board	State Water Resources Control Board
SWP	State Water Project
TCE	Trichloroethylene
TDS	Total dissolved solids
TFT	The Freshwater Trust
UCD	University of California, Davis
UNAVCO	University NAVSTAR Consortium
UR	Undesirable Result
USGS	United States Geological Survey
UST	Underground Storage Tanks
VOC	Volatile Organic Chemical
VSWTP	Vineyard Surface Water Treatment Plant

Water Forum  
Water Forum  
Agreement, WFA  
WG  
WQO  
WQPS

Sacramento Area Water Forum Successor Effort  
Sacramento Area Water Forum Successor Effort Agreement  
  
Working Group  
Water Quality Objectives  
Water Quality Protection Standards

# South American Subbasin Groundwater Sustainability Plan

## Abstract

---

The Sustainable Groundwater Management Act (SGMA), passed by the California legislature in 2014, requires local entities to jointly assess groundwater conditions in their local areas and to develop a Groundwater Sustainability Plan (GSP) by a specified deadline to ensure that sustainable conditions are achieved within 20 years of GSP adoption. An effective and efficient groundwater management plan is critical to the health and welfare of the people, the environment and all other uses and users of groundwater in a local area.

The South American Subbasin (SASb) is a groundwater basin in Sacramento County bounded by the American River to the north, the Sacramento River to the west, the Cosumnes and Mokelumne Rivers to the south, and the Sierra foothills to the east. Six local entities responded to the mandate of SGMA and formed Groundwater Sustainability Agencies (GSAs) within the SASb. Sacramento Central Groundwater Authority (SCGA), Omochumne-Hartnell Water District (OHWD), Sloughouse Resource Conservation District (SRCD), North Delta GSAs (NDGSA), Reclamation District 551 (RD 551), and Sacramento County, henceforth “the GSAs”, have agreed to work together to develop and implement a GSP for the SASb. RD 551 entered into an agreement to be represented by NDGSA during the GSP development process. The GSAs applied for and were awarded Proposition 1 and Proposition 68 grants to fund GSP development to meet a SGMA-mandated schedule for submittal of a GSA-approved GSP to the California Department of Water Resources by January 31, 2022.

The local entities represented by the six GSAs in the SASb include the City of Sacramento, Sacramento County Water Agency, City of Elk Grove, City of Rancho Cordova, City of Folsom, Rancho Murieta, Sacramento Regional County Sanitation District, Elk Grove Water District, OHWD, SRCD and Reclamation Districts. A variety of local interests are also represented by these GSAs, including agricultural-residential water users, agricultural water users, public water systems, local land use planning agencies, environmental interests, surface water users, the federal government, tribal governments, disadvantaged communities, groundwater monitoring and reporting entities, holders of overlying groundwater rights, adjacent Subbasins, industrial users, commercial users, remediation pumpers, natural ecosystems, and the general public. Many of these local entities have a long history with groundwater and surface water management in the SASb and are well equipped to perform SGMA-required planning functions.

The six GSAs in the SASb have undertaken a thorough and timely review of past, current and projected future water resources needs and groundwater conditions to meet SGMA requirements for GSP development. Throughout the development of the SASb GSP, regular communication and engagement activities were conducted to inform and receive input from local stakeholders and the general public. The SASb GSP includes a comprehensive groundwater subbasin description, which was used in the development of a regional surface and ground water model that quantifies current water budgets and projects future conditions associated with population growth, land use changes, water conservation, climate change, and consideration of beneficial projects that are planned to occur over the next five to ten years. The

SASb GSP also includes a thorough assessment of the impacts of predicted future groundwater levels on beneficial users, including groundwater-dependent ecosystems, shallow wells, and interconnected surface water. Importantly, these assessments are used to develop measurable sustainable management criteria that avoid significant and unreasonable impacts to these beneficial users, and that can be monitored and adjusted throughout plan implementation.

The key finding of the SASb GSP, based on thorough analysis of the best available information, is that the basin will be sustainable over the next twenty years as long as planned recycled water, recharge and other projects are implemented. These projects will raise groundwater levels above current levels, maintain storage volumes, and protect ecosystems, interconnected surface water, and shallow well users. Although projected climate change conditions will increase groundwater use, these effects are not expected to cause the SASb to become unsustainable or to cause significant decreasing trends in groundwater conditions. A groundwater monitoring network comprised of more than 50 wells will be used to track groundwater levels and groundwater quality. Management criteria set at each well in the network will be implemented to assess these conditions over time and ensure that levels and quality remain within a range that avoids significant and unreasonable impacts to beneficial uses and users of groundwater.

Once approved by the GSAs, the activities identified and developed through the SASb GSP development process will be implemented, including:

- Ongoing monitoring and annual reporting on conditions in the SASb;
- Ongoing public engagement and outreach;
- Coordination among the GSAs and with neighboring subbasins;
- Development and implementation of a shallow well protection and monitoring program;
- Coordination with regional entities to develop a regional water bank;
- Coordination with land use agencies and water supply agencies to promote consistency with the GSP;
- Coordination with regional agencies in the development of updated climate change projections; and,
- Preparation of a five-year update to the GSP to be submitted in 2027.

## Executive Summary

---

### Introduction

Groundwater management in the South American Subbasin (SASb) has been occurring for decades. Stable groundwater conditions in terms of groundwater levels, storage volume, and interconnected surface waters have been achieved due to a variety of historically implemented projects and management actions. To ensure continued sustainable conditions allowing for future groundwater use to the benefit of all users in the SASb over the next 50-years, with climate change considered, a groundwater sustainability plan (GSP) has been developed and will be implemented to achieve the sustainability goal for the basin in the next 20 years. The following topics are covered in the GSP:

- Sustainable Groundwater Management Act
- Basin Setting
- Plan Area
- Hydrogeologic Conceptual Model
- Groundwater Conditions and Monitoring
- Cosumnes, South American, North American (CoSANA) Model
- Sustainable Management Criteria
- Modeling scenarios for future conditions, including climate change
- Projects and Management Actions
- GSP Implementation

### ES-1 Sustainable Groundwater Management Act (Section 1)

*Section 1 describes the Sustainable Groundwater Management Act and the purpose of the Groundwater Sustainability Plan. Section 1 also introduces the management structure of the agencies developing and implementing the GSP.*

The 2014 Sustainable Groundwater Management Act (SGMA) was established to provide local and regional agencies the authority to sustainably manage groundwater resources through the development and implementation of GSPs for high and medium priority subbasins (e.g., SASb, which has been designated as a high priority subbasin). In accordance with SGMA, this GSP was developed and will be implemented by Groundwater Sustainability Agencies (GSAs) representing the entire South American Subbasin (SASb), shown in **Figure ES-1**: Sacramento Central Groundwater Authority (SCGA), Northern Delta GSA, Omochumne-Hartnell Water District (OHWD), Sloughouse Resources Conservation District (SRCD), Reclamation District No. 551 and Sacramento County.

The California Department of Water Resources (DWR) and the State Water Resources Control Board (State Board) provide primary oversight for implementation of SGMA. DWR adopted regulations that specify the components and evaluation criteria for groundwater sustainability

plans and coordination agreements to implement such plans. To satisfy the requirements of SGMA, local agencies must do the following:

- Locally controlled and governed GSAs must be formed for all high- and medium-priority groundwater basins in California.
- GSAs must develop and implement GSPs, or alternatives to GSPs, that define a roadmap for how groundwater basins will reach long-term sustainability.
- The GSPs must consider six sustainability indicators defined as: groundwater level decline, groundwater storage reduction, seawater intrusion, water quality degradation, land subsidence, and surface-water depletion.
- The GSP must review and consider the impacts of climate change
- GSAs must submit annual reports to DWR each April 1 following adoption of a GSP for the previous water year (October 1 to September 30).
- Groundwater basins should reach sustainability within 20 years of implementing their GSPs, and maintain sustainability thereafter.

This GSP was prepared to meet the regulatory requirements established by DWR, as shown in the completed GSP Elements Guide (**Appendix 1-E**) which is organized according to the California Code of Regulation Sections of the GSP Emergency Regulations.

### **Purpose of the Groundwater Sustainability Plan (Section 1.2)**

The SASb GSP outlines a 20-year plan for sustainable groundwater management activities that consider the needs of all users in the SASb and ensures a viable groundwater resource for beneficial use by many groups, including potable water purveyors, agricultural, agricultural-residential, domestic, commercial and industrial users, and various environmental services. This GSP is intended to achieve a sustainable regime that balances pumping and recharge and considers the needs of all water users.

Figure ES-1: South American Subbasin GSP. Project: SAC00509. Sac Central Groundwater Authority. Authority: 0011575.00. SCGA GSP.G. GIS12. MXD12-3. South American Subbasin GSAs.mxd



# South American Subbasin GSP

## South American Subbasin GSAs

Figure ES-1

### Legend

- South American Subbasin
- GSAs**
- Northern Delta GSAs
- OHWD GSA (SASb)
- RD 551 GSA
- SCGA GSA
- SRCD GSA (SASb)
- Sac Co GSA

0 1.25 2.5 5 Miles



South American SUBBASIN

Project #: 0011575.00  
Map Created: June 2020

## **ES-2 Plan Area and Basin Setting (Section 2)**

*Section 2 provides an overview of the SASb area, including groundwater conditions, interconnected surface waters, and groundwater-dependent ecosystems. These details inform the hydrogeologic conceptual model and water budgets developed for the SASb, which will be used to frame the discussion for sustainable management criteria (Section 3), sustainable yield, projects and management actions (Section 4), and implementation (Section 5).*

### **Plan Area (Section 2.1)**

*Section 2.1 describes existing water management programs, remediation activities, and groundwater monitoring programs in the SASb.*

The SASb has been designated by DWR as a high priority subbasin. The SASb is located within the larger Sacramento Valley Groundwater Basin that is surrounded by local rivers and the foothills of the Sierra Nevada. The SASb shares boundaries with five adjacent subbasins including the Yolo, Solano, North American, Eastern San Joaquin, and Cosumnes Subbasins, as shown in **Figure ES-2**. Several historical groundwater management activities and plans have been previously established prior to the 2014 SGMA and are detailed below. Although outside the jurisdiction of local groundwater management agencies, groundwater remediation activities are also considered as part of a complete adaptive management strategy for the SASb.

### **Existing Water Management Programs (Section 2.1.9)**

Coordinated groundwater management in the SASb began as early as 1993 with negotiations of the Sacramento Area Water Forum Successor Effort Agreement. Since then, representatives of beneficial users of the area's groundwater and surface water and numerous local entities have worked together to manage and preserve local water resources. **Section 2** documents this history of groundwater management, which includes water management programs, land use plans, and subbasin-wide well and stream gage monitoring in the surrounding SASb area.

#### **2000 Water Forum Agreement (Section 2.1.9.1)**

Since 2000, the Sacramento Area Water Forum Successor Effort (Water Forum), consisting of 40 stakeholder organizations, has coordinated surface water and groundwater planning in the Sacramento Metropolitan Region. Overall, the Water Forum aims to prevent water shortages, environmental degradation, groundwater contamination, threats to groundwater reliability, and limits to economic prosperity. The Water Forum maintains two co-equal objectives:

- Provide a reliable and safe water supply for the Sacramento region's long-term growth and economic health.
- Preserve the fishery, wildlife, recreational, and aesthetic values of the lower American River.

Figure ES-2: Neighboring Groundwater Basins.mxd



**South American Subbasin GSP**  
**Neighboring Groundwater Subbasins**  
**Figure ES-2**

**Legend**

	South American Subbasin		Solano
	Cosumnes		South American
	Eastern San Joaquin		Yolo
	North American		

0 1.25 2.5 5 Miles

**South American SUBBASIN**

Map Created: June 2020

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To achieve these objectives, all signatories to the Water Forum Agreement were required to endorse and, where appropriate, participate in each of the Agreement's seven elements as follows:

- Increased surface water diversions.
- Actions to meet customers' needs while reducing diversion impacts in drier years.
- Support for an improved pattern of fishery flow releases from Folsom Reservoir.
- Lower American River Habitat Management Element.
- Water Conservation Element.
- Groundwater Management Element.
- Water Forum Successor Effort.

#### *Central Sacramento County Groundwater Management Plan (Section 2.1.9.3)*

As a result of the Water Forum efforts, the Central Sacramento County Groundwater Management Plan (CSCGMP) was created to outline sustainable groundwater use in the SASb. Prior to the implementation of this GSP, the CSCGMP served as the overarching groundwater management document for the region. Five basin management objectives served as the foundation of the CSCGMP, including the following:

- Maintain a long-term average groundwater extraction rate at or below 273,000 acre-feet per year (AFY).
- Establish specific minimum groundwater elevations within all areas of the basin consistent with the Water Forum.
- Protect against any potential inelastic land surface subsidence.
- Protect against any adverse impacts to surface water flows.
- Attain water quality objectives for constituents of concern.

#### *Other Management Plans (Section 2.1.9.3 through Section 2.1.9.10)*

In addition to the CSCGMP serving as the overarching groundwater management document for the region, other water management initiatives have been developed by various agencies as summarized in **Table ES-1**. These and other existing management plans have been considered in the development of the SASb GSP.

**Table ES-1:** Existing water management plans in the SASb

<b>Existing Water Management Plans</b>	<b>Plan Purpose and Goals</b>
2016 Sacramento Central Groundwater Authority Groundwater Elevation Monitoring Plan	1) Sets guidelines for determining depth to water including equipment, preparation, procedures, quality assurance/quality control, and data reporting to the California Statewide Groundwater Elevation Monitoring Program (CASGEM) online submittal system.
2004 Sacramento County Water Agency (SCWA) Zone 40 Groundwater Management Plan	1) Maintain or improve groundwater quality in Zone 40 area for the benefit of basin groundwater users. 2) Maintain groundwater elevations that result in a net benefit to basin groundwater users. 3) Protect against any potential inelastic land surface subsidence. 4) Protect against adverse impacts to surface water flows in the American, Cosumnes, and Sacramento Rivers. 5) Protect against adverse impacts to water quality resulting from interaction between groundwater in the basin and surface water flows in the American and Sacramento Rivers.
2014 Central Valley Regional Water Quality Control Board—Irrigated Lands Regulatory Program – Waste Discharge Requirements for Sacramento Valley Water Quality Coalition	1) Prevents agricultural runoff from impairing surface waters and groundwaters. 2) Monitors the following parameters: water column and sediment toxicity, physical and conventional parameters, organic carbon, pathogen indicator organisms, trace metals, pesticides, and nitrogen and phosphorous compounds.
Sacramento County Environmental Management Wells Program	1) Authorizes the construction, modification, repair, inactivation, or destruction of wells in Sacramento County through a formal permit and inspection process.
2018 Central Valley Salinity Alternatives for Long-Term Sustainability Initiative (CV-SALTS)	1) Sustain the Central Valley's lifestyle. 2) Support regional economic growth. 3) Retain a world-class agricultural economy. 4) Maintain a reliable, high-quality water supply. 5) Protect and enhance the environment. 6) Ensure a safe drinking water supply. 7) Achieve balanced salt and nitrate loadings. 8) Implement managed aquifer restoration program. 9) Sustainably manage nitrate and salinity.

<b>Existing Water Management Plans</b>	<b>Plan Purpose and Goals</b>
2009 Delta Stewardship Council Delta Plan	1) Develop detailed findings to establish consistency with the Delta Plan. 2) Reduce reliance on the Delta through improved regional water self-reliance. 3) Practice transparency in water contracting. 4) Develop Delta flow objectives. 5) Restore habitats at appropriate elevations. 6) Protect opportunities to restore habitat. 7) Expand floodplains and riparian habitats in levee projects. 8) Avoid introducing/habitat improvements for invasive nonnative species. 9) Locate new urban development wisely. 10) Respect local land use when siting water or flood facilities or restoring habitats. 11) Prioritize state investments in Delta levees and risk reduction. 12) Require flood protection for residential development in rural areas. 13) Protect floodways and floodplains.
2016 Sacramento County Water Agency (SCWA) Zone 40 Water Supply Master Plan	1) Meet future water demands through a conjunctive use program of groundwater, surface water, and recycled water supplies.
2013 City of Sacramento Water Conservation Plan	1) Maximize the City's existing water and fiscal resources through a comprehensive and economically supported approach.

### **Remediation Monitoring (Section 2.1.8)**

Aerospace, industrial, manufacturing, and defense industries have been a key part in the development of greater Sacramento since the late 1950s. Unfortunately, many of these industries have used and disposed of toxic and unknown substances onsite resulting in the contamination of groundwaters and soils in specific areas of the SASb. Known contaminant plumes and sites in the SASb are shown in **Figure ES-3**. Several remediation actions have and are being performed to protect human health and the environment under various state and federal regulatory programs. Local groundwater management agencies have no jurisdiction over extractions and cleanup activities and must adaptively manage groundwater conditions as changes in the cleanup programs occur over time (SCGA, 2016). Major remediation activities are summarized in **Table ES-2**.

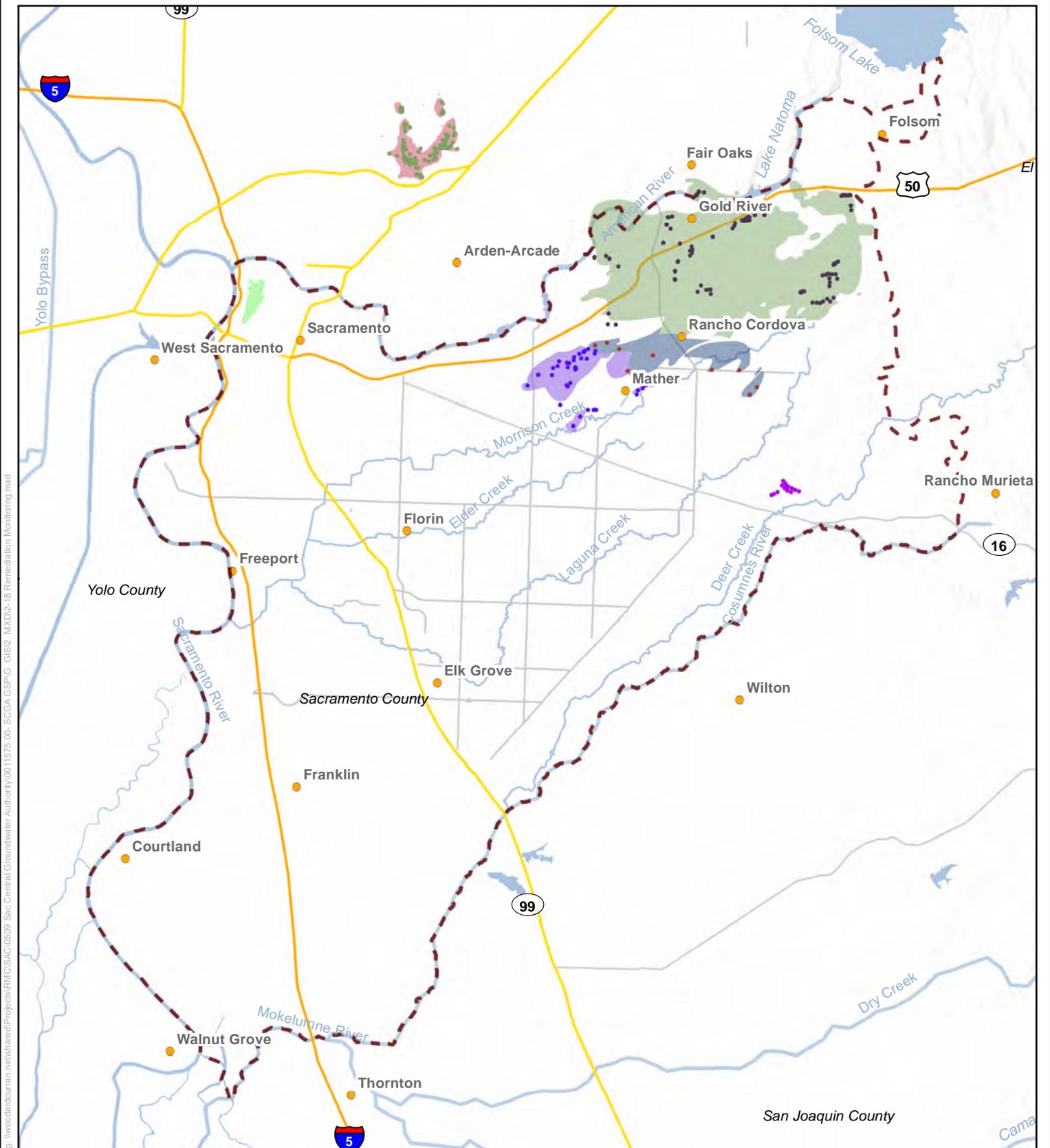


Figure ES-3: 10/5/2021. By: nmeyer. Using: \\woodandcurran.net\share\Projects\RAM\SAC\0509\_Sac Central Groundwater Authority\0011575\_00-SCGA\_GSP\G\_GIS2\_MXD\2-18 Remediation Monitoring.mxd

<p style="text-align: center;"><b>South American Subbasin GSP</b></p> <p style="text-align: center;"><b>Contamination Plumes and Remediation Wells (2008)</b></p> <p style="text-align: center;">Figure ES-3</p>	Legend	<p><b>Remediation Wells</b></p> <ul style="list-style-type: none"> <li>• Aerojet</li> <li>• Boeing</li> <li>• Mather</li> <li>• McClellan</li> <li>• Kiefer</li> </ul>	<p><b>Contamination Plume</b></p> <ul style="list-style-type: none"> <li>■ Aerojet</li> <li>■ Boeing</li> <li>■ Mather</li> <li>■ McClellan</li> <li>■ Union Pacific Downtown / Curtis Park</li> </ul>	<p>0 1 2 4 Miles</p>	<p>N</p>	<p><b>South American SUBBASIN</b></p> <p>Project #: 0011575.00 Map Created: October 2021</p>
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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. **Note:** Remediation well data was not available for UPRR or Sacramento Army Depot. Contamination plume data was not available for Sacramento Army Depot or Kiefer Landfill.

**Table ES-2:** SASb remediation activities

<b>Remediation Site</b>	<b>Description</b>
Mather Air Force Base	Mather Air Force Base was a former 5,845-acre Air Force Base located at the northern extent of the South American Subbasin. In 1982, environmental investigations began to find areas with significant soil/sediment contamination from fire training areas, drainage ditches, waste pits, oil/water separators sites, spill sites, landfills, and a wastewater treatment plant. Soils were contaminated with toxic and hazardous materials such as petroleum, oils, lubricants, solvents, and protective coatings used during routine operation and maintenance of Mather AFB. The US Air Force is currently conducting remediation activities to address the identified contaminant plumes and continues to monitor large water supply wells, nearby monitoring wells, and smaller, private-owned supply wells downgradient from the plumes.
Aerojet	The Aerojet Superfund Site is a former rocket-testing and chemical manufacturing site located in the northeastern quadrant of the subbasin. The 70-year-old site covers 5,900 acres and is located 15 miles east of Sacramento in Rancho Cordova, and half a mile from the American River. The activities at Aerojet have resulted in soil and groundwater contamination in a portion of the South American Subbasin. The site sits atop a large miles-long groundwater plume that contains various chemicals of concern, including Trichloroethylene (TCE), a volatile organic chemical (VOC), Perchlorate, and Nitrosodimethylamine (NDMA). Aerojet has installed several groundwater extraction and treatment systems, well fields, and numerous treatment facilities over the decades to contain the contaminated groundwater plume. Recent reports have found that the Aerojet Site continues to affect groundwater quality downgradient and additional remediation activities are planned.
Kiefer Landfill	The Kiefer Landfill is a 1,084-acre site with an active class III 335 acre solid waste disposal site that is owned and operated by Sacramento County. The groundwater remediation program includes source abatement with the operation of the landfill gas (LFG) extraction system and leachate collection and removal systems (LCRS). The County does consistent monitoring of groundwater parameters and LFG control to track the progress of the remediation program and for compliance with Water Quality Protection Standards (WQPS) at monitoring sites located beyond the perimeter of the contamination plume.

<b>Remediation Site</b>	<b>Description</b>
McDonnell Douglas (Boeing)	The McDonnell Douglas site is an inactive test site in Rancho Cordova. Historical activities at the site include cleaning tested materials and maintaining test areas, during which chlorinated solvents and fuels were used and released to the soil, surface water, and groundwater. Cleanup activities include pump and treat, extraction wells, soil vapor extraction, and in-situ groundwater remediation. Treated groundwater is discharged to Morrison Creek.

### **Hydrogeologic Conceptual Model (Section 2.2)**

*Section 2.2 includes descriptions of geologic formations and structures, aquifers, and properties of geology related to groundwater, setting the hydrogeological stage for the implementation of the SASb GSP.*

#### **Basin Boundaries (Section 2.2.5)**

The SASb is part of the Sacramento Valley Groundwater Basin and is divided into seven boundary segments including five groundwater divides, one impermeable bedrock boundary, and one political boundary between the Yolo and Sacramento Counties. Neighboring Subbasins are shown in **Figure ES-2**.

#### **Principal Aquifers and Aquitards and Surface Water Recharge (Section 2.2.6 and Section 2.2.8)**

There is one primary aquifer in the SASb, which is divided into the upper aquifer and the lower aquifer. The upper aquifer is typically of high quality and is often used for private domestic and/or irrigation wells in the SASb. The lower portion of the primary aquifer is also of high quality capable of producing high yields; therefore, larger municipal supply wells will often target this lower portion of the aquifer to avoid impacting domestic wells screened in the upper portion of the aquifer.

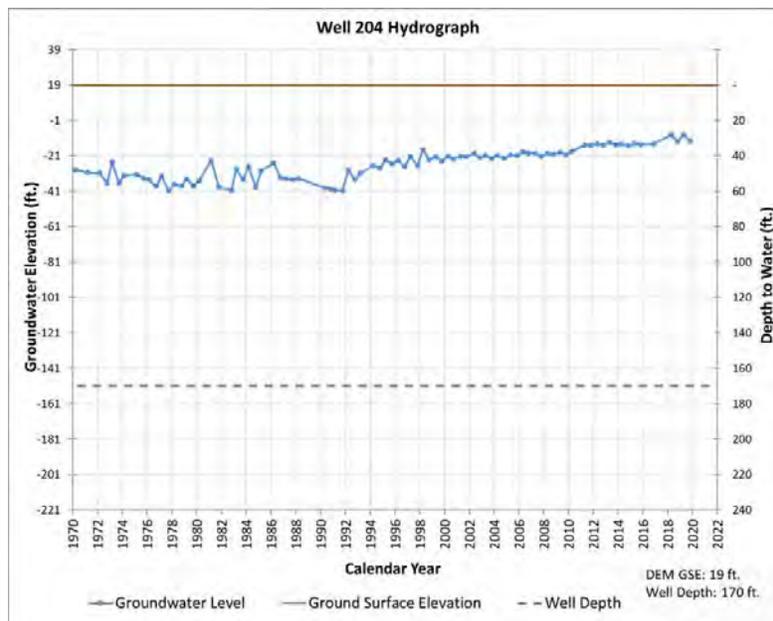
Most recharge to the aquifer occurs from streams and rivers and a combination of rainfall and applied water. Analytical results discussed in the Sacramento Central Groundwater Authority Recharge Mapping and Field Study Technical Memorandum indicate the majority of recharge occurs in areas where soils are coarse (e.g., southwest of Folsom) and where there is extensive occurrence of agricultural applied water (e.g., south of Elk Grove and between Grant Line Road and the Cosumnes River) (RMC Water and Environment, 2015). The study also indicates that recharge rates were lower from Elk Grove to the northwest, roughly between Morrison Creek and Grant Line Road.

#### **Groundwater Conditions (Section 2.3)**

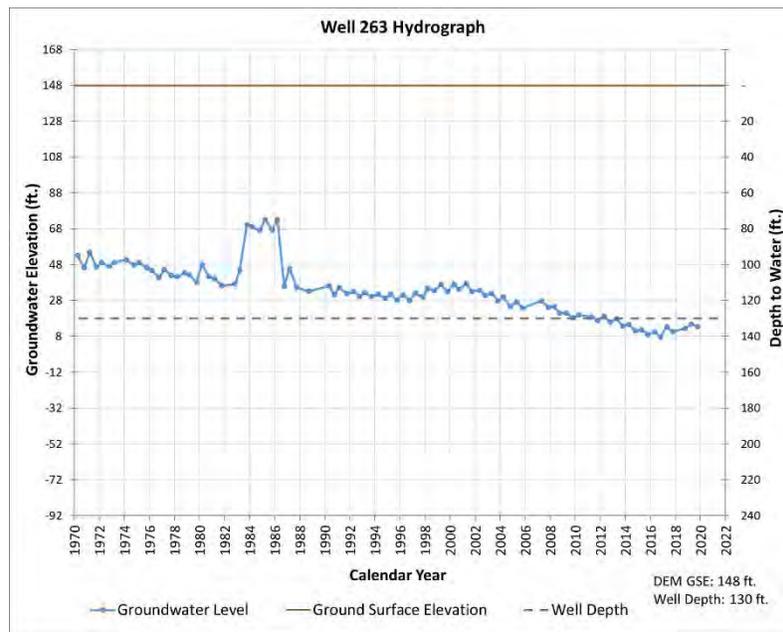
Current and historical conditions of the SASb including groundwater levels and storage, groundwater quality, interconnected surface water systems, groundwater dependent ecosystems, and remediation projects are detailed in **Section 2.3**. This section also discusses changes in the SASb in recent decades and presents groundwater hydrographs, vertical gradients, and contours that are based on available groundwater monitoring data.

**Groundwater Levels (Section 2.3.1)**

Groundwater levels in the western portion of the SASb have been generally increasing since the 1980s despite a turn towards drier conditions and increasing population (**Figure ES-4**). The recent increase in groundwater levels has been largely attributed to a combination of conjunctive use projects (i.e., the combined use of groundwater and surface water sources), construction of the Freeport diversion facility and Vineyard surface water treatment plant, urban conservation plans, and changes in use of previous agricultural land. Groundwater levels in some areas of the eastern portion of the SASb show decreases in groundwater levels despite the lack of significant changes in land or water use (**Figure ES-5**). The causes of these declines are not well understood but may be attributed to the combination of remediation activities at the Inactive Rancho Cordova Test Site, Aerojet Superfund Site, and Kiefer Landfill and the aquifer becoming thin and low-yielding in this area.



**Figure ES-4:** Groundwater levels as a function of time in a well in the western portion of the SASb (**Figure 2.3-8**)



**Figure ES-5:** Groundwater levels as a function of time in a well in the eastern portion of the SASb (Figure 2.3-11)

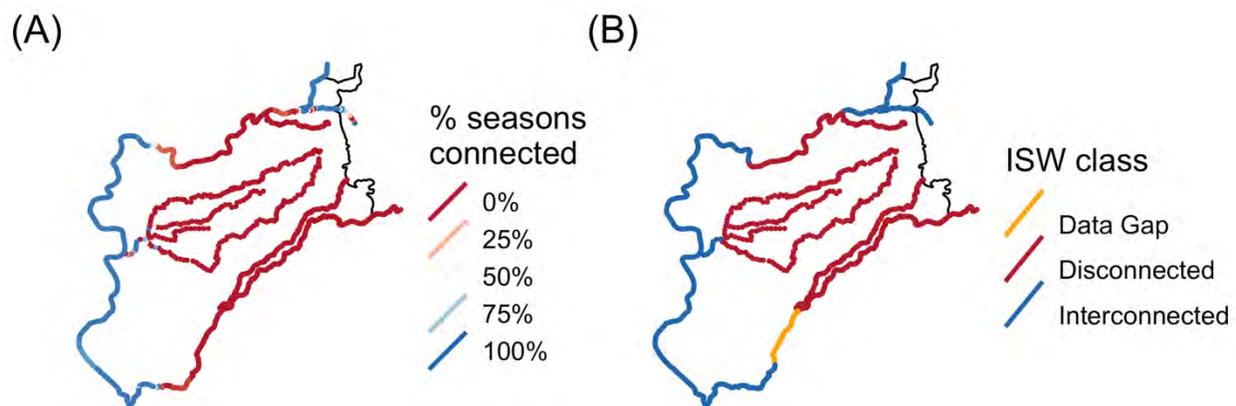
### **Groundwater Quality (Section 2.3.4)**

Groundwater quality in the SASb is generally of good quality and meets local needs for municipal, domestic, and agricultural uses. Several water quality parameters including nitrate, total dissolved solids (TDS), arsenic, hexavalent chromium, and per- and polyfluoroalkyl substances (PFASs) have been monitored at numerous wells in the SASb over time. Data obtained from the Groundwater Ambient Monitoring and Assessment Program (GAMA) and other data sources has been summarized and evaluated. In data spanning multiple decades, nitrate concentrations have remained consistently below the maximum contaminant level (MCL) of 10 mg/L as N and TDS concentrations have generally been lower than the recommended secondary maximum contaminant level (SMCL) of 500 mg/L. Arsenic data collected from the 1980s to present show concentrations exceeding the MCL of 10 µg/L in isolated areas in the upper aquifer of the SASb, with few exceedances in the lower aquifer. Hexavalent chromium and PFASs were monitored beginning in 2001 and 2017, respectively. Hexavalent chromium concentrations were consistently below the proposed MCL of 10 µg/L. PFOA and PFOS concentrations have been detected above State Water Board-issued reporting levels at some wells in the SASb.

### **Interconnected Surface Water Systems (Section 2.3.6)**

Interconnected surface water (ISW) is defined as surface water which is connected to groundwater through a continuous saturated zone. SGMA mandates an assessment of the location, timing, and magnitude of ISW depletions, and demonstration that projected ISW depletions will not lead to significant and undesirable results for beneficial uses and users of groundwater.

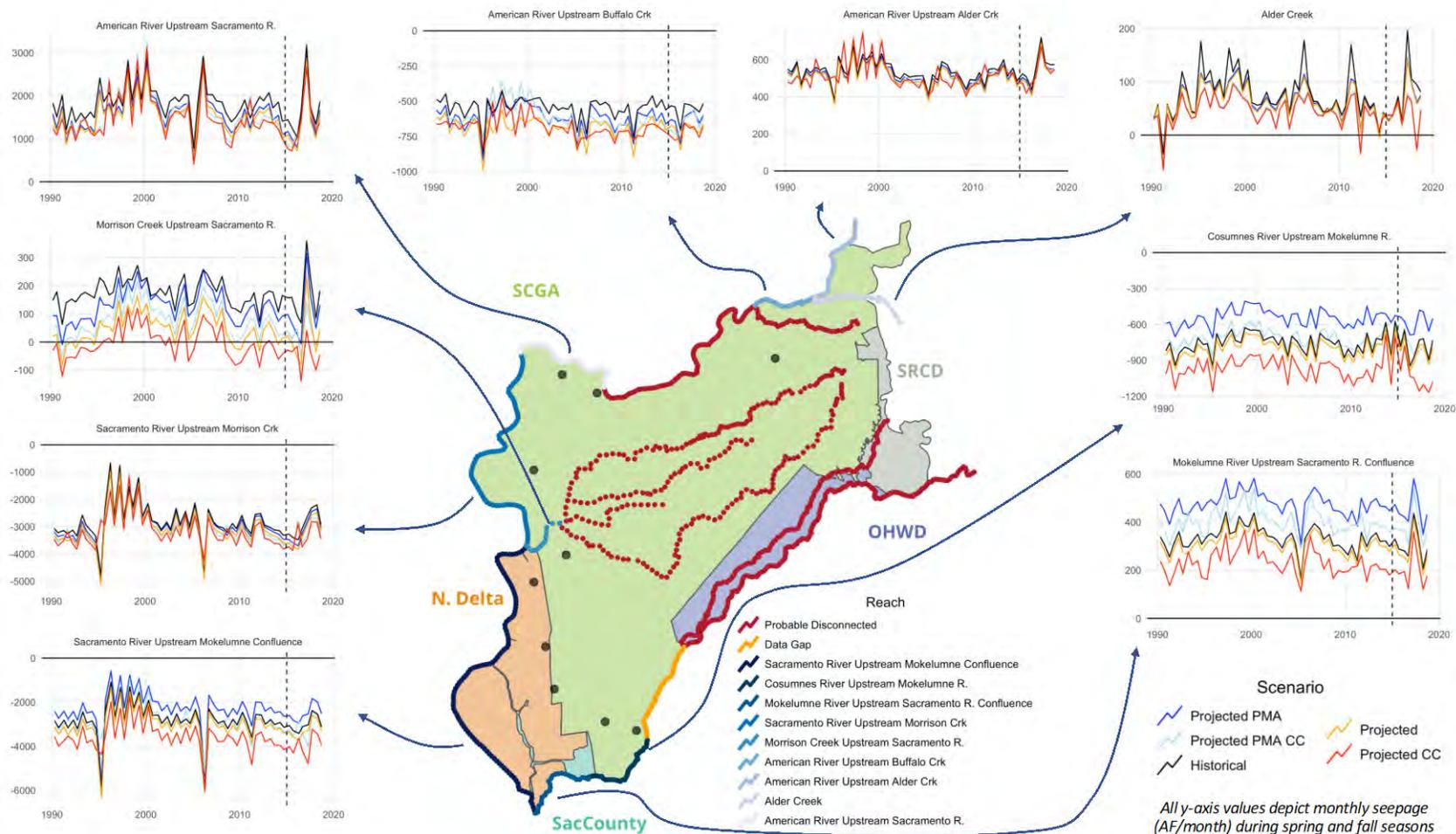
ISW and disconnected surface waters in the SASb have been classified and mapped by relating historical groundwater levels (which fluctuate over time) and the best available streambed elevations (largely fixed). Historical trends in seasonal interconnection between streams and groundwater have been characterized between 2005 and 2018 to map ISW and disconnected reaches (**Figure ES-6**). This time period was analyzed because it represents current groundwater level conditions, overlaps with the historical timeframe for the regional groundwater model (CoSANA) used in development of the GSP, and because groundwater level data is sufficiently dense during this period. Depletions of ISW are quantified as volumetric fluxes (i.e., seepage volumes per unit time) that occur along a stream reach. Negative seepage indicates a “losing” reach, and positive seepage indicates a “gaining” reach. ISW depletion occurs in the South American Subbasin along all losing reaches (negative seepage in **Figure ES-7**). However, modeling suggests that, compared to the current conditions, planned recharge and conjunctive use projects and management actions will increase groundwater fluxes to streams (i.e., some stream reaches become more gaining), and will increase the 50<sup>th</sup> percentile of October to December streamflows. In other words, projected future groundwater usage and management is not anticipated to increase stream depletions compared to current conditions.



**Figure ES-6:** South American Subbasin Interconnected and Disconnected stream nodes according to **(A)** historical percentage of seasons between 2005 and 2018 that the node is connected to groundwater; and **(B)** final classification of ISW based on historical analysis (**Figure 2.3-43**). The “data gap” labeled in (B) was due to the sub-seasonal, short-term interconnection events observed along the Cosumnes River north of Twin Cities Road and south of Deer Creek, a location where more monitoring is needed to better understand stream-aquifer interactions.

### **Land Subsidence and Seawater Intrusion (Section 2.3.5 and Section 2.3.3)**

Land subsidence is the lowering of the ground surface elevation. Little to no land subsidence has been observed in the SASb; elevation change generally ranges from 0 to -0.14 ft from 2005 to 2020. Seawater intrusion is not considered to be an applicable sustainability indicator for the SASb due to the distance between the SASb and the saline areas of the Bay-Delta influenced by the Pacific Ocean (approximately 30 miles to the west in San Francisco Bay).



**Figure ES-7:** Seasonally averaged ISW depletion estimated by CoSANA at ISW designated reaches. The black line represents historical to near present-day conditions. See **Section 3.3.1.2** for more details on projected scenarios (**Figure 2.3-44**).

### **Groundwater Dependent Ecosystems (Section 2.3.7)**

Groundwater dependent ecosystems (GDEs) are a beneficial user of groundwater that rely on a connection to near-surface groundwater, typically characterized by the land surface elevation, the depth to groundwater, and the vegetation rooting depth. GDEs were mapped and characterized, and special status species that rely on these ecosystems were catalogued. Of 26,245 acres of potential GDEs in the SASb, 11,340 acres exhibit historical groundwater levels indicative of GDEs as shown in **Figure ES-8**.

### **CoSANA Model (Section 2.4.1.2)**

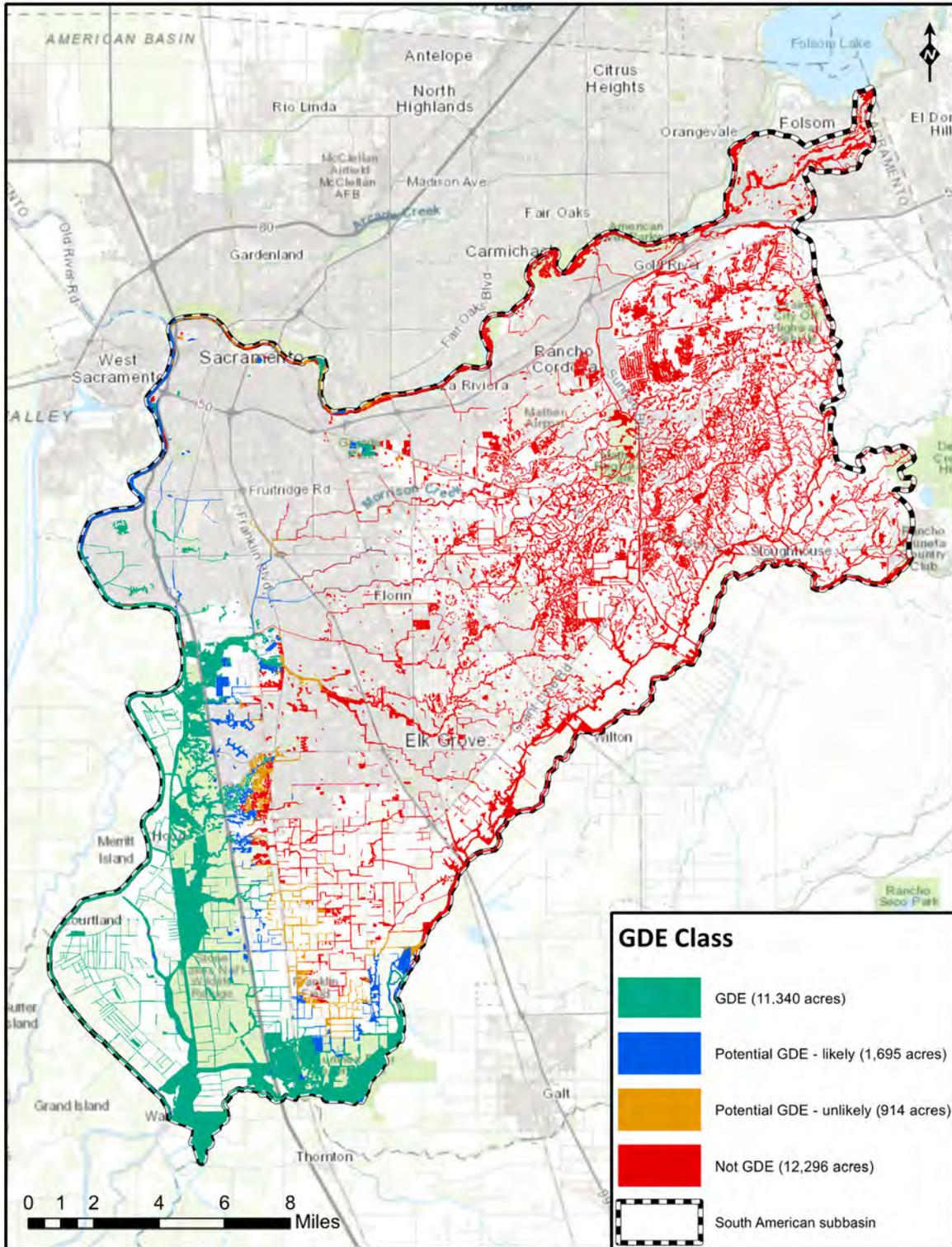
Water budgets (next section) were developed utilizing the Cosumnes-South American-North American (CoSANA) model, a fully integrated surface and groundwater numerical flow model that covers the entire South American Subbasin as well as the adjoining North American and Cosumnes Subbasins. CoSANA integrates the groundwater aquifer with the surface hydrologic system and land surface processes and operations. Using data from federal, state, and local resources, CoSANA was used to evaluate hydrogeologic conditions, agricultural and urban water demands, agricultural and urban water supplies, and current and projected future regional groundwater conditions.

### **Water Budget (Section 2.4)**

For each “baseline condition” depicted in **Table ES-3**, water budgets were developed for the stream and canal system, the land surface system, and for the groundwater system. The groundwater system budget reports inflows (deep percolation, stream losses to the groundwater system and subsurface inflow), outflows (stream gain from the groundwater system, groundwater production, and subsurface outflow) and the estimated change in groundwater storage under different land use and climate conditions. **Table ES-3** shows average annual estimated change in groundwater storage for each baseline condition. **Figure ES-9** through **Figure ES-11** depicts the average annual values for each groundwater system component.

**Table ES-3:** Projected change in groundwater storage in each baseline condition

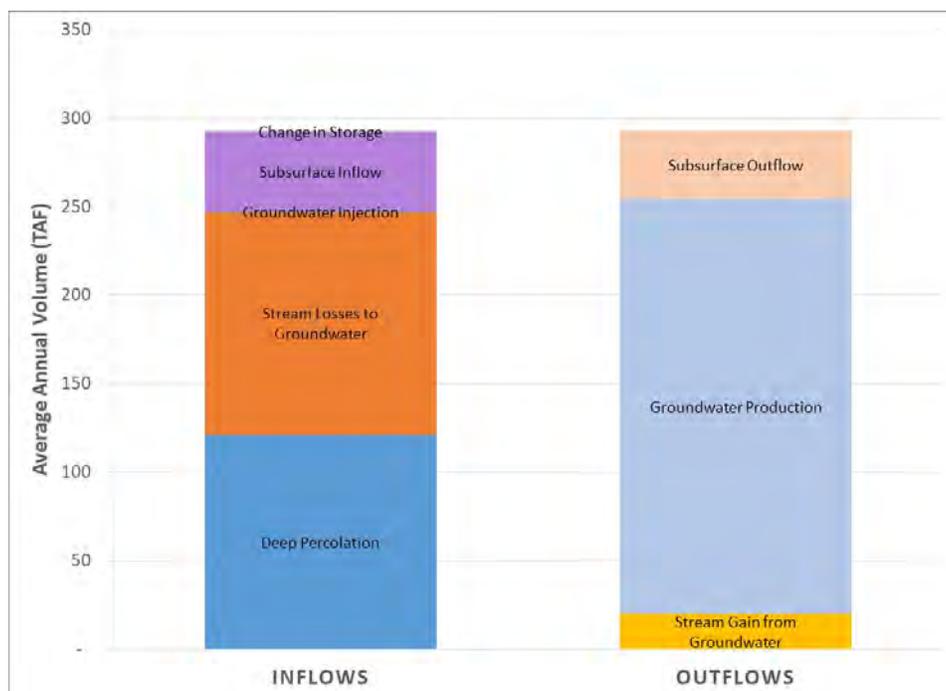
<b>Baseline</b>	<b>Average Annual Groundwater Storage Change (AFY)</b>
Historical Conditions	+7,700
Current Conditions	+2,200
Projected Conditions without Climate Change	-1,100
Projected Conditions with Climate Change	-6,200



**Figure ES-8: GDE likelihood classification of potential GDEs from 2005-2018**



**Figure ES-9:** Current conditions average annual water budget – groundwater system (Figure 2.4-8)



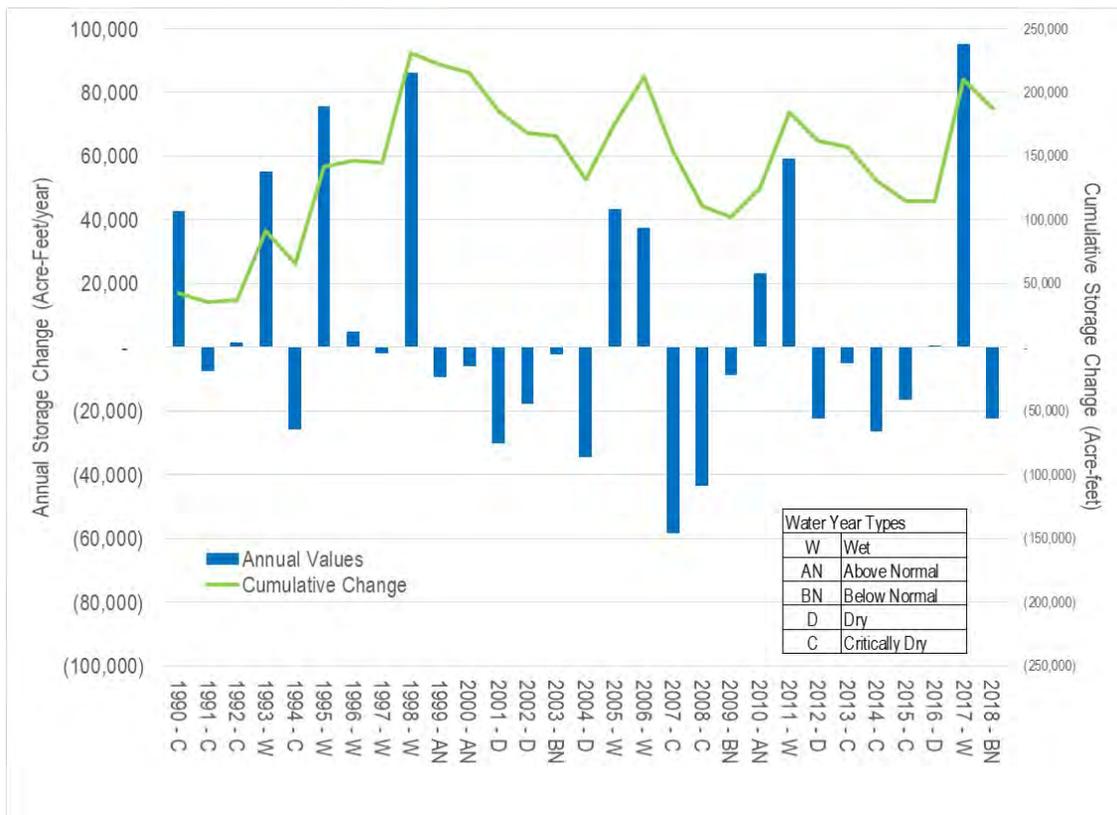
**Figure ES-10:** Projected conditions *without* climate change average annual water budget – groundwater system (Figure 2.4-11)



**Figure ES-11:** Projected conditions *with* climate change average annual water budget – groundwater system (**Figure 2.4-14**)

**Groundwater Storage (Section 2.3.2)**

The CoSANA model was used to estimate historical changes in storage of groundwater in the SASb from 1990 to 2018. **Figure ES-12** shows annual total groundwater storage for the SASb and the cumulative change in storage over varying water year types. Between 1990 and 2018, the cumulative storage in the subbasin is estimated to have increased by 188,000 acre-feet. For the most recent 10-year period (2009 to 2018), the cumulative storage increase is estimated to be approximately 77,000 acre-feet.



**Figure ES-12: Groundwater storage by year, water year type, and cumulative water volume (Figure 2.3-26)**

The CoSANA model was used to define a range of groundwater pumping for the SASb that does not cause significant and unreasonable results for the three sustainability indicators defined in Section 3: 1) Chronic Lowering of Groundwater Levels, 2) Reduction of Groundwater Storage, and 3) Depletion of Interconnection Surface Water. Based on analysis of historical and projected data and information from a number of CoSANA modeling scenarios representing various hydrologic and operating conditions in the Subbasin, the sustainable yield for the SASb can range between 210,000 AF and 270,00 AF in any given year, as long as a long-term average of 235,000 AFY is maintained.

### ES-3 Sustainable Management Criteria (Section 3)

**Section 3** builds on the information presented in the previous sections and details the key sustainability criteria developed for the GSP, as required by SGMA.

Recognizing the significant body of work in existing groundwater management plans and strategies that have been implemented in the SASb, this GSP builds on those efforts to establish a system of metrics to ensure the long-term viability of groundwater resources for urban, domestic, agricultural, industrial, and environmental beneficial users in the SASb.

### Sustainability Goal and Sustainability Indicators (Section 3.1)

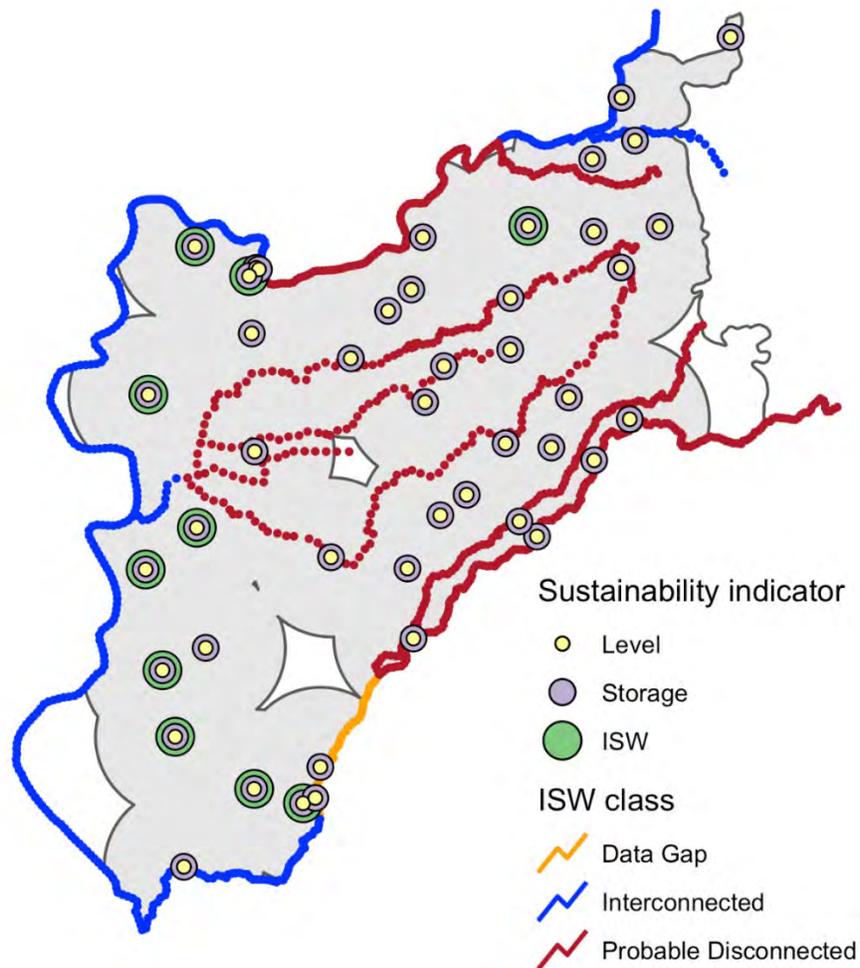
The Sustainability Goal for the SASb is to protect and ensure the long-term viability of groundwater resources for urban, domestic, agricultural, industrial, and environmental beneficial users of groundwater. The Sustainability Goal will be achieved by rigorous monitoring and assessment of potential impacts to these beneficial users, and scientifically-informed management that avoids significant and unreasonable impacts to beneficial uses and users of groundwater.

The GSP details four of the six sustainability indicators (as required by SGMA), with a goal of preventing undesirable results.

**Table ES-4** defines undesirable results for each sustainability indicator as developed for the SASb. Quantifiable minimum thresholds (MT), measurable objectives (MO), and interim milestones (IM) were also developed as “management goalposts” that will be used to evaluate progress made towards the sustainability goal and are quantified in **Section 3** of the GSP. Monitoring wells throughout the basin will be used to assess conditions relevant to each sustainability indicator. These monitoring wells were selected based on location, depth, monitoring history, well information, and well access. A total of 45 wells spanning the SASb were selected to monitor groundwater levels, storage, and interconnected surface water sustainability indicators as shown in **Figure ES-13**. Additionally, 21 wells spanning the SASb were selected to monitor water quality as shown in **Figure ES-14**.

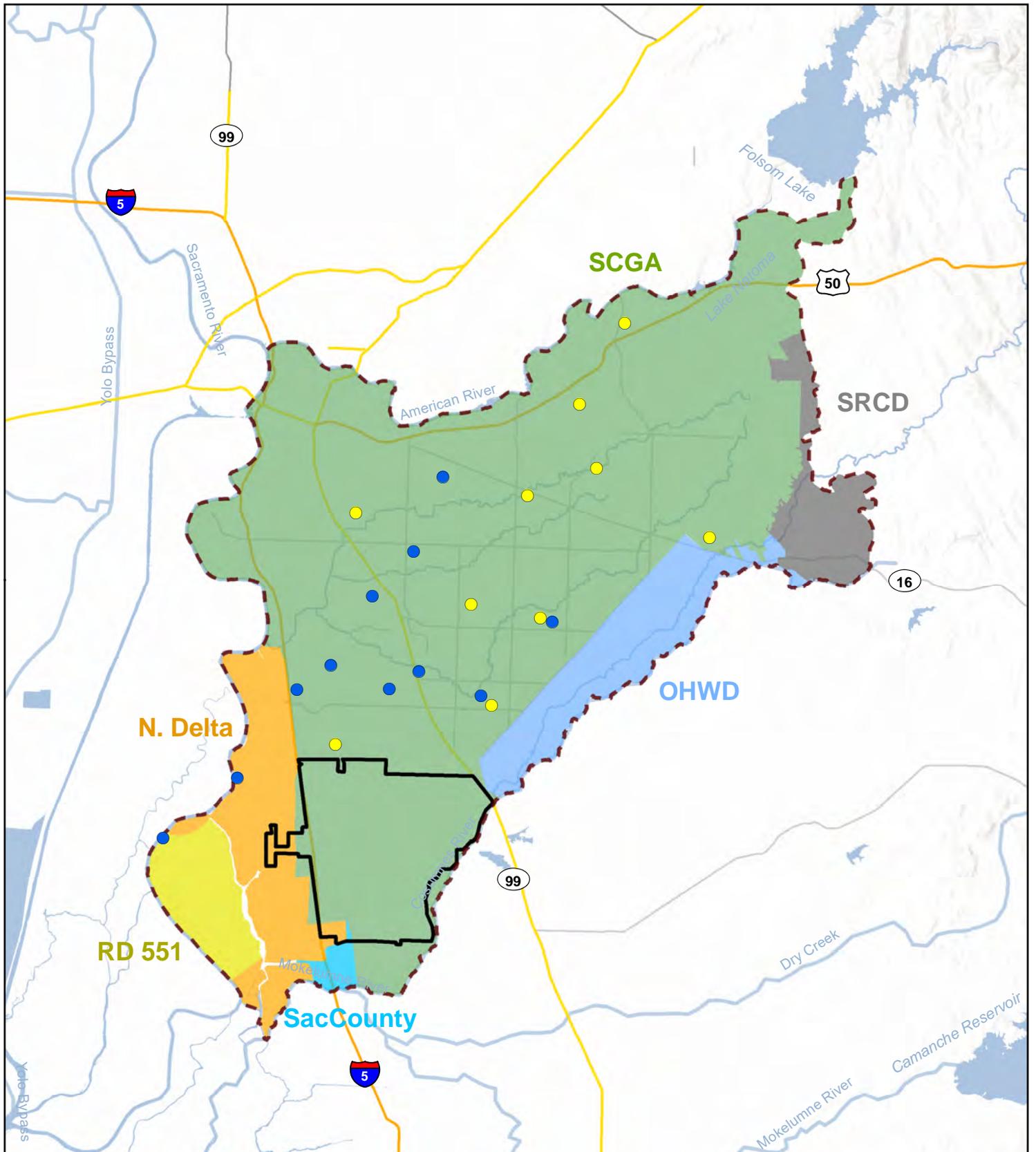
**Table ES-4:** SASb GSP sustainability indicators: Definitions of undesirable results

<b>Sustainability Indicator</b>	<b>Undesirable Results Definitions</b>
Chronic Lowering of Groundwater Levels	More than 25% of representative monitoring wells fall below the minimum threshold for 3 consecutive years.
Reduction of Groundwater Storage	Same as "Chronic Lowering of Groundwater Levels."
Degraded Water Quality	More than 10% of groundwater quality wells exceed maximum thresholds in each aquifer zone.
Depletions of Interconnected Surface Water	More than 25% of representative monitoring wells for ISW fall below their minimum thresholds for 3 consecutive years.
Seawater Intrusion	Not applicable to the SASb.
Land Subsidence	Not significant to the SASb.



**Figure ES-13:** Monitoring network for groundwater level, storage, and ISW depletion sustainability indicators for the 45 representative monitoring wells in the SASb. Network density is depicted with a gray, 24-square mile circular buffer around each monitoring point that together show 92% lateral coverage by the network. (Figure 3-23)

Figure Exported: 10/19/2021 By: C:\Inra Using: C:\Users\inra\Dropbox (LWA)\Inra\AG01\0.3 - GSP 2020\_LF\SAS GIS - Template and Final\Figures\Figure 3-26 - Water Quality Network\_6 GSAs - Oct 2021.mxd



**South American Subbasin GSP**  
**Proposed Water Quality Monitoring Network**  
**Figure ES-14**

<b>Legend</b>	<span style="color: yellow;">●</span> Lower Layer GWQ Monitoring Points	<b>GSA</b>
	<span style="color: blue;">●</span> Upper Layer GWQ Monitoring Points	<span style="background-color: orange; border: 1px solid black; display: inline-block; width: 15px; height: 10px;"></span> N. Delta
	<span style="border: 2px solid black; display: inline-block; width: 15px; height: 10px;"></span> Harvest Water	<span style="background-color: lightblue; border: 1px solid black; display: inline-block; width: 15px; height: 10px;"></span> OHWD
	<span style="border: 2px dashed brown; display: inline-block; width: 15px; height: 10px;"></span> South American Subbasin	<span style="background-color: yellow; border: 1px solid black; display: inline-block; width: 15px; height: 10px;"></span> RD 551
		<span style="background-color: green; border: 1px solid black; display: inline-block; width: 15px; height: 10px;"></span> SCGA
	<span style="background-color: grey; border: 1px solid black; display: inline-block; width: 15px; height: 10px;"></span> SRCD	
	<span style="background-color: cyan; border: 1px solid black; display: inline-block; width: 15px; height: 10px;"></span> SacCounty	

0 1.25 2.5 5 Miles

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**South American SUBBASIN**

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## **ES-4 Projects and Management Actions (Section 4)**

*Section 4 describes past, current, and future projects and management actions that will contribute to the achievement of the SASb GSP sustainability goal.*

To achieve the sustainability goal for the SASb by 2042, and to avoid undesirable results over the remainder of a 50-year implementation horizon, multiple planned projects and potential management actions (PMAs) have been identified and considered by the GSAs in the SASb GSP.

### **Types of Projects and Management Actions (Section 4.2)**

A number of PMAs have been considered in the development of the GSP to evaluate the attainment of sustainability goals, measurable objectives, and minimum thresholds, and to avoid undesirable results described in the SASb GSP. PMAs considered in this GSP can be divided into three groups as follows:

- Group 1: Existing PMAs currently being implemented and expected to continue to be implemented, as needed, to support achievement of the sustainability goal.
- Group 2: PMAs already planned for near-term implementation by individual entities, which may likely, individually or in aggregate, contribute to achieving sustainability in the SASb over the next 20 years.
- Group 3: Supplemental PMAs that are in conceptual stages which may be implemented by entities in the future and would provide additional benefit in improving groundwater conditions and/or adapting to changes in future conditions.

More than 170 PMAs have been identified in available planning documents in the SASb, dedicated to topics ranging from recharge, flood/stormwater management, water quality, supply augmentation, demand management, community stewardship, and conjunctive use. Notably, several PMAs focus on enhanced conjunctive use, which is defined as the coordinated use of groundwater and surface water to meet water supply demands and preserve groundwater sustainability.

### **Projects (Section 4.3 through Section 4.5)**

Several Group 1 projects have been implemented to date that primarily focus on conjunctive use. Specifically, these projects include:

1. The construction of the Freeport Intake on the Sacramento River as a result of a joint venture by the Sacramento County Water Agency and East Bay Municipal Utility District to divert 185 million gallon per day (MGD) of water from the Sacramento River.
2. The construction of the 50-MGD Vineyard Surface Water Treatment Plant (VSWTP) in 2011. The 80-acre site includes adequate space to expand the capacity to 100 MGD.
3. Ongoing efforts to increase operational flexibility and capacity for conjunctive use by construction of system interties, treatment plant improvements, and development of groundwater wells. These efforts have been and are being taken by

California--American Water, City of Sacramento, Sacramento County Water Agency, and the Golden State Water Company.

Group 2 projects are expected to be operational within the next 5 years and implemented by entities in the SASb. Major projects include:

1. The Harvest Water project is sponsored by the Sacramento Regional County Sanitation District and will provide a safe and reliable supply of disinfected tertiary-treated recycled water, up to 50,000-acre feet per year (AFY) to irrigate more than 16,000 acres of agricultural and 400 acres of habitat lands. Moreover, this project will reduce the need for groundwater pumping, support habitat protection efforts, restore depleted groundwater levels by up to 35 feet within 15 years, and increase groundwater storage by approximately 245,000 AF within 10 years.
2. Omochumne-Hartnell Water District groundwater recharge project will divert up to 4,000 AF per year of surface water from the Cosumnes River to an 1,168-acre spreading basin between the Cosumnes River and Deer Creek to help alleviate groundwater storage overdraft in both the SASb and the Cosumnes Subbasin. The use of available water during high flow events could allow the watershed to recover and cause longer flows in the Cosumnes River to persist during the dry season as the groundwater levels are incrementally increased through the recharge. To the extent the duration and location of flows in the Cosumnes River are extended, the local ecosystem will also be enhanced as a result of the project.
3. Regional Conjunctive Use Program elements will increase conjunctive use among both the SASb and the North American Subbasin municipal and industrial water purveyors, currently including California-American Water, Citrus Heights Water District, City of Lincoln, City of Sacramento, Golden State Water Company, Sacramento County Water Agency, and Sacramento Suburban Water District. The planned projects will utilize existing infrastructure to leverage ongoing planning processes to use available additional surface water through water transfers, groundwater recharge projects, wholesale agreements, or wheeling agreements. The goal is to provide long-term basin benefits through use of additional surface water supplies during wet years which would result in a net reduction of groundwater use and contribute to basin recovery. It is expected that an average of 20,400 AF of surface water would be made available during wet years within the SASb, directly offsetting the use of groundwater and equating to an average annual benefit of about 7,200 AF/year. Consistent with other conjunctive use projects, this project will increase regional and state water supply reliability and drought resiliency.

Group 3 projects are still in the conceptual stage and not expected to be operational within the next 5 years. One major project in this category includes:

1. The Sacramento Area Flood Control Agency's (SAFCA) Flood-MAR<sup>1</sup> project would modify the three largest non-federal dams in the American River Basin to safely contain floods with a 1-in-500 annual probability of occurrence. This project has been initiated due to concerns regarding climate-driven changes in precipitation patterns and is enabled by recent advances in meteorological forecasting. The SAFCA Floor-MAR project also includes measures to conserve water for environmental, agricultural, and

urban use by allowing conditional storage, aquifer recharge, and beneficial use of winter runoff (<sup>1</sup>Managed Aquifer Recharge).

### Projected Future Conditions (Section 4.6)

To evaluate the potential effects of proposed projects and management actions in meeting the sustainability goals of the SASb GSP, the Group 2 (near-term) projects described above were analyzed using the CoSANA model. Several scenarios were modeled, and the results are summarized in **Table ES-5** below for scenarios without consideration of climate change and, in **Table ES-6** below, for scenarios simulated with climate change. The tables show the projected change from current baseline conditions under different scenarios.

All scenarios result in lower average annual groundwater pumping and an improvement in groundwater storage in the SASb relative to the balance between inflows and outflows. Note that Scenarios 1 and 2 (Demand Reduction) were run separately from Scenarios 3, 4 and 5 (Project) to assess the isolated benefit of either expected urban reductions or potential agricultural reductions. Therefore, estimated storage benefits resulting from Scenarios 1 and 2, which fall in the Group 1 category, are additive to the outcomes from the other scenarios, which are comprised of Group 2 projects. Long-term groundwater basin sustainability will be achieved under any of the project and management action scenarios without climate change. With implementation of all the planned projects included in Scenario 5 and accounting for an expected minor planned reduction in demand, long-term groundwater basin sustainability is projected to be achieved under the modeled climate change conditions.

**Table ES-5:** Summary of PMA modeling scenarios *without* consideration of climate change

CoSANA Model Scenarios	Description	Average Annual Groundwater Pumping (AFY)	Average Annual Groundwater Storage Change (AFY)
PCBL	Projected Condition Baseline	234,000	-1,100
Scenario 1	Demand reduction (5% Ag; 10% Urban)	216,500	+2,000
Scenario 2	Demand reduction (10% Ag; 10% Urban)	210,900	+2,800
Scenario 3	Harvest Water & OHWD Recharge	211,800	+3,200
Scenario 4	Regional Conjunctive Use Harvest Water,	227,400	+200
Scenario 5	OHWD Recharge & Regional Conjunctive Use	205,200	+4,500

**Table ES-6:** Summary of PMA modeling scenarios, *with* consideration of climate change

<b>CoSANA Model Scenarios</b>	<b>Description</b>	<b>Average Annual Groundwater Pumping (AFY)</b>	<b>Average Annual Groundwater Storage Change (AFY)</b>
PCBL CC	Projected Condition Baseline with Climate Change	245,800	-6,200
Scenario 2	Demand reduction (10% Ag; 10% Urban)	220,400	-1,800
Scenario 4	Regional Conjunctive Use	239,100	-4,800
Scenario 5	Harvest Water, OHWD Recharge & Regional Conjunctive Use	216,600	-100

### Management Actions (Section 4.7)

In addition to the identified planned projects and expected actions that will be implemented by individual entities in the SASb, the following additional management actions are proposed to be implemented by GSAs in the SASb to ensure protection of sensitive users and to fulfill SGMA requirements.

1. The Shallow/Vulnerable Well Protection Program will provide financial relief for qualifying users of shallow wells that may be impacted by groundwater decline in the vicinity of their wells. Analysis, based on best available information, indicates that the incidence of such impacts on vulnerable wells is projected to be very low in the SASb over the GSP implementation horizon. The creation of the program is intended to address the cases of shallow well users impacted by groundwater level decline and will be developed jointly by participating GSAs and local stakeholders.
2. GSAs will coordinate with the Sacramento County Environmental Management Wells Program and local agencies to establish revised requirements for well construction to avoid future impacts on shallow well users, GDEs and on the GSP monitoring network.
3. GSAs will plan, implement and fund efforts to fill data gaps identified in the GSP (e.g., to refine information regarding specific wells in the GSP Monitoring Network, to improve understanding of surface water and groundwater interactions along a portion of the Cosumnes River)
4. GSA Coordination Activities: Multiple coordination activities and resource commitments between the GSAs of the SASb are required to support GSP implementation; and these coordination activities are summarized in **Table ES-7**.

**Table ES-7:** GSA coordination activities

<b>GSA Coordination Activities</b>	<b>Topic/Action</b>
GSA in SASb	Overarching groundwater management consistent with the GSP, GSP implementation measures, joint management actions, regional water bank/accounting, and grant applications supporting recharge and other beneficial projects
Local land use authority agencies	Identify and proactively address development activities to promote consistency with the GSP. Identify issues and communicate regarding activities that may impact SASb sustainability
Entities sponsoring beneficial projects	Provide support and facilitate implementation, including support for grant funding.
Water supply agencies	Obtain updated information regarding water use efficiency programs, encourage such programs, and obtain information regarding the impacts of those programs on water demands. Coordination with subbasin water purveyors and groundwater pumpers to monitor water conservation and efficiency results of regional water conservation programs that impact the subbasin
GSA in adjacent basins	Coordinate possible future agreements, information exchange, and monitoring network augmentation. Because CoSANA is a common modeling tool among the North American Subbasin (NASb), SASb, and Cosumnes Subbasin (COSb), coordination on data collection, model upgrades, calibration updates, and application is needed among various GSAs in SASb and neighboring subbasins
Regional Water Authority (RWA)	Support and participate in continued planning effort to develop Sacramento Region Groundwater Bank and associated accounting framework that is consistent with long term sustainability of the SASb and encourages beneficial conjunctive use operations.
RWA, Water Forum, and the neighboring subbasin GSAs	Support a regional project to track climate change research and coordinate with regional partners to continue to refine climate change modeling and analysis in preparation for the next five year update to the GSP

## ES-5 GSP Implementation (Section 5)

**Section 5** details key GSP implementation steps and timelines. Cost estimates and elements of a plan for funding GSP implementation are also presented in this section.

Implementation of the GSP will focus on the following several key elements:

1. GSA management, administration, legal, and day-to-day operations.
2. Implementation of the annual GSP monitoring program.
3. Technical support, including model updates and other technical analysis.
4. Coordination activities among GSAs within SASb and with other entities as described in **Table ES-7**.
5. Reporting, including preparation of annual reports and 5-year evaluations and GPS updates.
6. Implementation of Management Actions pertaining to protection of shallow/vulnerable wells, revision of Sacramento County well construction requirements, and actions to collect information to fill identified data gaps.
7. Ongoing engagement and outreach activities to stakeholders consistent with existing Communication and Engagement Plan and policy of transparency in information sharing and decision making.

The 20-year GSP implementation timeline is shown in **Table ES-8**.

**Table ES-8:** GSP implementation timeline

Description	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
GSP Development & Adoption																						
GSP Submittal to DWR																						
<b>Agency Administration &amp; Operations</b>																						
<b>Management &amp; Coordination</b>																						
Monitoring: Groundwater																						
Monitoring: Streamflow																						
Data Collection																						
Data Management																						
<b>GSP Reporting</b>																						
Annual Reports																						
Five-year Assessment Report																						
<b>Outreach &amp; Education</b>																						

Implementation of the GSP over the 20-year horizon by the SASb GSAs is projected to cost \$860,000 per year, to be shared among the GSAs. The costs for management and administration of each GSA are not included in this estimate, which is preliminary and will be refined during the implementation of the GSP. A portion of the funding for GSP implementation

will be obtained from the annual contributions made by the GSA member agencies. This cost allocation may change as the GSA's understanding of Subbasin sustainability evolves over time through GSP data collection and the assessment of the beneficial impacts of agency PMAs on groundwater sustainability. The total and individual agency contributions will be evaluated and may be refined annually, as needed.

The GSAs will be expected to pursue funding from state and federal sources for GSP implementation. As the GSP implementation proceeds, the GSAs will further evaluate funding mechanisms and fee criteria. During GSP implementation, the GSAs may perform additional analysis of revenue sources to support potential refinements to the GSP.

## **ES-6 Summary**

In conjunction with projects that are currently planned to occur in the SASb through the initiative of individual entities and proposed management actions by the GSAs, the SASb is projected to maintain sustainable conditions under conditions of future planned growth and with anticipated climate change impacts. By operating in a collaborative and coordinated fashion, the entities comprising the GSAs in the SASb can ensure that beneficial uses and users of groundwater are protected and that undesirable results associated with SGMA's sustainability indicators are avoided into the foreseeable future.

## Section 1: Introduction

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In September 2014, Governor Jerry Brown signed into law the Sustainable Groundwater Management Act (SGMA), a three-bill legislative package composed of Assembly Bill (AB) 1739 (Dickinson), Senate Bill (SB) 1168 (Pavley) and SB 1319 (Pavley), which is codified in Section 10720 et seq. of the California Water Code. The legislation provides a framework for long-term sustainable groundwater management across California. The intent of SGMA is to provide local and regional agencies the authority to sustainably manage groundwater resources to help preserve water supplies for existing and potential beneficial uses and to protect communities, farms, and the environment against prolonged dry periods and climate change.

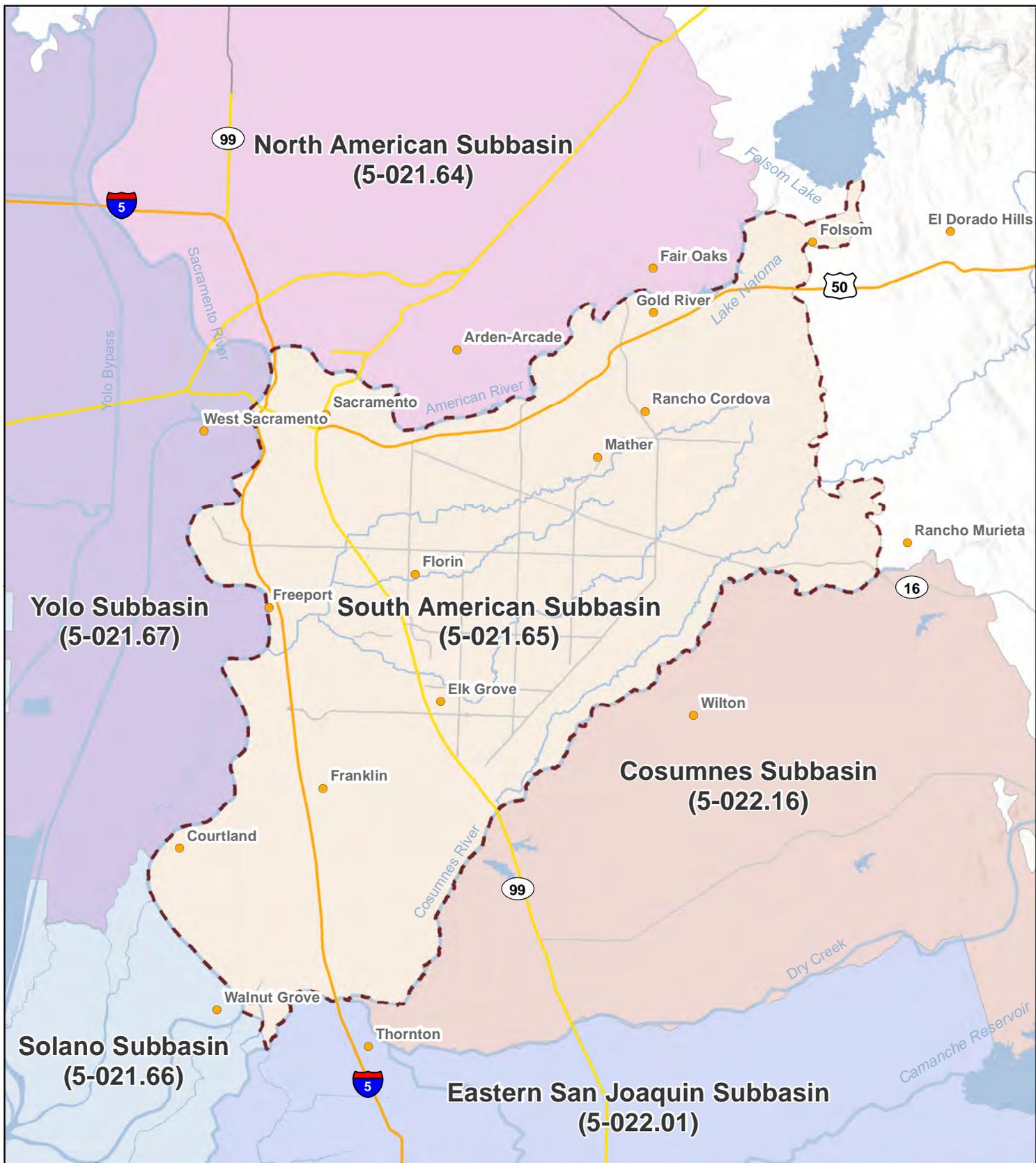
The California Department of Water Resources (DWR) and the State Water Resources Control Board (State Board) provide primary oversight for implementation of SGMA. DWR adopted regulations that specify the components and evaluation criteria for groundwater sustainability plans (GSPs), and coordination agreements to implement such plans. SGMA requires the following:

- Locally-controlled and governed Groundwater Sustainability Agencies (GSAs) must be formed for all high- and medium-priority groundwater basins in California.
- GSAs must develop and implement a GSP(s) or an Alternative to a GSP that defines a roadmap for how groundwater basins will reach long-term sustainability.
- The GSPs must consider six sustainability indicators: groundwater level decline, groundwater storage reduction, seawater intrusion, water quality degradation, land subsidence, and surface-water depletion.
- GSAs must submit annual reports to DWR each April 1 following adoption of a GSP for the preceding water year (October 1 to September 30).
- GSAs must evaluate their GSPs and progress to sustainability every 5 years.
- Groundwater basins must reach sustainability within 20 years of implementing their GSP(s).

### 1.1 Background

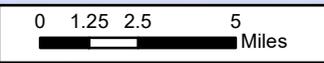
The South American Subbasin (SASb; listed as Groundwater Subbasin 5-21.65 per DWR Bulletin 118, *California's Groundwater*) is a high priority subbasin within the larger Sacramento Valley Groundwater Basin. A majority of the SASb is surrounded by rivers including the American River on the northern boundary, the Cosumnes and Mokelumne Rivers on the south, and the Sacramento River forming the western boundary. The eastern boundary is located at the transition between the alluvial sediments of the groundwater basin and the bedrock of the foothills of the Sierra Nevada mountains. As shown in **Figure 1-1**, the SASb shares boundaries with five adjacent subbasins: the Yolo Subbasin to the northwest, Solano Subbasin to the southwest, North American Subbasin to the north, and the Eastern San Joaquin and Cosumnes Subbasins to the south.

Figure Exported: 12/14/2020 By: videanda Using: \\woodandcurran.net\shared\Projects\MC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GA.GSP.G - GIS12.MXD12.Figure 2-2.Neighboring Groundwater Basins.mxd



**South American Subbasin GSP**  
**SASb and Neighboring Groundwater Subbasins**  
**Figure 1-1**

<b>Legend</b>	South American Subbasin	Solano
	Cosumnes	South American
	Eastern San Joaquin	Yolo
	North American	



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**South American SUBBASIN**

Map Created: June 2020

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.

Additional characteristics of the SASb, including a summary of the jurisdictional areas, water resources monitoring and management, land use, and groundwater conditions are presented in **Section 2: Plan Area and Basin Setting**.

In accordance with SGMA, this GSP was developed and will be implemented by the GSAs representing the entire South American Subbasin (SASb), as shown in **Figure 1-2**: Sacramento Central Groundwater Authority (SCGA), Northern Delta GSA (NDGSA), Omochumne-Hartnell Water District (OHWD), Reclamation District (RD) 551, Sloughhouse Resources Conservation District (SRCD), and Sacramento County. SCGA served as the fiscal and administering entity for the development of the SASb GSP under the guidance of a GSP Working Group (GSPWG). RD 551 agreed to be represented by NDGSA in the development of the GSP. As described in further detail in **Section 1.4**, the GSPWG is governed by a Memorandum of Understanding adopted by participating GSAs in May 2020.

### **1.1.1 Relationship to Other Planning Activities**

#### **1.1.1.1 Water Forum**

The Sacramento Area Water Forum Successor Effort (Water Forum) is an overarching surface water and groundwater planning body that has coordinated water planning in the Sacramento Metropolitan Region since the negotiation of the Water Forum Agreement (WFA), signed in 2000 and subsequently updated in 2015. The Water Forum was created in 1993 by stakeholders in the Sacramento Region with goals to provide safe and reliable water supply for the Sacramento Region and preserve the environmental values of the Lower American River. The Water Forum is comprised of a large group of agricultural and business leaders, representatives of citizens' and environmental groups, water managers, and representatives of local governments. From the outset, Water Forum participants recognized that, unless they took action, the Sacramento region faced water shortages, environmental degradation, groundwater contamination, threats to groundwater reliability, and limits to economic prosperity. A major outcome of the Water Forum was the creation of the SCGA and development of the Central Sacramento County Groundwater Management Plan (CSCGMP), provided in **Appendix 1-A**.

#### **1.1.1.2 Groundwater Management Plans**

Prior to the passage of SGMA, AB 3030, the Groundwater Management Act under California Water Code Section 10750 *et. sec.*, provided for the preparation of groundwater management plans (GMPs) to promote planned and coordinated monitoring, operation, and administration of groundwater basins with the goal of long-term groundwater resource sustainability. Prior to the adoption and implementation of this GSP, two existing GMPs were in effect within the boundaries of the SASb: (1) the Zone 40 GMP and (2) the CSCGMP. The Zone 40 GMP was developed first and was meant to serve as a framework for the CSCGMP, which encompasses the former and covers the majority of the SASb. Prior to the development and implementation of this GSP, the CSCGMP served as the overarching groundwater management document for the region.



SCGA, established as an outcome of the Water Forum, developed the CSCGMP for what was referred to as the Central Basin, which took into account the hydrogeologic boundaries and the political boundaries of organized water purveyors/districts, cities, and the County of Sacramento. The Central Basin is a locally defined subarea of the Sacramento Groundwater Basin that overlaps considerably with the SASb, as defined by the DWR Bulletin 118-03. The Central Basin does not include the southwestern corner of the SASb, which lies in the Sacramento-San Joaquin Delta and extends south into the adjacent Cosumnes Subbasin, as well as other minor boundary deviations.

The CSCGMP defined five Basin Management Objectives (BMOs) to help ensure viable groundwater resources for beneficial uses. The BMOs served as important information for the development of the Sustainable Management Criteria (SMC) in this GSP, which are detailed in **Section 3: Sustainable Management Criteria**. The five BMOs established by the CSCGMP are:

- **BMO No. 1:** Maintain the long-term average groundwater extraction rate at or below 273,000 acre-feet per year (AF/year), which is equal to the WFA sustainable yield quantity for the Central Basin. The WFA sustainable yield was calculated via groundwater modeling of the NASb, the SASb, and the COSb to avoid undue risk to private and public well owners associated with dewatering wells, degrading water quality, creating ground subsidence, and adding cost to pumping groundwater from lower elevations.
- **BMO No. 2:** Maintain specific groundwater elevations within all areas of the groundwater basin consistent with agreements in the WFA.
- **BMO No. 3:** Protect against any potential inelastic land surface subsidence by limiting subsidence to no more than 0.007 feet per 1 foot of drawdown in the groundwater basin.
- **BMO No. 4:** Protect against any adverse impacts to surface water flows in the American, Cosumnes, and Sacramento Rivers.
- **BMO No. 5:** Attain adopted water quality objectives.

### 1.1.1.3 Groundwater Modeling

This GSP was developed using a numerical groundwater model developed for the Cosumnes, South American, and North American Subbasins (the CoSANA model). The CoSANA model is intended to effectively represent the relationships between land surface processes, hydrologic cycle (climate, surface, subsurface), geology, and movement of water through the entire system. The Regional Water Authority, GSA representatives, and consultants were involved in the model calibration process using available empirical data to ensure a reasonable water budget for various components of the model. The development, calibration, and results of the CoSANA model are documented in **Section 2.2, Section 3, Section 4 and Appendix 2-B**.

Prior to the development of the CoSANA model, the Water Forum relied upon the Sacramento Integrated Groundwater Surface Water Model (SaciGSM). The SaciGSM was used in the Water Forum process and accounted for the hydrogeologic boundaries and the political boundaries of organized water purveyors/districts, cities, and the County of Sacramento.

## 1.2 Purpose of the Groundwater Sustainability Plan (GSP)

The purpose of the GSP is to satisfy the requirements of SGMA to ensure that groundwater will be used sustainably in the SASb and will provide for the protection of beneficial uses and beneficial users of groundwater in the subbasin. GSPs are required to describe the groundwater basin conditions and to establish various metrics that ensure sustainable groundwater management in the basin within 20 years of GSP adoption. The GSP is intended to achieve a sustainable regime that balances pumping and recharge and considers the needs of all water users. The GSP needs to consider and demonstrate the applicability of six SGMA-prescribed sustainability indicators in the SASb:

1. Lowering groundwater levels
2. Reduction in storage
3. Seawater intrusion
4. Degraded groundwater quality
5. Land subsidence
6. Surface water depletion

A significant and unreasonable change in any of the six sustainability indicators constitutes an Undesirable Result. This GSP establishes locally-derived Sustainable Management Criteria (SMC) for each of the applicable sustainability indicators that will achieve the SASb sustainability goal. SMCs are comprised of minimum thresholds, measurable objectives, and interim milestones for each monitoring point for each applicable sustainability indicator. Monitoring networks have been established to characterize and inform performance of the sustainability indicators.

## 1.3 Sustainability Goal

A narrative sustainability goal is required for the SASb that culminates in the absence of undesirable results to the Subbasin's groundwater, beneficial users, groundwater dependent ecosystems, and the Subbasin overall within 20 years of the applicable statutory deadline. The sustainability goal of the GSP is to ensure a viable groundwater resource for beneficial uses, including water for purveyors and agricultural, domestic, and industrial user, as well as environmental purposes. This GSP will maintain the Water Forum coequal objectives of providing a reliable and safe water supply for the region's economic health and preserving the fishery, wildlife, recreational, and aesthetic values of the Lower American River, as well as the CSCGMP objectives of protecting against adverse impacts to groundwater and interconnected surface water, to groundwater dependent ecosystems, and to the Cosumnes, Mokelumne, and Sacramento Rivers. The development and a full statement of the SASb sustainability goal is discussed in **Section 3: Sustainable Management Criteria**.

## 1.4 Agency Information and Management Structure

The GSAs in the SASb have worked together to meet SGMA requirements and collaboratively prepare a single GSP that was submitted by January 31, 2022 deadline. The SASb GSP Working Group (GSPWG) was established to provide recommendations on the development of the GSP and was comprised of representatives from the GSAs within the Subbasin. The GSPWG followed a consensus-based decision-making structure, where each GSA

representative received an equal voice. As mentioned previously, the SCGA served as the fiscal and administering entity that worked with the Consultant Team to develop the SASb GSP under the guidance of the GSPWG. Meetings of the GSPWG were open to the public and provided an opportunity for public input throughout the GSP development process.

## 1.4.1 Agency Information

### 1.4.1.1 Sacramento Central Groundwater Authority (SCGA) GSA

SCGA is governed by a Joint Powers Agreement (JPA) between the County of Sacramento, and the Cities of Elk Grove, Folsom, Rancho Cordova, and Sacramento. The JPA established a Board of Directors (Board) for SCGA which currently consists of 16 members who are appointed to 4-year terms. The Board elects a Chair, Vice Chair, and other officers as the Board finds appropriate, to serve a 1-year term. Representation includes a Board member from nine public agencies, two private water purveyors, one representative of agricultural interests, one representative of agriculture-residential groundwater users, one representative of commercial/industrial self-supplied groundwater users, one representative of conservation landowners, and one representative of public agencies that are self-supplied groundwater users. **Table 1-1** describes the representative organizations on SCGA's Board and their respective appointing authorities.

**Table 1-1: Representative Organizations on SCGA's Board of Directors**

<b>Organization</b>	<b>Appointing Authority</b>
City of Elk Grove	City of Elk Grove
City of Folsom	City of Folsom
City of Rancho Cordova	City of Rancho Cordova
City of Sacramento	City of Sacramento
County of Sacramento / Sacramento County Water Agency	County of Sacramento
Florin Resource Conservation District / Elk Grove Water District	City of Elk Grove
Agricultural Interests	County of Sacramento
Agricultural-Residential	County of Sacramento
Commercial / Industrial Self-Supplied	County of Sacramento
Conservation Landowners	County of Sacramento
Public Agencies Self-Supplied	County of Sacramento
California-American Water Company	County of Sacramento
Omochumne-Hartnell Water District	County of Sacramento
Rancho Murieta Community Services District	County of Sacramento
Sacramento Regional County Sanitation District	County of Sacramento
Golden State Water Company	City of Rancho Cordova

Each of the above representatives agrees to represent the interests of their respective stakeholder groups on the governing board of the SCGA. This responsibility includes, in part, disclosure of all relevant groundwater information and concerns, implementation of applicable groundwater management objectives, and a robust communication process that allows the board members' constituencies to fully participate in groundwater management through their representative.

The SCGA was established for the purposes of:

1. Maintaining the long-term sustainable groundwater yield of the Central Basin.
2. Ensuring implementation of the Basin Management Objectives that are prescribed by the current version of the GMP.
3. Overseeing the operation of any Well Protection Program that may be prescribed by the GMP.
4. Managing the use of groundwater in the Central Basin and facilitating implementation of an appropriate conjunctive use program by water purveyors.
5. Coordinating efforts among those entities represented on the governing body of the Joint Powers Authority to devise and implement strategies to safeguard groundwater quality.
6. Working collaboratively with other entities, including the Sacramento Groundwater Authority, the Southeast Sacramento County Agricultural Water Authority and other groundwater management authorities that may be formed in the County of Sacramento and adjacent political jurisdictions, to promote coordination of policies and activities throughout the region.

The SCGA elected to become the GSA for its jurisdictional area in July 2016. The Sacramento Central Groundwater Authority GSA may be contacted through the following:

Name: John Woodling, Interim Executive Director  
c/o Sacramento Central Groundwater Authority  
827 7<sup>th</sup> Street, Sacramento, CA 95814  
Website: <https://scgah2o.saccounty.net/pages/default.aspx>  
Phone: (916) 812-9118  
Email Address: [jwoodling@geiconsultants.com](mailto:jwoodling@geiconsultants.com)

#### **1.4.1.2 Northern Delta GSA (NDGSA)**

The Northern Delta GSA (NDGSA) was officially formed in June 2017 for the purpose of acting as the GSA for the northern portions of the Sacramento-San Joaquin River Delta. The NDGSA consists of local agencies that have taken responsibility for sustainably managing groundwater resources according to SGMA, and was formed through a JPA signed by its member agencies. Although a collection of reclamation districts (RDs) and the Franklin Drainage District were responsible for forming the NDGSA, the NDGSA is a separate and distinct entity. The NDGSA focuses solely on groundwater issues, while the various local agencies comprising the NDGSA may independently be involved with other challenges, such as levee or land management activities. The NDGSA has also been closely working with several other Partner GSAs.

The NDGSA was formed to retain local control over local groundwater resources, ensuring that groundwater management decisions are made by local entities familiar with the area. As such, local agency representatives within the NDGSA are local landowners themselves. The goal of the NDGSA is to provide cost-effective, responsive, and collaborative management of

groundwater that achieves compliance with SGMA without adding significant burden to local interests. This concern for local issues drives the NDGSA’s decision-making process.

Representatives for the member agencies serve on the NDGSA Board of Directors and have the authority to participate in all meetings, bring matters before the Board, and vote on issues impacting the Agency. **Table 1-2** lists the representative organizations on NDGSA Board and their respective appointing authorities.

**Table 1-2: NDGSA Member Agencies and Board Members**

<b>Member Agency</b>	<b>Subbasin</b>	<b>Board Member</b>
Reclamation District 1002 – Glannvale	South American	Jeff McCormack
Reclamation District 813 – Ehrhardt Club	South American	Norm Peters
Reclamation District 744 – Scribner District	South American	Russell Van Loben Sels
Reclamation District 2110 – McCormack Williamson	South American	Dewit Zeleke
Reclamation District 369 – Libby McNeil	South American	Clarence Chu
Reclamation District 755 – Randall Island	South American	Doug Hemly
Franklin Drainage District	South American	Richard Elliot Sr.
Reclamation District 349 – Sutter Island	Solano	Richard Elliot Sr.
Reclamation District 501 – Ryer Island	Solano	Craig Nakahara

The Northern Delta GSA may be contacted through the following:

Name: Erik Ringelberg  
 The Freshwater Trust  
 1717 I Street Suite A, Sacramento, California 95811  
 Website: <https://www.ndgsa.org/>  
 Phone: (916) 668-7345  
 Email Address: [NorthernDeltaGSA@gmail.com](mailto:NorthernDeltaGSA@gmail.com)

#### **1.4.1.3 Omochumne-Hartnell Water District (OHWD) GSA**

Omochumne-Hartnell Water District was established in 1953 and has historically purchased and managed supplemental water from the Central Valley Project for the benefit of District agricultural users adjacent to the Cosumnes River and Deer Creek. OHWD is committed to working to develop an effective management strategy that protects its member’s interests, protects local water resources, and meets the future water needs of the region. OHWD has continued to develop and create new projects that will enhance the water supply for its landowners and the region. These projects include conjunctive use projects such as groundwater recharge, Cosumnes River flow augmentation to increase fish flows in the river, and dam improvement projects.

The Omochumne-Hartnell Water District may be contacted through the following:

Name: Mike Wackman, General Manager  
 8970 Elk Grove Blvd., Elk Grove, CA 95624  
 Website: <http://www.ohwd.org/>  
 Phone: (916) 682-5958  
 Email Address: [info@ohwd.org](mailto:info@ohwd.org)

#### **1.4.1.4 Reclamation District 551 GSA**

RD 551 is a California Reclamation District formed and operating under the provisions of the Water Code § 50000, et seq. Under this law, RD 551 provides water delivery, drainage, and water management functions within its service area, which includes agricultural groundwater users, domestic well owners, municipal well owners (including the Town of Courtland), as well as surface water users. RD 551 has agreed to collaborate with the NDGSA and to be represented by the NDGSA on the GSPWG for GSP development.

Reclamation District 551 may be contacted through the following:

Name: Topper Van Loben Sels  
PO Box 7, Walnut Grove, CA 95690  
Phone: (916) 775-1941  
Email Address: [lindatoppervls@gmail.com](mailto:lindatoppervls@gmail.com)

#### **1.4.1.5 Sloughhouse Resources Conservation District (SRCD) GSA**

Sloughhouse Resource Conservation District (SRCD) was formed in 1956 by local farmers and ranchers to address local soil conservation issues. Landowners within SRCD boundaries in Southeast Sacramento County are represented by a five-member Board of Directors. Since the formation of SRCD, there have been several historic votes and changes to annex additional lands into the SRCD boundaries.

SRCD operates under the provisions of Division 9 of the Public Resources Code, section 9000 et seq. with the authority to control runoff, prevent or control soil erosion, develop and distribute water, and improve land capabilities. SRCD is also authorized to form improvement districts to fund and construct flood prevention facilities and facilities for the conservation, development, utilization, drainage disposal, and distribution of water for agricultural purposes.

Sloughhouse Resources Conservation District may be contact through the following:

Name: Austin Miller, District Manager  
8698 Elk Grove Blvd., Ste. 1-207, Elk Grove, CA 95624  
Website: <http://sloughhousercd.org/>  
Phone: (916) 526-5447  
Email Address: [Austin@SloughhouseRCD.org](mailto:Austin@SloughhouseRCD.org)

#### **1.4.1.6 Sacramento County GSA**

Sacramento County accepted GSA responsibility for a small unmanaged area in the southwestern corner of SASb where local interests did not take responsibility.

The Sacramento County GSA may be contacted through:

Name: Kerry Schmitz, Water Supply Division Chief  
827 7th Street, Room 301, Sacramento, CA 95814  
Website: <https://waterresources.saccounty.net/Pages/SGMA.aspx>  
Phone: (916) 874-4681  
Email Address: [schmitzk@saccounty.net](mailto:schmitzk@saccounty.net)

## **1.4.2 Management Structure**

GSP development and management is represented by the roles of the SCGA, GSPWG, and the other five GSA Boards.

### **1.4.2.1 Plan Management and Administration**

SCGA is designated as the Plan Manager and serves as the point of contact with DWR. As the Plan Manager, SCGA will be responsible for:

- Being the point of contact for the GSPWG to coordinate with the consultants.
- Overseeing the consultants per the contract.
- Ensuring grant obligations are met and reimbursements received.
- Delivering GSP priorities within the state-mandated GSP schedule.

The point of contact for the Plan Manager is:

Name: John Woodling, Interim Executive Director  
c/o Sacramento Central Groundwater Authority  
827 7th Street, Sacramento, CA 95814  
Phone: (916) 812-9118  
Email Address: [jwoodling@geiconsultants.com](mailto:jwoodling@geiconsultants.com)

### **1.4.2.2 GSP Working Group**

The GSPWG was formed upon execution of the Memorandum of Understanding Establishing a SASb SGMA Working Group and Identifying Cost Share Provisions for GSP Development (referred to as “the MOU”), provided as **Appendix 1-B**. The GSPWG is made up of senior staff and governing board members from each of the SASb GSAs who coordinate planning activities and public outreach. The GSPWG established and signed a Partnering Commitment (**Appendix 1-C**) which defined principles for engagement and operation and established a framework of commitments among the members to work collaboratively, efficiently, and with the necessary dedication to promote the development, adoption and submission of a SGMA--compliant GSP by the statutory deadline of January 31, 2022. The Partnering Commitment identifies the core parties and their responsibilities for delivering the SASb GSP.

The GSPWG was responsible for:

- Sharing feedback from their respective GSA related to the GSP development.
- Making recommendations to their respective GSA regarding the consideration and adoption of the GSP.
- Providing or ensuring the provision of timely responses and supporting information related to GSP development to the Consultants upon request in order to meet the state-mandated GSP deadline.
- Performing and supporting appropriate and coordinated outreach to stakeholders within the Subbasin.
- Ultimately delivering an acceptable GSP to all GSA Boards for adoption.

As part of their responsibilities to perform and support outreach, the GSPWG members agreed that:

- Parties are committed to an inclusive and transparent process that proactively seeks the engagement and input of potentially impacted parties as identified in SGMA. Parties will work to develop protocols for public engagement, both at public workshops and during regular Working Group meetings.
- Parties will work collectively to develop an agreed-upon outreach plan, but each GSA is responsible for outreach and engagement with stakeholders within their respective jurisdictions.
- Parties recognize the value in developing shared messages to ensure consistency; in joint participation in outreach efforts to foster consistency in message and concretely demonstrate the parties' coordinated effort.
- Parties recognize the need to conduct outreach in the near-term to better understand additional representation needs (e.g., environmental, tribal, riparian water users, overlying water users, disadvantaged communities (DACs), etc.) beyond the signatories to this agreement.

Membership of the GSPWG consisted of the following individuals:

- **Northern Delta GSA – 1 member**
  - Erik Ringelberg
  - Chris Thomas, Alternate
- **Omochumne Hartnell Water District – 2 members**
  - Mike Wackman
  - Mark Stretars
  - Mark Wilson, Alternate
- **Sacramento County – 1 member**
  - Linda Dorn
  - Kerry Schmitz, Alternate
- **Sloughhouse Resource Conservation District – 1 member**
  - Austin Miller
  - Herb Garms, Alternate
- **Sacramento Central Groundwater Authority – 7 members**
  - Todd Eising
  - Paul Schubert
  - Bruce Kamilos
  - Evan Jacobs
  - Dave Ocenosak
  - Ted Rauh
  - Christine Thompson

#### 1.4.2.3 GSA Boards

Each GSA Board assigned their GSPWG members to work on the development of the GSP and stakeholder communication and engagement (C&E) plan. The GSA Boards were responsible for:

- Ensuring appropriate public outreach is executed per the SASb C&E Plan on behalf of their GSA.
- Accepting approvals to meet the mandated schedule for the completion and adoption of the Final GSP.
- Being informed about the GSP development by their designated GSPWG members.
- Informing their respective GSPWG Members with their insights, perspectives, and opinions.
- Ultimately adopting the Final GSP for submittal to DWR by January 31, 2022.

As part of developing the GSP, the SASb GSAs informed and involved stakeholders and Interested Parties within their own jurisdictions through their respective Board meetings and on their individual websites.

#### 1.4.3 Legal Authority

Recognizing that groundwater is most effectively managed at the local level, SGMA empowers local agencies with the authority to establish GSAs, which are responsible for the development and implementation of a GSP. In accordance with SGMA, six GSAs were formed, and under the MOU, five of six of the GSAs entered into an agreement to develop one GSP for the SASb. RD 551 subsequently entered into an agreement with the NDGSA to be represented in GSP development. Per Section 10723.8(a) of the California Water Code, SCGA, the 7 agency members of the NDGSA, OHWD, RD 551, SRCD, and Sacramento County gave notice to DWR

of their decision to develop a single GSP for the SASb as described in DWR Bulletin 118, Basin No. 5-21.65.

#### **1.4.4 Estimated Cost of Implementing the GSP and the Approach to Meet Costs**

The members and contracting entities of the SASb GSPWG agreed to a cost share methodology and signed an MOU for the development of the GSP. The cost estimate and methodology to implement the GSP are addressed in **Section 5: Plan Implementation**.

### **1.5 Notice and Communication (Reg. § 354.10)**

The goal of communication and engagement efforts was to involve a broad and diverse group of Interested Parties, including stakeholders, the public, and beneficial users of groundwater throughout the GSP development process and to ensure that Interested Parties' concerns, issues, and aspirations were consistently understood and considered in the GSAs' decision-making process.

#### **1.5.1 Notice**

GSP information, meeting schedules, and useful links were posted to the SASb Groundwater Website<sup>1</sup>. Anyone could register as an Interested Party to be notified of events and activities regarding GSP development.

The GSPWG held two types of meetings: 1) regularly scheduled working sessions to focus on the technical content and guidance to consultants working on the GSP and 2) publicly-noticed public meetings to allow stakeholders to engage and provide input prior to key GSP milestones throughout the process. Following adoption, as the GSP is implemented, the website will be updated accordingly with new information for public review and comment.

Through Stakeholder Assessment and interviews with the GSPWG, it was determined that targeted communications would be provided to Spanish speakers. Notices of public hearings were published in a variety of media, including radio and local newspapers, informing the public on meeting information, meeting topics, and how to provide comments prior to decision-making.

#### **1.5.2 Decision-Making Process**

The GSPWG, comprised of senior staff and governing board members, was established per the MOU to coordinate planning activities and public outreach. This GSPWG included representatives from five GSAs within the SASb and followed a consensus-based decision-making structure, where each member received an equal voice. GSP decision-making and input was represented by the roles of the GSPWG, GSA Boards and Stakeholders.

Decision-making during GSP development, as well as for final approval, followed a streamlined process. It was the goal of the GSPWG to make decisions through consensus. Each member of

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<sup>1</sup> [www.sasbgroundwater.org](http://www.sasbgroundwater.org)

the GSPWG committed to make a genuine effort to achieve consensus. In the absence of a consensus, and as a last resort, members of the GSPWG could have been called upon to cast votes.

### **1.5.3 Public Outreach**

In the summer of 2020, the first version of the Communication and Engagement Plan (C&E Plan) was created for the SASb GSP (see **Appendix 1-D**). The purpose of the C&E Plan was to assist the GSAs with stakeholder outreach and other related actions as required by SGMA. This C&E Plan, which can be found on the SASb website<sup>2</sup>, served as a roadmap to meet one of the statutory requirements of SGMA and the GSP Regulations. The SASb website provides meeting schedules and includes a high-level overview of the GSAs and the MOU enacted to develop one GSP, the requirements of a GSP and the final GSP, and useful links to external resources for more information. The SASb email list was used to send periodic updates and announcements about the progress of the GSP to its subscribers. The website tracks outreach efforts by the GSAs in its database, storing meeting attendance information, logging targeted outreach, and hosting the Interested Parties list.

#### **1.5.3.1 SASb Beneficial Uses and Users**

Groundwater in the SASb serves the needs of cities, farms, and businesses; and is a source of high-quality drinking water to urban and rural residents, all while helping to sustain vital ecosystems. Beneficial uses of groundwater in the SASb include water for irrigation, agriculture, domestic use, industrial use, municipal use, and water for the protection and enhancement of fish and wildlife. Beneficial uses and users of the SASb have been identified as the following:

- Agricultural users (farmers, ranchers, dairy)
- Rural, Ag-Residential and Domestic well owners
- Municipal well operators
- Public water systems
- Local land use planning agencies
- Environmental uses and users of groundwater, including but not limited to habitat that supports fish, birds, animals and insects; endangered species protection; protection of beneficial habitat for recreation and other societal benefits
- Surface water users
- The federal government (not limited to the military and managers of federal lands)
- Tribal Governments
- Disadvantaged communities
- Entities monitoring or reporting groundwater elevations in the subbasin
- Holders of overlying groundwater rights
- Adjacent Subbasins including Yolo, North American, Cosumnes, East San Joaquin and Solano
- Industrial Users
- Commercial Users
- Remediation pumpers
- Natural ecosystems
- General public

<sup>2</sup> [http://www.sasbgroundwater.org/assets/pdf/SASb\\_CE\\_Plan\\_Draft\\_Final\\_20200720-Final.pdf](http://www.sasbgroundwater.org/assets/pdf/SASb_CE_Plan_Draft_Final_20200720-Final.pdf)

### 1.5.3.2 Public Engagement Opportunities

The SASb GSAs are committed to encouraging the active involvement of diverse social, cultural, and economic elements of the population within the groundwater basin. Each GSA hosts a website, listed in **Table 1-3**, designed to provide information on GSA Board Meeting frequency, background information, maps, documents, status updates, useful links, contact information, and a means of communicating between the GSAs and the public. GSP updates were included as noticed per GSA respective meeting agendas that are published in advance. Meetings on the SASb GSP development were scheduled on a regular basis to inform the public and Interested Parties and provide opportunities to ask questions and make suggestions. These GSP development meetings were posted on the SASb website<sup>3</sup> and were announced via email.

**Table 1-3: GSA Website and Board Meeting Information**

<b>GSA</b>	<b>Meeting Frequency</b>	<b>Location</b>
<a href="#">County of Sacramento</a>	Meets on various Tuesdays and Wednesdays throughout the month	Sacramento County Board Chambers 700 H St. Sacramento, CA
<a href="#">Northern Delta</a>	June & December each year	Walnut Grove Library 14177 Market St. Walnut Grove, CA
<a href="#">Omochumne-Hartnell Water District</a>	3rd Tuesday of each month at 10:00 am	Sacramento County Farm Bureau 8970 Elk Grove Blvd. Elk Grove, CA
<a href="#">Sacramento Central Groundwater Authority</a>	2nd Wednesday of each month at 9:00 am	Elk Grove City Council Chambers 8400 Laguna Palms Way Elk Grove, CA
<a href="#">Sloughhouse Resource Conservation District</a>	2nd Wednesday of each month at 1:00 pm	Rancho Murieta CSD 15160 Jackson Rd. Rancho Murieta, CA
<a href="#">Reclamation District No. 551</a>	2 <sup>nd</sup> Tuesday of each month at 2:00 pm	Courtland Post Office 125 Primasing Avenue Courtland, CA

In addition, GSP Staff were available throughout the GSP development process to communicate and engage with Interested Parties and the public. Interested Parties were involved in GSP development and provided input throughout the process.

<sup>3</sup> <http://www.sasbgroundwater.org/meetings.html>

Other avenues for public engagement included:

- **GSPWG Meetings:** GSPWG meetings were held beginning in May 2020. Since August 2020, these meetings were open to the public and noticed on the SASb website<sup>4</sup>. Seventeen of the GSPWG meetings were open to public. A Master Meeting Schedule was included on the website to provide the dates and topics for GSPWG and public meetings.
- **Public Meetings:** Public meetings were held to update the public on the development of the SASb GSP. The Public meetings were held mid-week and, in the evenings, so the public could more conveniently attend. In addition to the public, attendance included: GSPWG members, SCGA Staff and Consultants. Special Meetings were also convened with representatives of the Rural, Ag-Residential and Domestic well owners. Meetings were widely noticed on the SASb website<sup>5</sup>.
- **Focus Group Meeting:** A focus group meeting with members of the agricultural community was held on May 13, 2021 at the Sacramento County Farm Bureau office in Elk Grove.
- **Public Surveys:** Public surveys were conducted to solicit specific input from Interested Parties on GSP development. One SASb Stakeholder Assessment was conducted in Spring 2020 where beneficial water users were interviewed and many of their suggestions on C&E were included as part of the C&E Plan.
- **Mail and Emails:** Postal mail was utilized to reach areas of the groundwater basin that may not have otherwise been informed of GSP activities. Email blasts (emails to the entire list of Interested Parties) were sent when significant information was available to communicate regarding GSP development.
- **Public Hearings:** Public hearings by individual GSA Boards were held to consider the approval and adoption of the SASb GSP. Public hearings were held and noticed in accordance with applicable laws and procedures. Public hearings will also be required for any future updates to the GSP.

**Table 1-4** summarizes the public engagement activities conducted during the development of the SASb GSP. A report on the outreach activities conducted as of October 21, 2021 is provided in **Appendix 1-E**.

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<sup>4</sup> <http://www.sasbgroundwater.org/meetings.html>

<sup>5</sup> <http://www.sasbgroundwater.org/meetings.html>

**Table 1-4: Outreach Activities**

<b>Format</b>	<b>Date</b>	<b>Detail</b>	<b>Participation</b>	<b>Purpose</b>
<b>Public Meetings</b>	July 23, 2020 Aug. 6, 2021 Nov. 5, 2020 Mar. 25, 2021 May 25, 2021 July 25, 2021	Via Zoom Video Conference	50-120	Milestone updates of SASb GSP Working Group public meetings
<b>Postcard Mailings/Other Direct Mailings/ Notifications</b>	July 2020 October 2020 March 2021 June 2021	Sent via USPS to Interested Parties/Stakeholders/DACs/ Small Water Systems/Tribal Contacts	Varied by GSA	Announcement of SASb GSP development/ Working Group Public Meeting milestones/ Availability of public draft GSP
<b>Press Releases</b>	July 2020 October 2020 March 2021 June 2021	Via Sacramento County Public Information Officer	14 media outlets	Press release announcing SASb Working Group public meetings
<b>Sacramento County Electronic Subscription</b>	July 2020 October 2020 March 2021 June 2021	Sacramento County Go Delivery Subscription List	5,460-5,650	Announcements of SASb Working Group public meetings
<b>Emails to Stakeholders</b>	July 2020 to October 2021	Notifications to interested parties list via SASb distribution list	190-500 contacts on subscription list, which increased over time	SASb GSP development updates/ notifications
<b>SASb GSA Public Board Meetings</b>	November 2015 to October 2021	51 GSA public Board meetings	Varied	SGMA/SASb GSP updates
<b>SASb GSP Working Group Meetings</b>	May 2020 to October 2021, monthly	21 meetings held via Zoom video conference	35-50	GSP Development
<b>Website</b>	July 2020 to present	sasbgroundwater.org	~2,500 website visits	GSP Development

### 1.5.3.3 Public Comments

The Public Draft SASb GSP was made available for public review on the SASb GSP website<sup>6</sup> from July 23, 2021 through August 18, 2021. Comments received were posted to the website and entered into the Comment Log (**Appendix 1-G**).

<sup>6</sup> <http://sasbgroundwater.org/resources.html>

## 1.6 GSP Organization

The GSP is organized in accordance with the GSP Emergency Regulations and statutory provisions of SGMA. The format of the GSP is similar to the outline provided by the DWR Sustainable Groundwater Management program. A brief summary of each GSP section is provided below.

- **Executive Summary.** Provides a summary of the contents of the GSP.
- **Section 1 – Introduction.** Includes the purpose and administration of the GSP, agency information, and GSP organization.
- **Section 2 – Plan Area and Basin Setting.** Plan Area describes the geographic setting, existing water resources planning and programs, relationship of the GSP to other documents within the SASb boundary, and additional GSP components. The Basin Setting includes a detailed discussion of the hydrogeologic conceptual model of the SASb; current and historical groundwater conditions; future groundwater conditions after allowances for growth, land use changes, and climate change; and a discussion of the area's current and future groundwater budgets and sustainable yield.
- **Section 3 – Sustainable Management Criteria.** Provides the adopted sustainability goal, addresses the six sustainability indicators that monitor undesirable results; defines the Minimum Thresholds, Measurable Objectives, and Interim Milestones at each monitoring location for each sustainability indicator for the 20-year implementation period. This Section describes the network of monitoring wells and other facilities that will track the hydrologic conditions of the SASb, assesses the need for improvements to the network to provide fully representative data, and addresses monitoring protocols and data analysis techniques.
- **Section 4 – Projects and Management Actions to Achieve Sustainability.** Describes projects and management actions that have been evaluated and will be supported and/or adopted by GSAs in pursuit of sustainability. Project details include measurable objectives that are expected to benefit from the project or management action, required permits, anticipated benefits, estimated costs, and how the project or management actions will be accomplished.
- **Section 5 – Plan Implementation.** Describes the GSP implementation process, including estimated costs, sources of funding, a preliminary schedule through full implementation, the data management system, methodology for annual reporting, and how progress evaluations and GSP updates will be conducted every five years.
- **Appendices – References and Technical Studies.** Contains the references and sources used to prepare this GSP.

### **1.6.1 Preparation of the DWR GSP Elements Guide**

This GSP was prepared to meet the regulatory requirements established by DWR, as shown in the completed GSP Elements Guide, provided in **Appendix 1-F**, which is organized according to the California Code of Regulation Sections of the GSP Emergency Regulations.

## Section 2: Plan Area and Basin Setting

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### 2.1 Plan Area

This section describes the South American Subbasin (SASb) Groundwater Sustainability Plan (GSP) area including the following plan area components:

- Major streams
- Institutional entities
- Agricultural and urban land uses
- Locations of groundwater wells
- State, federal, and tribal lands
- Watersheds

This section also describes existing monitoring programs for surface water flow and water quality, groundwater elevation and quality, subsidence, municipal and remediation operations, plus water management plans in the SASb. Information in this section was gathered from publicly available sources.

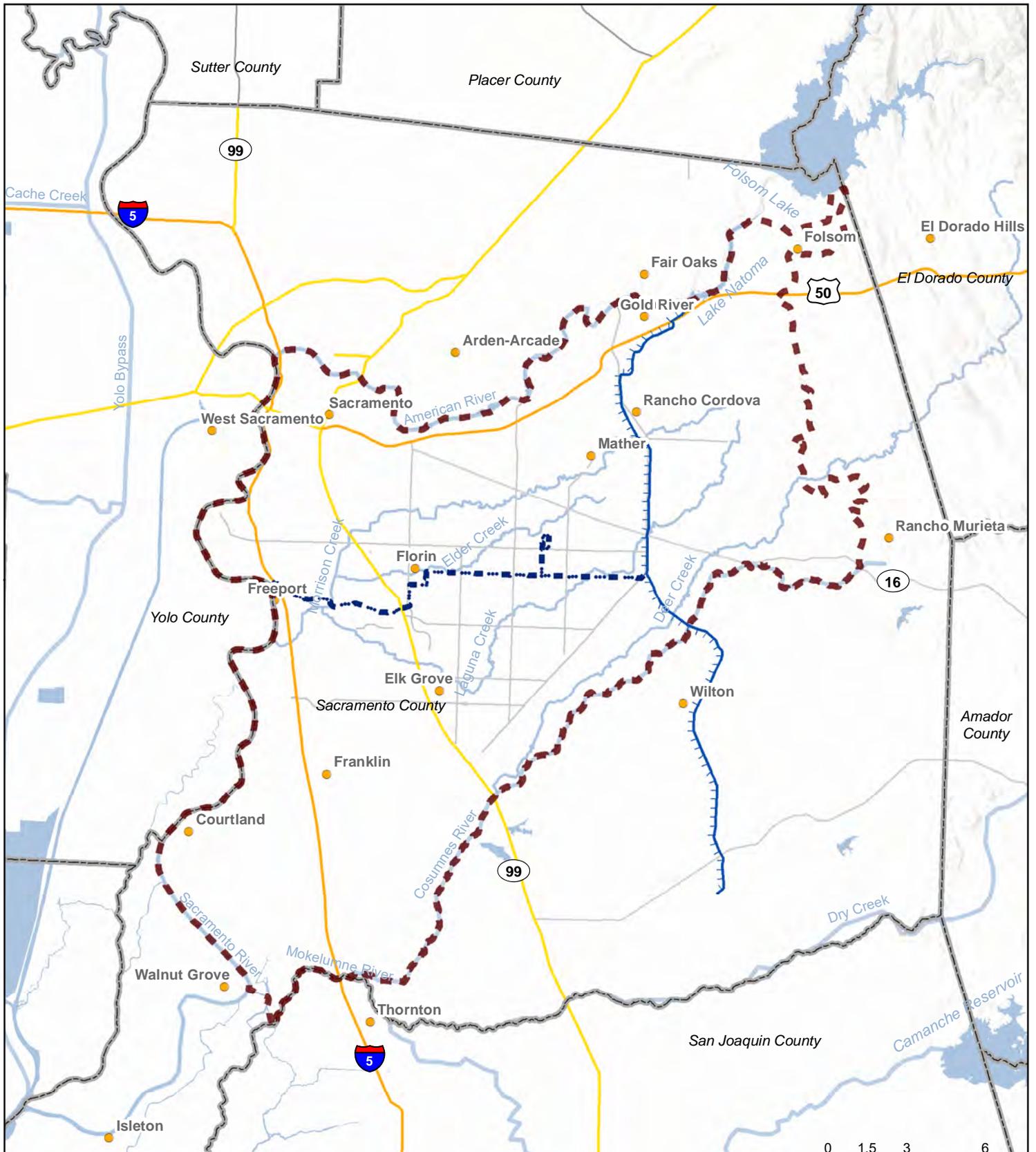
#### 2.1.1 Plan Area Definition

The SASb (defined as Basin 5-21.65 in Bulletin 118) encompasses roughly 388 square miles of the southeastern portion of the Sacramento Valley Groundwater Basin (SVGB) and spans the border between the Sacramento River Hydrologic Region and the San Joaquin River Hydrologic Region. The SVGB is a structural trough that represents the northern portion of the Great Central Valley of California. **Figure 2.1-1** shows the key geographic features in the SASb, which are described below.

According to DWR's *Bulletin 118 Update 2016: California's Groundwater* (Bulletin 118), the SASb is generally bounded on the north by the American River, on the east by the Sierra Nevada, on the south by the Cosumnes and Mokelumne Rivers, and on the west by the Sacramento River. The northern boundary begins at the confluence of the American River and Sacramento River and extends upstream, where the eastern boundary becomes the geologic contact between alluvial sediments and fractured bedrock. The southern boundary extends along the Cosumnes River to the confluence with the Mokelumne River and continues to Dead Horse Cut canal. The western boundary includes Dead Horse Cut, Snodgrass Slough, and the Delta Cross Channel and then follows the Sacramento River north to its confluence with the American River (DWR, 2016a).

The SASb is located entirely within the central portion of Sacramento County and contains an estimated population of nearly 752,000 residents (DWR, 2016b). The majority of these residents are located in the cities of Elk Grove, Rancho Cordova, the southern portion of Sacramento, the southern portion of Folsom, and an unincorporated area of Sacramento County that falls within the SASb. The cities of Sacramento and Elk Grove are in the mid- to north-central portion of the SASb along Highway 99 and Interstate 5. Rancho Cordova is located along the central northern boundary and Folsom is in the northeastern portion of the SASb along Highway 50. Natural waterways within the SASb include Alder, Buffalo, Morrison, Elder, Beacon, Laguna, and Deer Creeks. Major anthropogenic water features in the SASb include Lake Natoma, the Freeport Regional Water Authority Pipeline, and the northern portion of the Folsom South Canal.

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0 1.5 3 6 Miles

### South American Subbasin GSP

#### Key Geographic Features

Figure 2.1-1

#### Legend

- Cities and Towns
- Rivers and Creeks
- ▬▬▬ Folsom South Canal
- - - - - Freeport Pipeline
- Counties
- South American Subbasin



South American SUBBASIN

Map Created: June 2020

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.

## 2.1.2 Plan Area Setting

### 2.1.2.1 Overview

The SASb is one of 16 subbasins that comprise the SVGB. The SASb occupies the southeastern corner of the SVGB and is bordered to the southwest by the Solano Subbasin, to the northwest by the Yolo Subbasin, and to the north by the North American Subbasin. The San Joaquin Valley Groundwater Basin borders the SVGB to the south and constitutes the southern portion of the Great Central Valley of California. The SASb is bordered to the south by the Eastern San Joaquin Subbasin and the Cosumnes Subbasin. **Figure 2.1-2** shows the neighboring subbasins within the SVGB and San Joaquin Valley Groundwater Basin.

There are six GSAs that cooperatively manage groundwater within the SASb. As shown in **Figure 2.1-3**, the jurisdictional boundaries of these GSAs cover the entirety of the SASb, leaving no unmanaged area. There are no adjudicated areas in the SASb.

The SASb falls entirely within Sacramento County and is bordered on the west by Yolo County and on the south by San Joaquin County as shown in **Figure 2.1-4**.

### 2.1.2.2 Regional Watersheds

As mentioned above, natural waterways in the SASb include the American, Sacramento, Mokelumne, and Cosumnes Rivers, which bound the basin on the North, West, and South sides. In addition, Alder, Buffalo, Morrison, Elder, Beacon, Laguna, and Deer Creeks flow through the basin. **Table 2.1-1** shows the SASb's overlying watersheds as defined by U.S. Geological Survey (USGS) Watershed Boundary Dataset. **Figure 2.1-5** shows the watersheds that overlie the SASb.

**Table 2.1-1: Regional Watersheds**

HUC-8	Watershed
18020111	Lower American
18020163	Lower Sacramento
18040012	Upper Mokelumne
18040013	Upper Cosumnes

**Note:**

*HUC-8 = eight-digit hydrologic unit code*

### 2.1.2.3 Water Purveyors

There are nine municipal and three agricultural water purveyors in the SASb. Municipal water purveyors include the California American Water Company, City of Folsom, City of Sacramento, Elk Grove Water District, Florin County Water District, Golden State Water Company, Rancho Murieta Community Services District, Sacramento County Water Agency (SCWA), and the Tokay Park Water Company. Agricultural purveyors include Sacramento Regional Sanitation District, and North Delta Water Agency. The Sacramento Regional County Sanitation District is the only recycled water purveyor in the SASb. **Table 2.1-2** lists the total water distributed by water purveyors for the 2018 water year in acre-feet per year (AF/year) (SCGA, 2020).

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**South American Subbasin GSP**

**Neighboring Groundwater Subbasins**

Figure 2.1-2

**Legend**

- South American Subbasin
- Cosumnes
- Eastern San Joaquin
- North American
- Solano
- South American
- Yolo

0 1.25 2.5 5 Miles



**South American SUBBASIN**

Map Created: June 2020

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.

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## South American Subbasin GSP

### South American Subbasin GSAs

Figure 2.1-3

#### Legend

- South American Subbasin
- GSAs**
- Northern Delta GSAs
- OHWD GSA (SASb)
- RD 551 GSA
- SCGA GSA
- SRCD GSA (SASb)
- Sac Co GSA

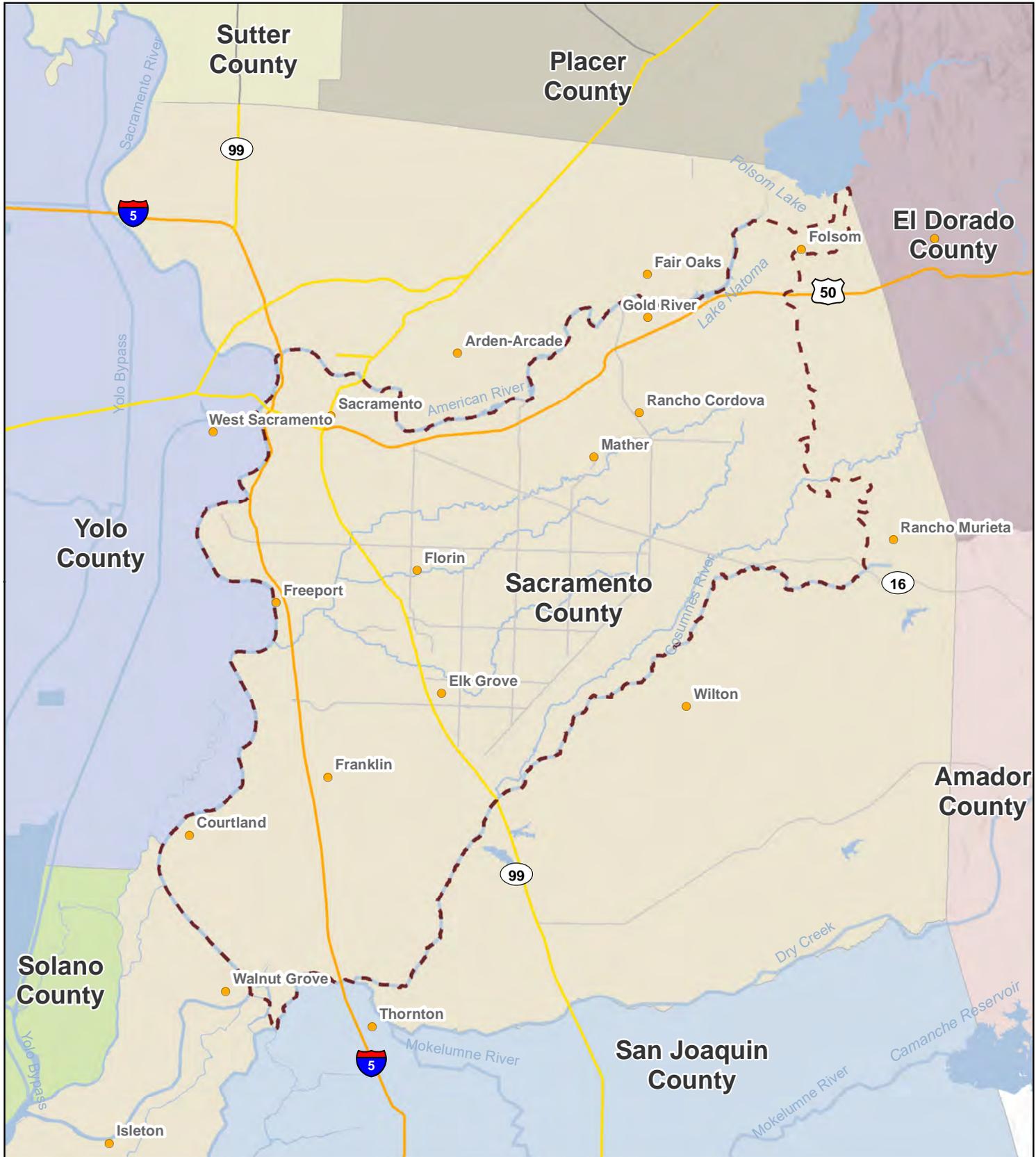
0 1.25 2.5 5 Miles



**South American SUBBASIN**

Project #: 0011575.00  
Map Created: June 2020

Figure Exported: 12/14/2020. By: vdeanda. Using: \\woodandcurran.net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\0011575.00- SC.GA.GSP.HG - GIS\2. MXD\4. Figure 2.4 Counties Overlaying SASsb.mxd



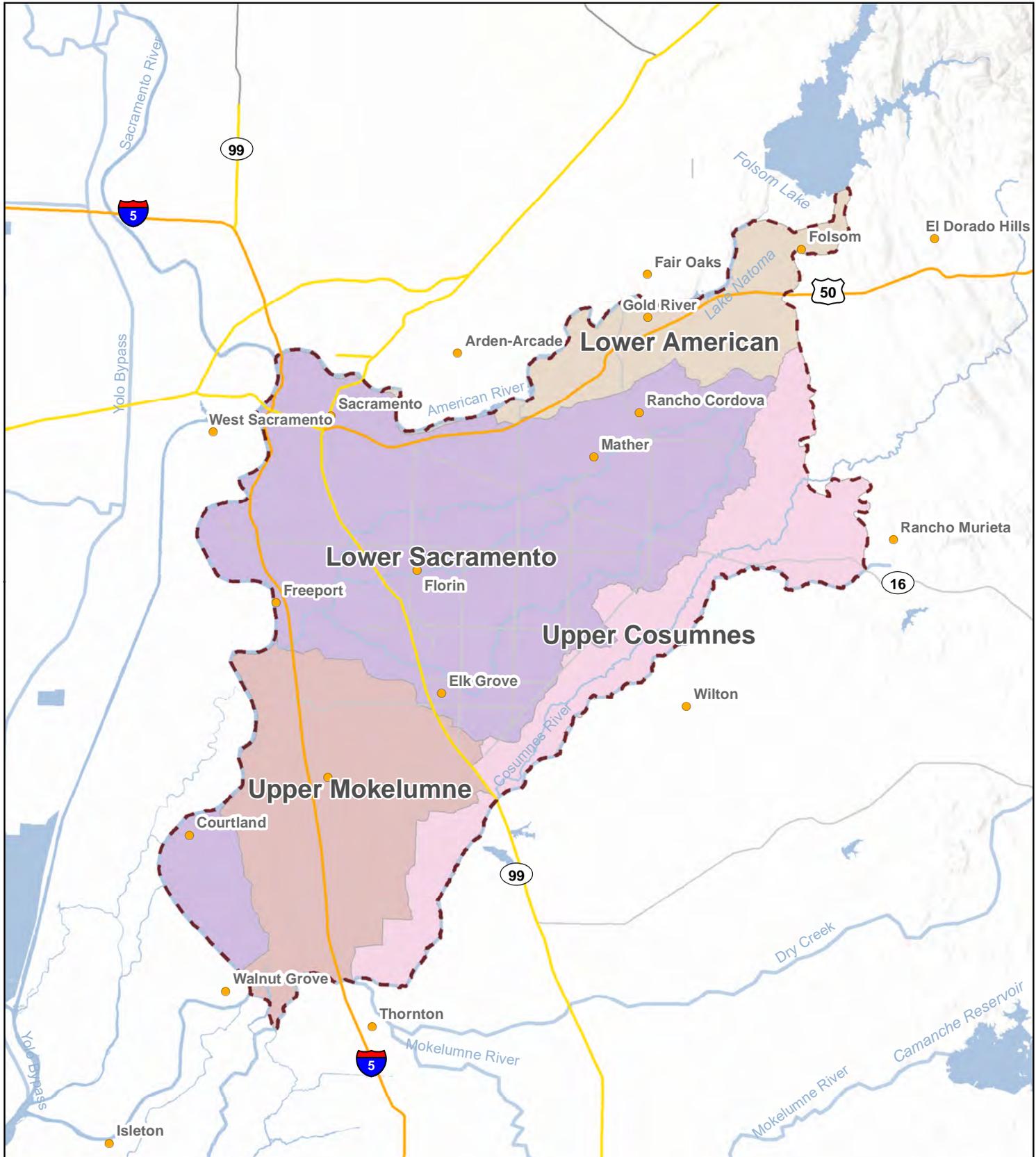
**South American Subbasin GSP**  
**Counties Overlaying South American Subbasin**  
 Figure 2.1-4

<b>Legend</b>	<ul style="list-style-type: none"> <li><span style="border-bottom: 1px dashed red; width: 20px; display: inline-block;"></span> South American Subbasin</li> </ul>	<ul style="list-style-type: none"> <li><span style="background-color: #f0e68c; border: 1px solid black; width: 15px; height: 10px; display: inline-block;"></span> Sacramento</li> <li><span style="background-color: #c0c0c0; border: 1px solid black; width: 15px; height: 10px; display: inline-block;"></span> San Joaquin</li> <li><span style="background-color: #90ee90; border: 1px solid black; width: 15px; height: 10px; display: inline-block;"></span> Solano</li> <li><span style="background-color: #d9ead3; border: 1px solid black; width: 15px; height: 10px; display: inline-block;"></span> Sutter</li> <li><span style="background-color: #b4c7e8; border: 1px solid black; width: 15px; height: 10px; display: inline-block;"></span> Yolo</li> </ul>
	<p><b>Counties</b></p> <ul style="list-style-type: none"> <li><span style="background-color: #e1e0e0; border: 1px solid black; width: 15px; height: 10px; display: inline-block;"></span> Amador</li> <li><span style="background-color: #c0c0c0; border: 1px solid black; width: 15px; height: 10px; display: inline-block;"></span> El Dorado</li> <li><span style="background-color: #a6a6a6; border: 1px solid black; width: 15px; height: 10px; display: inline-block;"></span> Placer</li> </ul>	

<p>0 1.25 2.5 5 Miles</p>	<p>N</p>
<p><b>South American SUBBASIN</b></p>	
<p>Project #: 0011575.00              Map Created: June 2020</p>	

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Figure Exported: 12/14/2020 By: videanda Using: \\woodandcurran.net\shared\Projects\PMCSAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GA.GSP\G - GIS\2. MXD\5. Figure 2-5 Regional Watersheds.mxd



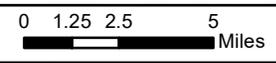
**South American Subbasin GSP**

**Regional Watersheds**

Figure 2.1-5

*Legend*

- South American Subbasin
- Lower American
- Lower Sacramento
- Upper Cosumnes
- Upper Mokelumne



**South American SUBBASIN**

Project #: 0011575.00  
Map Created: June 2020

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.

**Table 2.1-2: Water Purveyors 2018 Water Year, Total Water Use**

<b>Water Purveyor</b>	<b>2018 Water Year (AF/year)</b>
California American Water Company	13,825
City of Folsom	9,981
City of Sacramento	60,672
Elk Grove Water District	4,075
Florin County Water District	2,647
Fruitridge Vista Water Company (now part of the California American Water Company)	3,377
Golden State Water Company	8,213
Rancho Murieta Community Services District	464
SCWA	33,329
Tokay Park Water District	163
Sacramento Regional Sanitation District	119
North Delta Water Agency	2,323

**Note:**

Source: SCGA, 2020

**2.1.2.4 The Water Forum**

In 1993, the City of Sacramento and Sacramento County created the Water Forum to address growing concern for the environment and for access to water amid the area’s increasing population and water demand. On April 24, 2000, the Water Forum Agreement was executed by stakeholder organizations representing business and agricultural leaders, citizen groups, environmentalists, water managers, and local governments. As shown in **Table 2.1-3**, Water Forum signatories are included as members of one of four caucuses (business, environmental, public, water) that meets periodically to coordinate their activities. Members of all four caucuses meet quarterly at Water Forum Plenary meetings to coordinate actions and provide mutual updates (Water Forum, 2020).

**Table 2.1-3: Water Forum Caucuses**

<b>Caucus</b>	<b>Members</b>
Business	<ul style="list-style-type: none"> <li>• AKT Development</li> <li>• Associated General Contractors</li> <li>• North State Building Industry Association</li> <li>• Sacramento Association of Realtors</li> <li>• Sacramento Metropolitan Chamber of Commerce</li> <li>• Sacramento Sierra Building and Construction Trades Council</li> </ul>
Environmental	<ul style="list-style-type: none"> <li>• Environmental Council of Sacramento</li> <li>• Friends of the River</li> <li>• Save the American River Association, Inc.</li> <li>• Sierra Club Mother Lode Chapter</li> </ul>
Public	<ul style="list-style-type: none"> <li>• City of Sacramento</li> <li>• Sacramento County</li> <li>• League of Women Voters of California</li> <li>• Sacramento County Taxpayers League</li> <li>• Sacramento Municipal Utility District</li> </ul>

<b>Caucus</b>	<b>Members</b>
Water	<ul style="list-style-type: none"> <li>• California American Water Company</li> <li>• Carmichael Water District</li> <li>• Citrus Heights Water District</li> <li>• City of Folsom</li> <li>• City of Roseville</li> <li>• Clay Water District</li> <li>• Del Paso Manor Water District</li> <li>• El Dorado County Water Agency</li> <li>• El Dorado Irrigation District</li> <li>• Fair Oaks Water District</li> <li>• Galt Irrigation District</li> <li>• Georgetown Divide Public Utility District</li> <li>• Golden State Water Company/Arden-Cordova Water District</li> <li>• Natomas Central Mutual Water Company</li> <li>• OHWD</li> <li>• Orange Vale Water Company</li> <li>• Placer County Water Agency</li> <li>• Rancho Murieta Community Services District</li> <li>• Regional Water Authority</li> <li>• Rio Linda/Elverta Community Water District</li> <li>• Sacramento County Farm Bureau</li> <li>• Sacramento Suburban Water District</li> <li>• San Juan Water District</li> </ul>

*Source: Water Forum, 2020*

Groundwater Management is one of seven elements included in the Water Forum Agreement and allows the region to maintain a balanced approach toward groundwater sustainability. Sacramento Water Forum members agreed to establish a comprehensive program to manage these groundwater supplies. As part of the Water Forum Agreement, the Sacramento region was divided into three locally defined areas in Sacramento County, each managed by a different authority, and each provided with an annual sustainable yield:

- The North Area is located north of the American River and is governed by the Sacramento Groundwater Authority.
- The Central Area is located between the American and Cosumnes Rivers and is governed by the SCGA.
- The South Area is located south of the Cosumnes River and is governed by the Southeast Sacramento County Agricultural Water Authority.

#### **2.1.2.5 Land Ownership**

**Figure 2.1-6** shows state and federal lands in the SASb. These protected areas include the Stone Lake State Park and Wildlife Management Area, Delta Meadows State Park, the Prairie City State Vehicular Recreation Area, and small portions of the Cosumnes River Ecological Reserve. The only tribal land that falls within the SASb is located south of Elk Grove near the intersection of Kammerer Road and Hwy 99.

### 2.1.2.6 Land Use Types

Land use types within the SASb include residential, agricultural, commercial, industrial, recreational, and wildlife preserves and easements. **Figure 2.1-7** shows urban and agricultural land use in the SASb as included in the DWR 2015 land survey of Sacramento County. There were an estimated 57,089 acres of agricultural land in the SASb during 2015. **Table 2.1-4** lists the local crop types and estimated acreages.

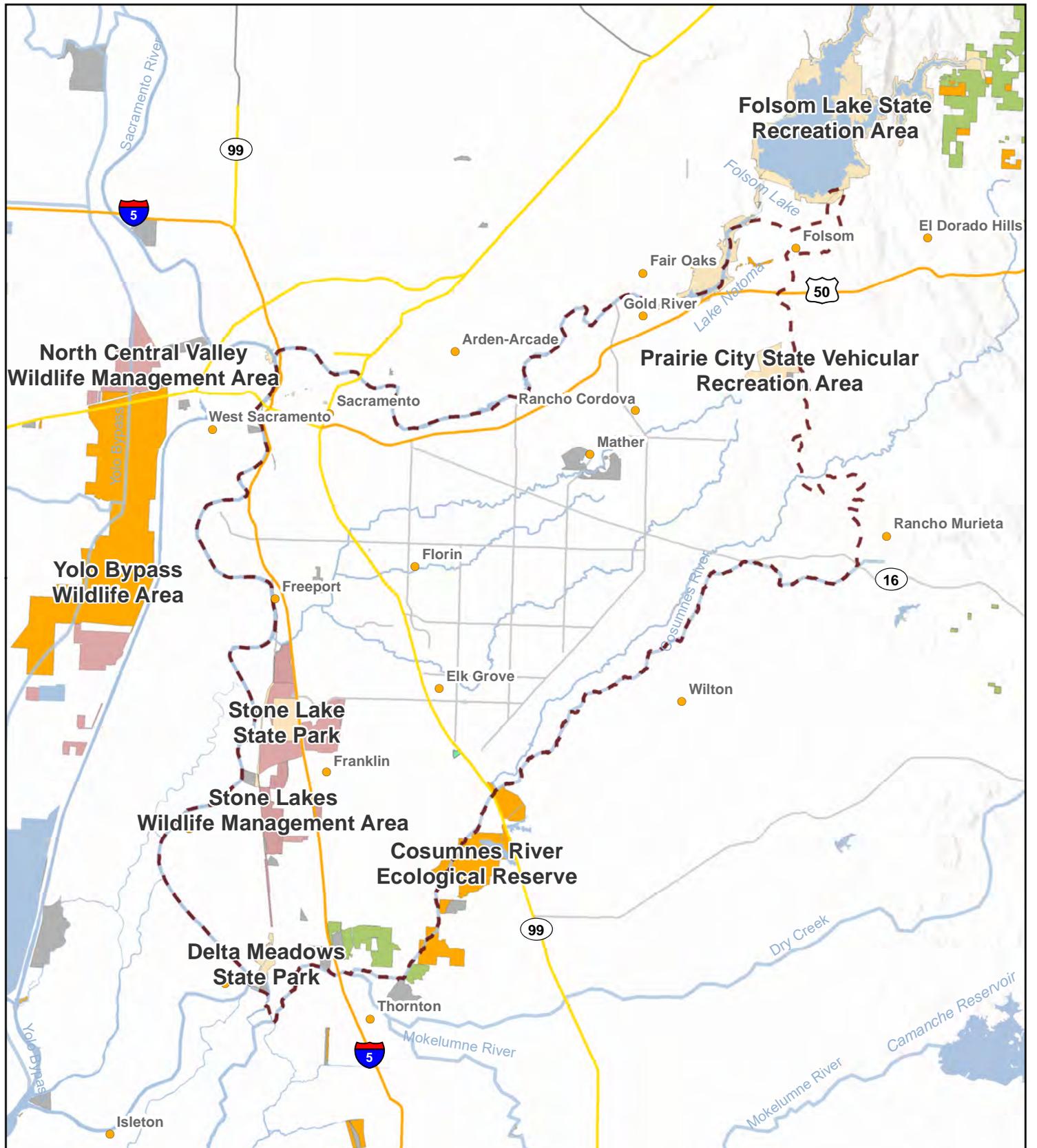
**Table 2.1-4: Local Crop Types and Estimated Acreages**

<b>Crop</b>	<b>Acres</b>
Alfalfa	5,059
Almonds and pistachios	204
Corn	4,365
Citrus	57
Cucurbits	416
Dry beans	673
Field crops	1,211
Grain	11,873
Idle	1,142
Orchards	3,119
Pasture	10,064
Rice	821
Safflower	677
Tomatoes	2,307
Truck crops	1,388
Vineyards	13,713
<b>TOTAL</b>	<b>57,089</b>

*Source: DWR 2015*

Agricultural irrigation water in the SASb is provided by surface water, groundwater, and a mix of surface and groundwater. Irrigated areas and water sources are shown in **Figure 2.1-8**.

Figure Exported: 10/4/2021 10:47:24 AM By: mmeyer Using: \\woodlands\man.net\share\Projects\RMCSAC\0509 Sac Central Groundwater Authority\0011575.00 - SCGA.GSP/G - GIS2.MXD:2-6 Federal and State Lands.mxd



**South American Subbasin GSP**  
**Federal and State Lands**

Figure 2.1-6

**Legend**

- South American Subbasin
- U.S. Fish and Wildlife Service
- U.S. Dept. of the Interior - Bureau of Land Management
- CA Dept. of Parks and Recreation
- CA Dept. of Fish and Wildlife
- Native American / Tribal Land
- Other State and Federal

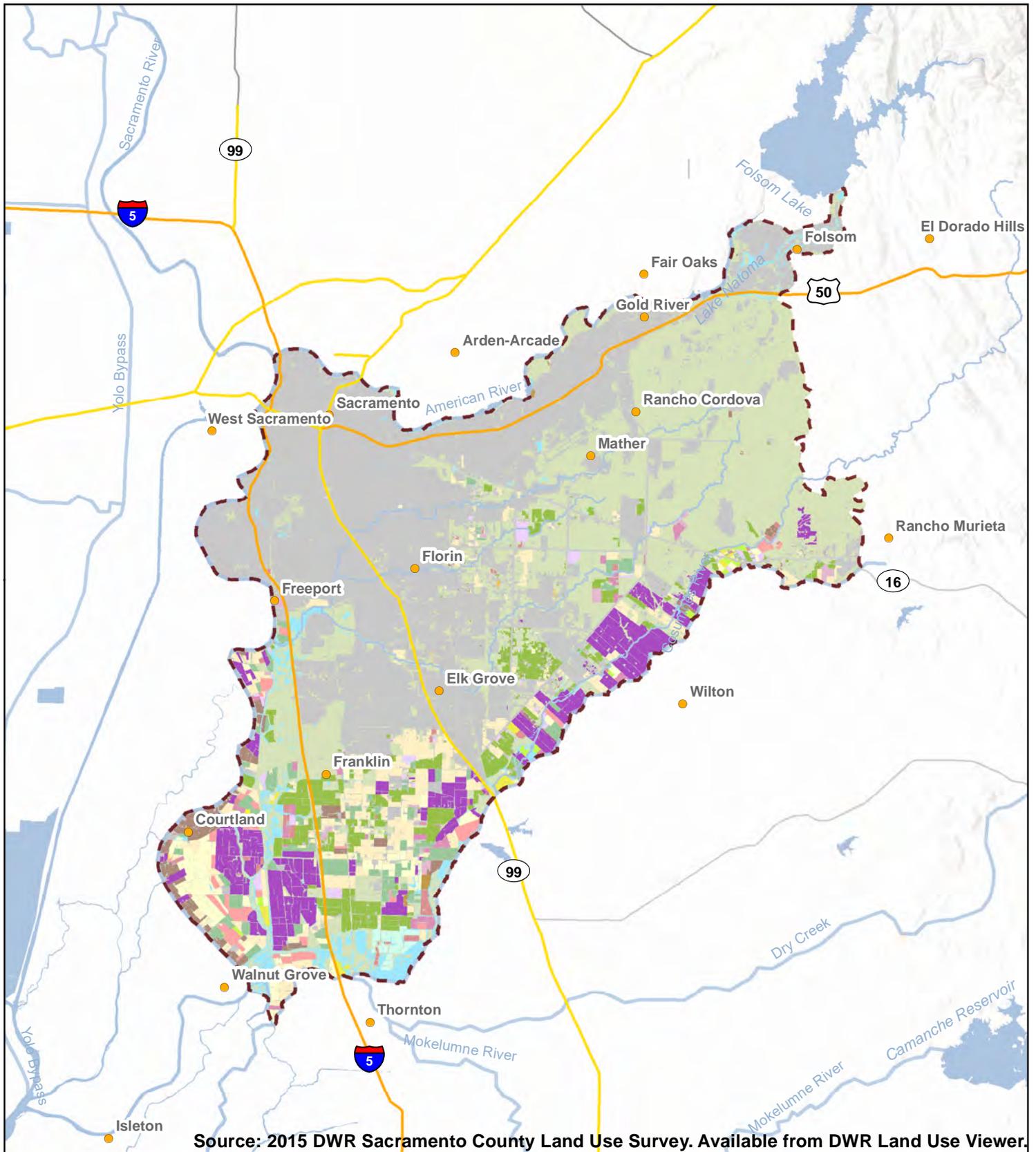
0 1.25 2.5 5 Miles



**South American SUBBASIN**

Project #: 0011575.00  
 Map Created: October 2021

Figure Exported: 12/14/2020 By: videanda Using: \\woodandcurran.net\shared\Projects\MC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GA.GSP\G - GIS\2. MXD\7. Figure 2-7 Land Use.mxd

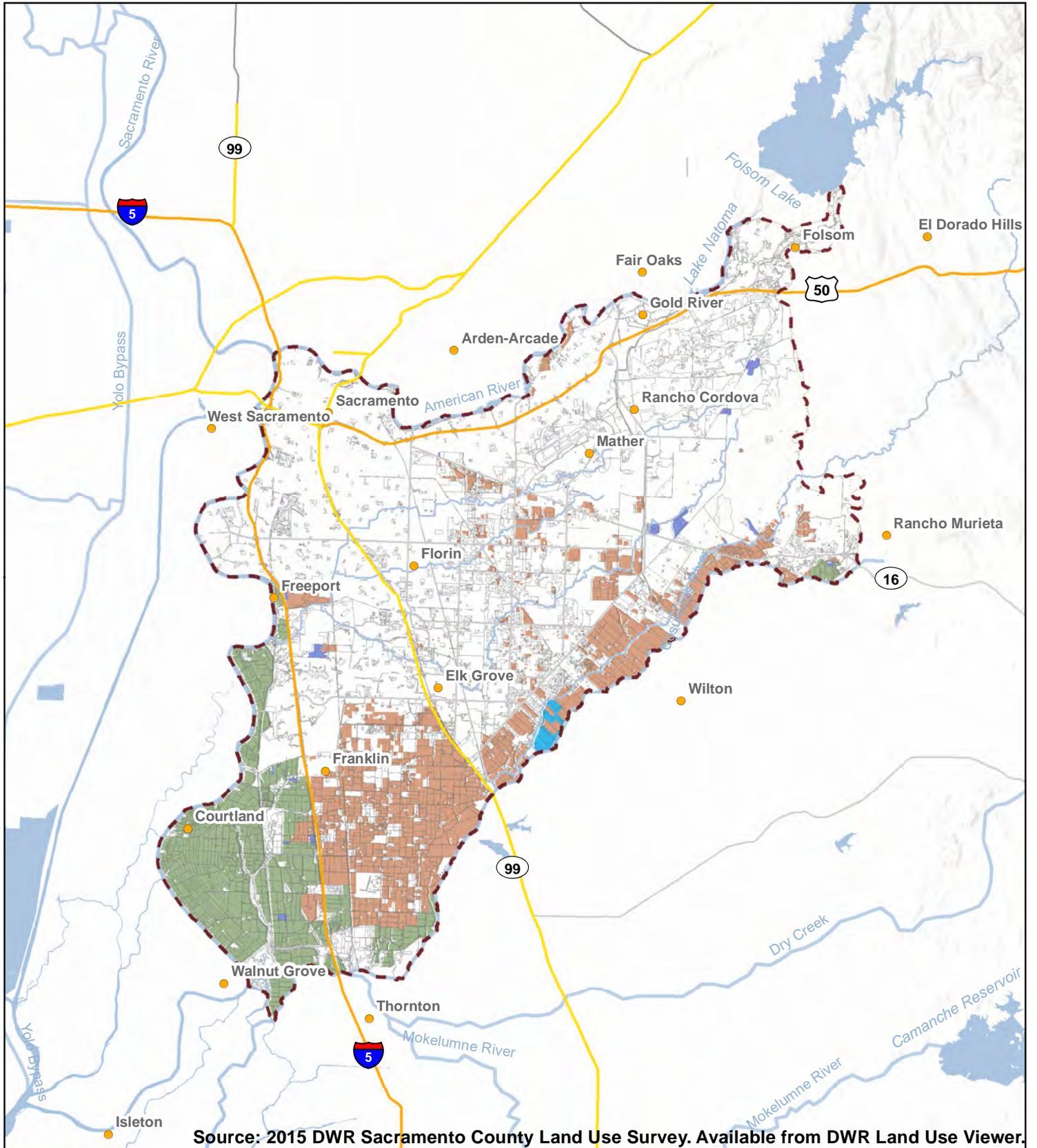


Source: 2015 DWR Sacramento County Land Use Survey. Available from DWR Land Use Viewer.

<h2>South American Subbasin GSP</h2> <p>Land Use</p> <p>Figure 2.1-7</p>	<p><b>Legend</b></p>	<ul style="list-style-type: none"> <li><span style="border-bottom: 2px dashed brown; width: 20px; display: inline-block;"></span> South American Subbasin</li> </ul>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #90EE90; border: 1px solid black;"></span> Cucurbits</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #FFDAB9; border: 1px solid black;"></span> Dry Beans</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #FFB6C1; border: 1px solid black;"></span> Field Crops</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #FFFACD; border: 1px solid black;"></span> Grain</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #FFF2CC; border: 1px solid black;"></span> Idle</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #90EE90; border: 1px solid black;"></span> Native Veg</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #8B4513; border: 1px solid black;"></span> Orchards</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #3CB371; border: 1px solid black;"></span> Pasture</li> </ul>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #ADD8E6; border: 1px solid black;"></span> Rice</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #4682B4; border: 1px solid black;"></span> Riparian Veg.</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #FFFF00; border: 1px solid black;"></span> Safflower</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #FF6347; border: 1px solid black;"></span> Tomatoes</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #DDA0DD; border: 1px solid black;"></span> Truck Crops</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #A9A9A9; border: 1px solid black;"></span> Urban</li> <li><span style="display: inline-block; width: 10px; height: 10px; background-color: #800080; border: 1px solid black;"></span> Vineyards</li> </ul>	<p>0 1.25 2.5 5 Miles</p>
			<p><b>South American SUBBASIN</b></p> <p>Project #: 0011575.00 Map Created: June 2020</p>		

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Figure Exported: 12/14/2020. By: vdeanda. Using: \\woodandcurran.net\shared\Projects\PMCSAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GA.GSP\G - GIS\2. MXD\8. Figure 2-8 Land Use by Water Use.mxd



Source: 2015 DWR Sacramento County Land Use Survey. Available from DWR Land Use Viewer.

### South American Subbasin GSP

#### Land Use by Water Use

Figure 2.1-8

#### Legend

- South American Subbasin
- Irrigation Water Source**
- Surface Water
- Surface and Groundwater
- Groundwater
- Unknown Source

0 1.25 2.5 5 Miles



South American SUBBASIN

Project #: 0011575.00  
Map Created: June 2020

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### 2.1.2.7 Wells

**Figure 2.1-9** through **Figure 2.1-11** show the estimated total number of domestic, production, and public wells in each square mile of the SASb and was downloaded from DWR's Well Completion Report Map Application. This application allows government agencies and the public to review these data as well density information per the Public Land Survey System section (DWR, 2020b). DWR's well designations are based on information contained in well completion reports and have not been modified or verified for this GSP.

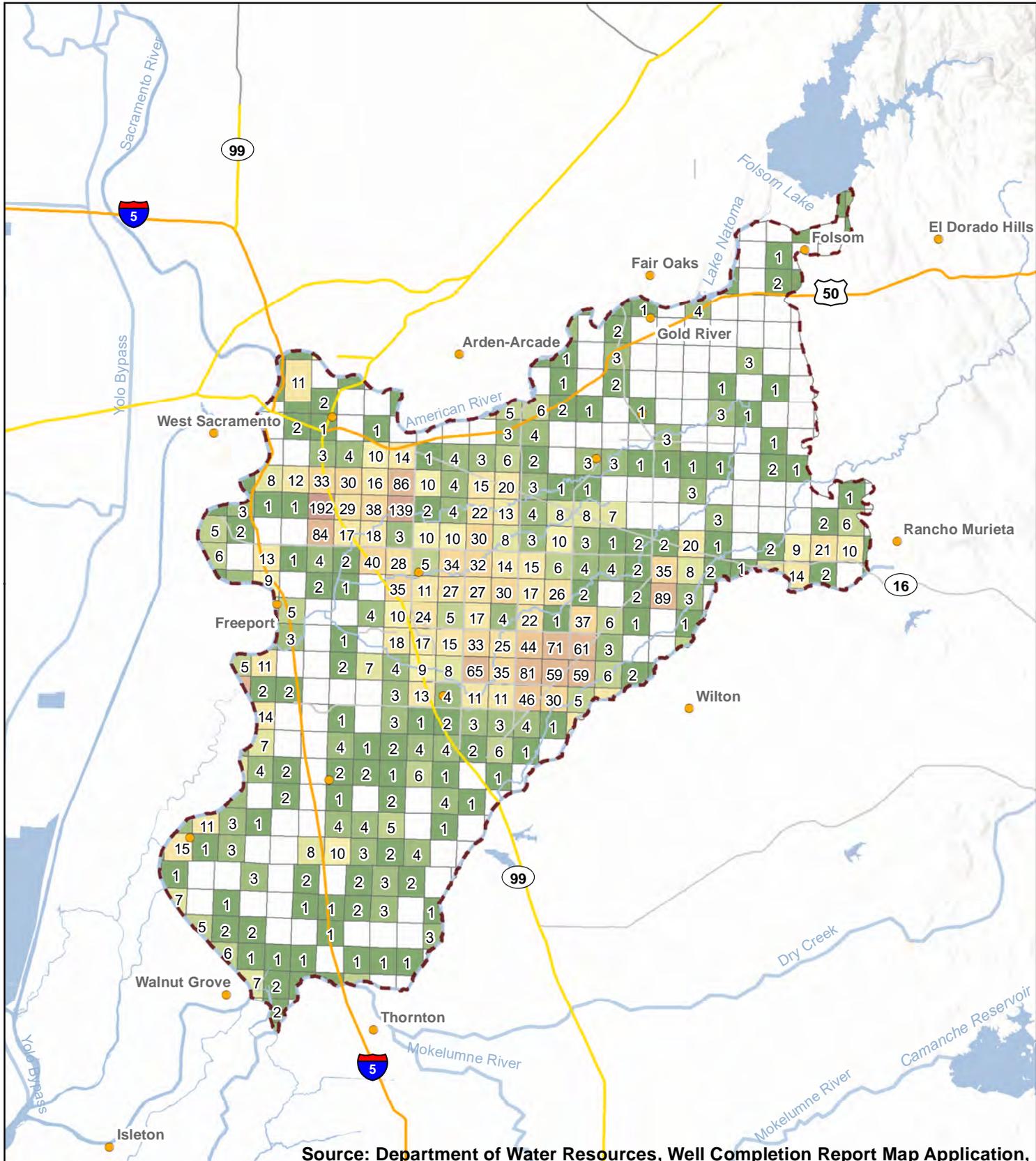
**Figure 2.1-9** shows the approximate number of domestic wells in the SASb. There are approximately 3,337 domestic wells in the GSP area with well completion depth ranging from 25 to 1,330 feet (DWR, 2020b).

**Figure 2.1-10** shows the approximate number of production wells in the SASb. There are approximately 915 production wells in the GSP area with well completion depth ranging from 67 to 1,493 feet (DWR, 2020b).

**Figure 2.1-11** shows the approximate number of public wells in the SASb. There are approximately 254 public wells in the GSP area with well completion depth ranging from 80 to 1,493 feet (DWR, 2020b).

Note that these figures contain information about wells drilled after 1947, and some wells may not have been reported to DWR and therefore, are not included in the database or in these figures. Furthermore, designations of each well as a domestic, production, or public well by DWR were based on information contained in the well completion reports and have not been verified or modified for this document. Finally, some wells that have been abandoned or destroyed may not be designated as such in the database. For these reasons, the information contained in the well completion report database only provides an approximate estimate of the number of active pumping wells in the SASb.

Figure Exported: 12/14/2020 By: vobanda Using: \\woodandcurran.net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GA.GSP.HG - GIS12 - MXD19 - Figure 2-9 Domestic Well Density.mxd



Source: Department of Water Resources, Well Completion Report Map Application,

**South American Subbasin GSP**  
**Domestic Well Density**  
 Figure 2.1-9

<b>Legend</b>	<span style="border: 1px dashed red; padding: 2px;"> </span> South American Subbasin	<span style="background-color: #c8e6c9; border: 1px solid black; padding: 2px;"> </span> 7 - 8	<span style="background-color: #e0e0e0; border: 1px solid black; padding: 2px;"> </span> 51 - 100
	<span style="border: 1px solid black; padding: 2px;">#</span> Number of Wells	<span style="background-color: #fff9c4; border: 1px solid black; padding: 2px;"> </span> 9 - 10	<span style="background-color: #e0e0e0; border: 1px solid black; padding: 2px;"> </span> 101 - 150
<span style="background-color: #c8e6c9; border: 1px solid black; padding: 2px;"> </span> 1 - 2	<span style="background-color: #fff9c4; border: 1px solid black; padding: 2px;"> </span> 11 - 20	<span style="background-color: #e0e0e0; border: 1px solid black; padding: 2px;"> </span> 151 - 192	
<span style="background-color: #c8e6c9; border: 1px solid black; padding: 2px;"> </span> 3 - 4	<span style="background-color: #fff9c4; border: 1px solid black; padding: 2px;"> </span> 21 - 30		
<span style="background-color: #c8e6c9; border: 1px solid black; padding: 2px;"> </span> 5 - 6	<span style="background-color: #fff9c4; border: 1px solid black; padding: 2px;"> </span> 31 - 40		
	<span style="background-color: #fff9c4; border: 1px solid black; padding: 2px;"> </span> 41 - 50		

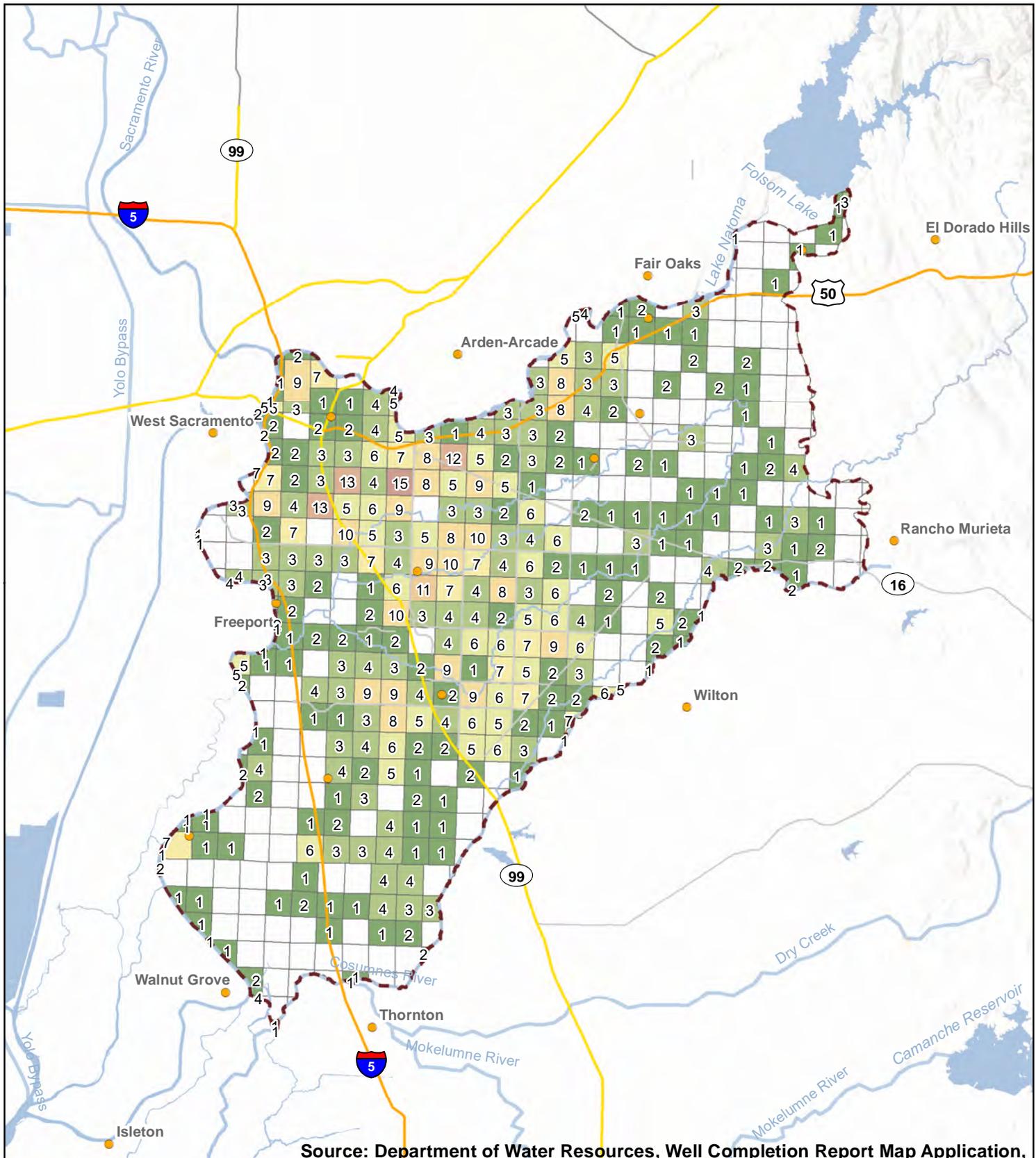
0 1.25 2.5 5 Miles

N

**South American SUBBASIN**

Project #: 0011575.00  
 Map Created: June 2020

Figure Exported: 12/14/2020 By: vdeanda Using: \\woodandcurran.net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\0011571500-SC.GA.GSP.HG - GIS\2\_MXD\10\_Figure 2-10 Production Well Density.mxd



Source: Department of Water Resources, Well Completion Report Map Application,

**South American Subbasin GSP**  
**Production Well Density**  
 Figure 2.1-10

<b>Legend</b>	South American Subbasin	7 - 8
	# Number of Wells	9 - 10
1 - 2	11 - 12	
3 - 4	13 - 14	
5 - 6	15	

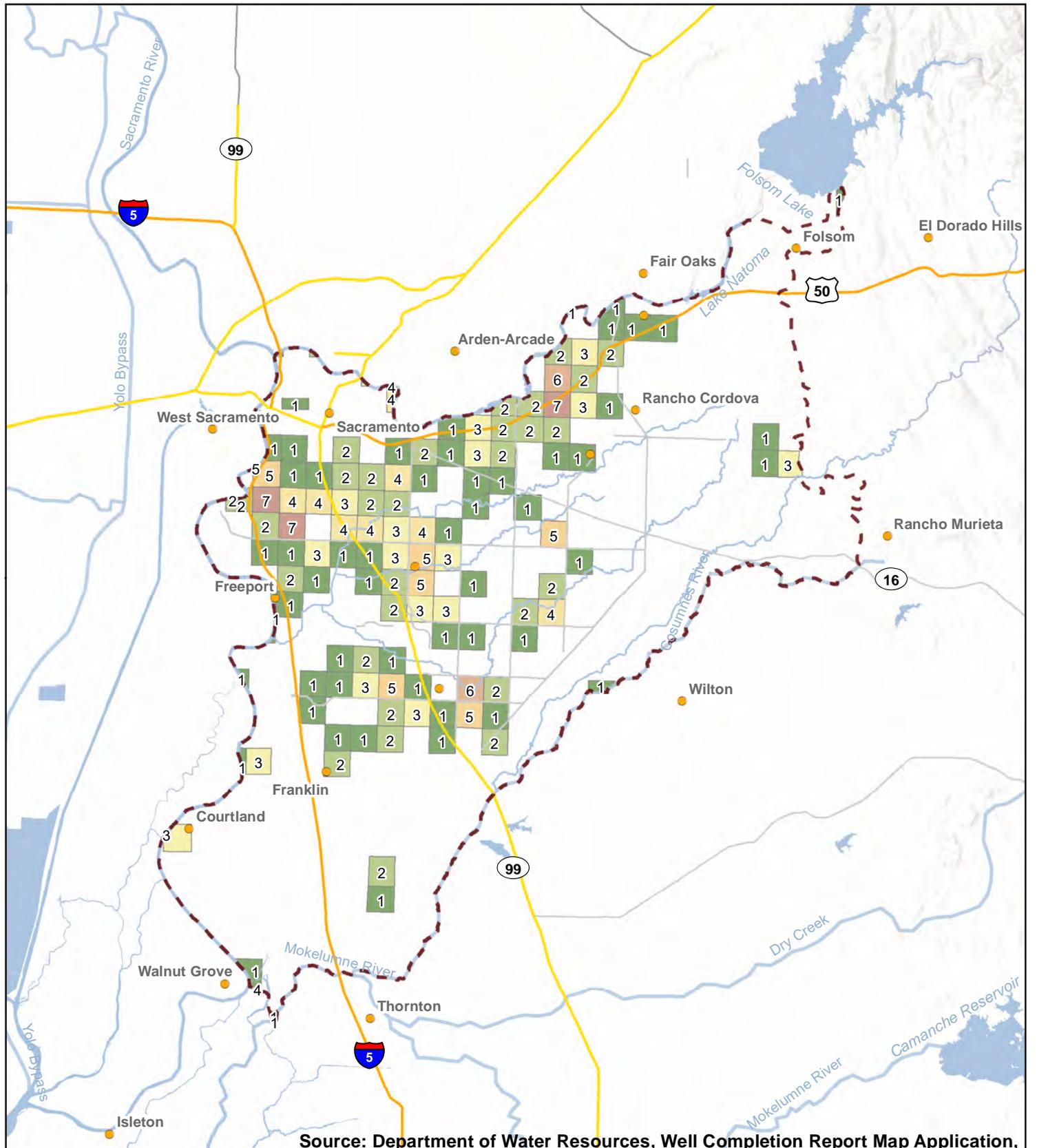
0 1.25 2.5 5 Miles

**South American SUBBASIN**

Project #: 0011575.00  
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Figure Exported: 12/14/2020 By: vdeanda Using: \\woodandcurran-net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GA.GSP.G - GIS12\_MXD11 - Figure 2-11 Public Supply Well Density.mxd



Source: Department of Water Resources, Well Completion Report Map Application,

### South American Subbasin GSP

Public Well Density

Figure 2.1-11

Legend

South American Subbasin	4
# Number of Wells	5
1	6
2	7
3	

0 1.25 2.5 5 Miles



South American SUBBASIN

Project #: 0011575.00  
Map Created: June 2020

### 2.1.3 Description of Beneficial Uses and Users of Groundwater

The *Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region, The Sacramento River Basin and San Joaquin River Basin* (Central Valley Regional Water Quality Control Board [CVRWQCB], 2018) defines beneficial uses of groundwater in the SASb as municipal and domestic water supply, agricultural supply, industrial service supply, and industrial process supply. The quantities of pumping for each of these uses is described in the water budget section of the GSP. Other beneficial uses include environmental uses, including groundwater dependent ecosystems (GDEs).

### 2.1.4 Surface Water Monitoring

Surface water is used extensively in the SASb to augment the region’s water supply and increase its reliability. American River surface water diverters in the SASb include the Golden State Water Company, Sacramento Municipal Utility District, and cities of Folsom, and Sacramento. Sacramento River water diverters include SCWA and the City of Sacramento (Water Forum, 2015). Agricultural use of surface water occurs primarily at diversions in the Delta and along the Cosumnes River (SCGA, 2020). **Table 2.1-5** summarizes total surface water extractions in the SASb for the 2018 water year.

**Table 2.1-5: Total Surface Water Use**

<b>Water Sector</b>	<b>2018 Water Year Total (AF/year)</b>
Municipal	90,414
Agricultural	31,219
Rural Residential	0
Remediation	0
<b>Total</b>	<b>121,633</b>

*Source: SCGA 2010[??] for 2018 totals[??]*

The USGS monitors surface water flow in the SASb. USGS, DWR, and various agencies reporting to the California Data Exchange Center (CDEC) monitor surface water quality in the SASb. Historical and current surface water monitoring in the SASb is described below.

#### 2.1.4.1 Surface Water Flow Monitoring Programs

##### 2.1.4.1.1 USGS—National Water Information System

The USGS monitors surface water flow in the SASb at four active stream gages: American River near Fair Oaks, Sacramento River near Freeport, and Laguna Creek and Morrison Creek (**Table 2.1-6** and **Figure 2.1-12**). In addition, there are active stream gages east of the SASb in Deer Creek and the Cosumnes River, and north of the SASb on the Sacramento River, American River, Arcade Creek, Magpie Creek, and Strong Ranch Slough.

**Table 2.1-6: Surface Water Flow Gages in the SASb**

Reporting Agency	Gage	Location	Status	Years of Record
USGS	11447500	Sacramento River near Sacramento	Inactive	1948–1979
USGS	11447000	American River near Sacramento	Inactive	1943–1959
USGS	11447650	Sacramento River near Freeport	Active	1948–2021
USGS	11446500	American River near Fair Oaks	Active	1904–2021
USGS	11335000	Cosumnes River at Michigan Bar	Active	1907-2021
USGS	11336000	Cosumnes River near SR 99	Inactive	1936–1982
USGS	11336585	Laguna Creek near Elk Grove	Active	1995–2021
USGS	11336580	Morrison Creek near Sacramento	Active	1959–2021

#### 2.1.4.1.2 DWR—CDEC

CDEC installs, maintains, and operates a hydrologic data collection network including automatic snow reporting gages for the Cooperative Snow Surveys Program and precipitation and river stage sensors for flood forecasting (CDEC, 2020). Four active sensors and one inactive sensor are located in the SASb. **Table 2.1-7** and **Figure 2.1-12** show the flow monitoring stations.

**Table 2.1-7: CDEC Flow Stations in the SASb**

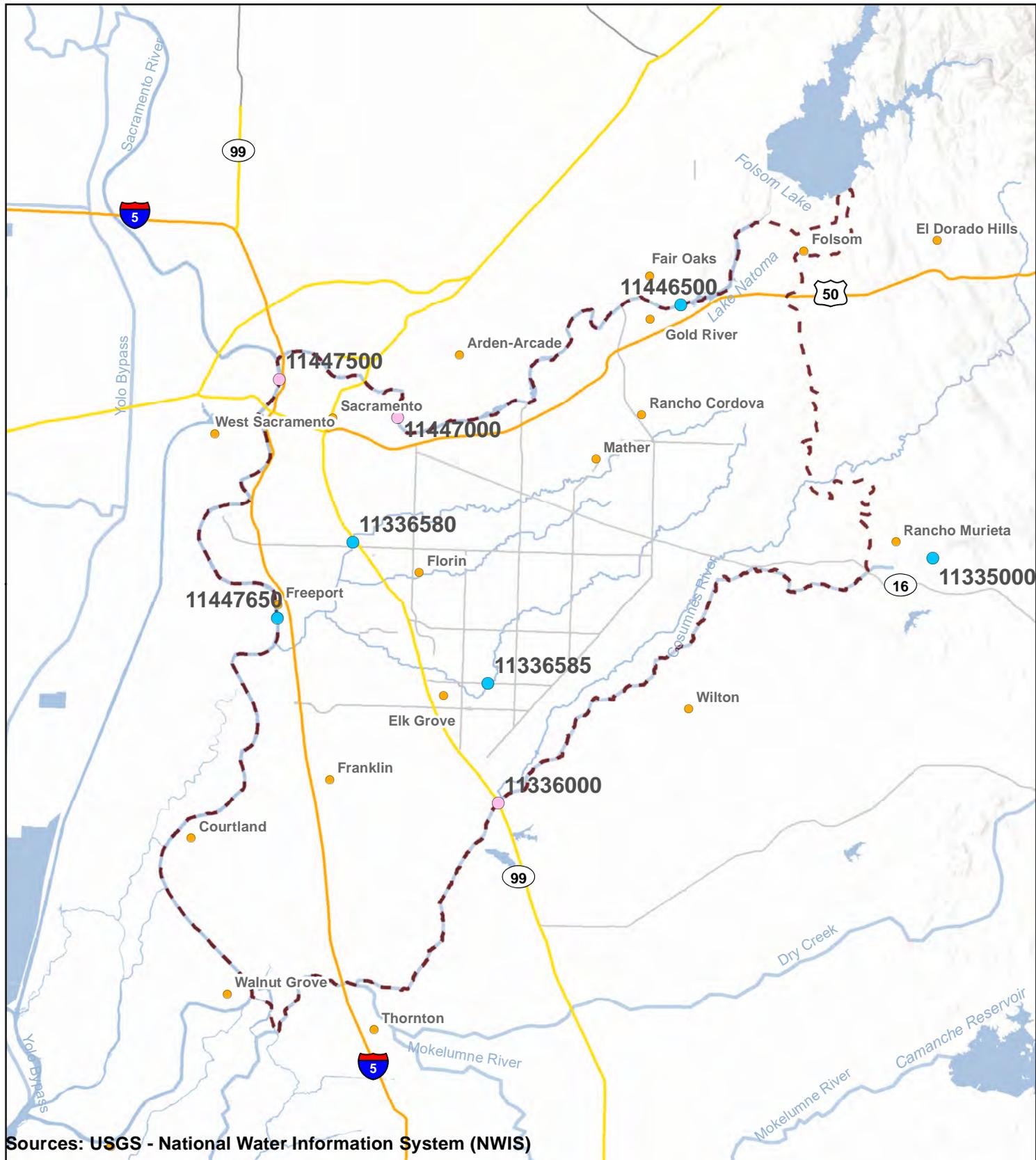
Station	Station Name	Monitoring Agency	Active
FPT	Sacramento River at Freeport	USGS	Yes
FPX	Sacramento River at Freeport Auxiliary	USGS	No
IST	Sacramento River at I Street Bridge	DWR/North Central Region Office	Yes
MFR	Morrison Creek at Florin Road	USGS	Yes
SPE	Sacramento Regional Wastewater Treatment Plant	Sacramento County	Yes

#### 2.1.4.2 Surface Water Quality Monitoring

##### 2.1.4.2.1 USGS—National Water Information System

USGS monitors surface water quality in the SASb. There are 17 active and 48 inactive surface water quality monitoring stations in the SASb with available data from 1951 through 2020 (**Table 2.1-8** and **Figure 2.1-13**). In addition, there are active surface water quality stations east of the SASb in Deer Creek and the Cosumnes River, and north of the SASb in the Sacramento River, American River, Arcade Creek, Magpie Creek, and Strong Ranch Slough.

Figure Exported: 12/14/2020 By: vobanda Using: \\woodandcurran-net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GA.GSP.MXD Figure 2-12 Surface Water Flow Monitoring.mxd



Sources: USGS - National Water Information System (NWIS)

### South American Subbasin GSP

#### Surface Flow Monitoring

Figure 2.1-12

Legend

South American Subbasin  
**Stream Gages**

- USGS NWIS - Active (5)
- USGS NWIS - Inactive (3)

0 1.25 2.5 5 Miles



South American SUBBASIN

Project #: 0011575.00  
Map Created: June 2020

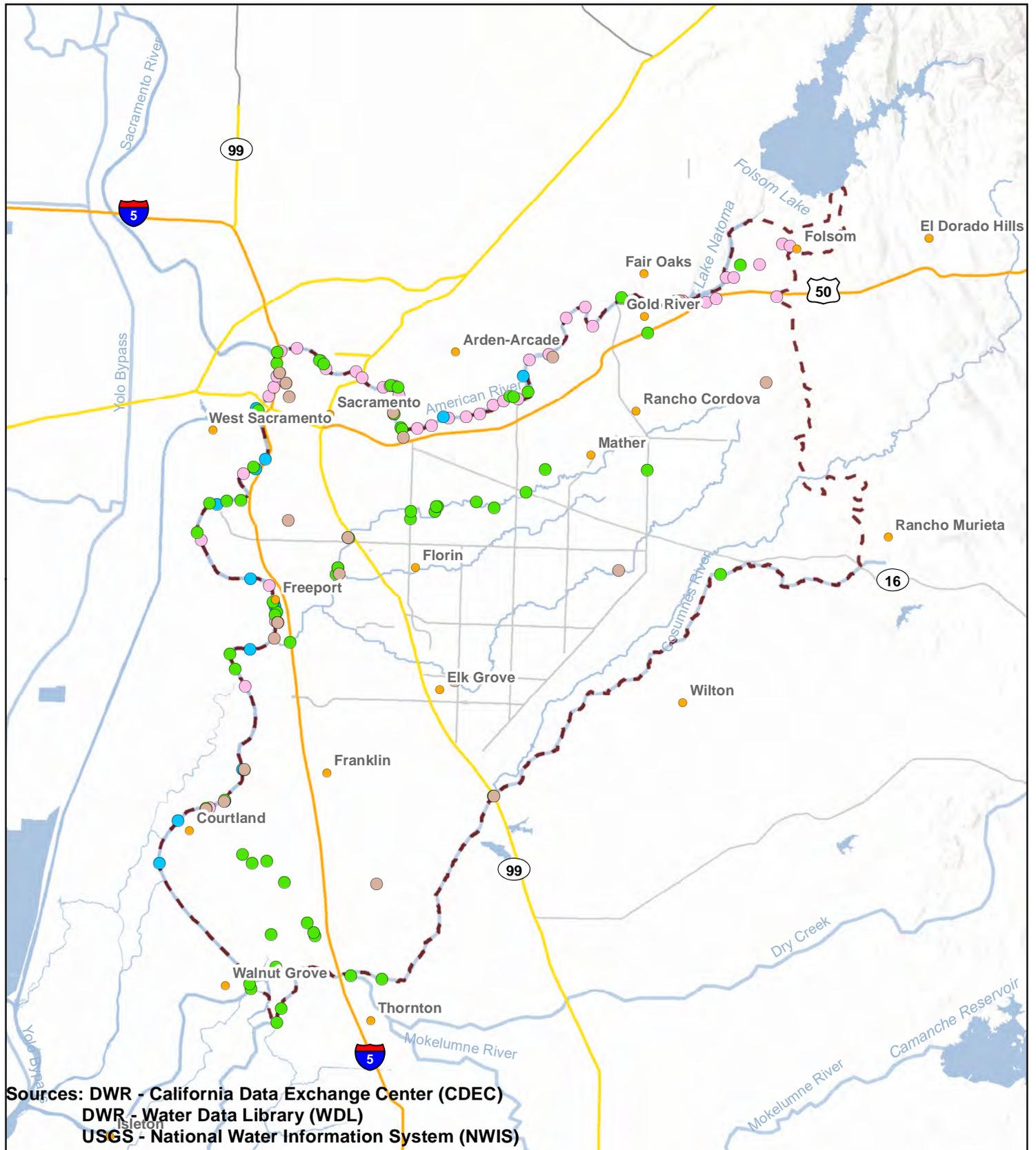
**Table 2.1-8: Surface Water Quality Gages**

Station	Station Name	Monitoring Agency	Active
11446500	AMERICAN R A FAIR OAKS CA	Active	1951–2003
11446700	AMERICAN R A WILLIAM B POND PARK A CARMICHAEL CA	Active	2015–2017
11446980	AMERICAN R BL WATT AVE BRDG NR CARMICHAEL CA	Active	2014 - 2017
382825121311301	DELTA RMP SACR-007	Active	2019–2019
381852121343801	DELTA RMP SACR-009	Active	2019–2020
382732121300901	DELTA RMP SACR-010	Active	2019–2019
383052121324401	DELTA RMP SACR-011	Active	2019–2019
382018121335501	DELTA RMP SACR-013	Active	2019–2019
383205121310901	DELTA RMP SACR-015	Active	2020–2020
11336585	LAGUNA C NR ELK GROVE CA	Active	unavailable
11336580	MORRISON C NR SACRAMENTO CA	Active	unavailable
11447650	SACRAMENTO R A FREEPORT CA	Active	1958–2020
382205121311300	SACRAMENTO R A HOOD CA	Active	1977–2020
11447540	SACRAMENTO R A PIER A WEST SACRAMENTO CA	Active	2018–2019
382605121310401	SACRAMENTO R A R MILE 44.0 CA	Active	1999–2019
383225121304601	SACRAMENTO R A R MILE 55.8 NR SACRAMENTO CA	Active	2016–2019
11447800	SACRAMENTO R A SNODGRASS SLOUGH NR HOOD CA	Active	1972–2019
383816121115001	ALDER C A FOLSOM BLVD NR NIMBUS CA	Inactive	2003–2003
383824121091601	ALDER C A PRAIRIE CITY RD NR FOLSOM CA	Inactive	2003–2003
383809121121601	ALDER C POND A HWY 50 A NIMBUS CA	Inactive	2003–2003
383344121234300	AMERICAN R 0.5 MI AB HOWE AVE BR NR SACRAMENTO CA	Inactive	1981–1981
383609121293200	AMERICAN R 1 MI AB MOUTH CA	Inactive	1981–2016

<b>Station</b>	<b>Station Name</b>	<b>Monitoring Agency</b>	<b>Active</b>
11447230	AMERICAN R A 16TH ST BR AT SACRAMENTO CA	Inactive	1978–1981
383603121301200	AMERICAN R A I5 BR. CA	Inactive	1981–1981
383515121264400	AMERICAN R A I80 BR. CA	Inactive	1981–1981
383729121181000	AMERICAN R A LO ROSSMOR BAR CA	Inactive	1981–1981
11446400	AMERICAN R A NIMBUS DAM CA	Inactive	1960–1981
383444121250800	AMERICAN R A NORTHROP AVE. CA	Inactive	1981–1981
383501121253100	AMERICAN R A PARADISE BEACH CA	Inactive	1981–1981
383531121281600	AMERICAN R A POWERLINES AB 16TH ST CA	Inactive	1981–1981
383615121185100	AMERICAN R A RANCHO CORDOVA PARK CA	Inactive	1981–1981
11447000	AMERICAN R A SACRAMENTO CA	Inactive	1960–1998
383751121172200	AMERICAN R A SAN JUAN RAPIDS CA	Inactive	1981–1981
383527121270000	AMERICAN R A SOUTHERN PACIFIC RR BRIDGE CA	Inactive	1981–1981
383810121155000	AMERICAN R A SUNRISE BIKE BR. CA	Inactive	1981–1981
383602121194000	AMERICAN R A UP GOETHE PARK CA	Inactive	1981–1981
383404121221600	AMERICAN R A WATERTON PARK NR CARMICHAEL CA	Inactive	1981–1981
383411121214100	AMERICAN R A WHITEWATER WAY NR SACRAMENTO CA	Inactive	1981–1981
383443121200500	AMERICAN R AB ARDEN STP CA	Inactive	1981–1981
383338121241900	AMERICAN R AB HOWE AVE BR. CA	Inactive	1981–1981
383500121251700	AMERICAN R AB HOWE AVE STP CA	Inactive	1981–1981
383438121204200	AMERICAN R BL ARDEN STP CA	Inactive	1981–1981
383429121210900	AMERICAN R BL ARDEN STP SECOND CHANNEL CA	Inactive	1981–1981
383501121252000	AMERICAN R BL HOWE AVE STP CA	Inactive	1981–1981

<b>Station</b>	<b>Station Name</b>	<b>Monitoring Agency</b>	<b>Active</b>
383457121254900	AMERICAN R BL PARADISE BEACH CA	Inactive	1981–1981
383401121230000	AMERICAN R BL WATT AVE. CA	Inactive	1981–1981
383714121170200	AMERICAN R NR UP ROSSMOR BAR CA	Inactive	1981–1981
11336000	COSUMNES R A MCCONNELL CA	Inactive	1960–1967
383431121304201	DELTA RMP SACR-019	Inactive	unavailable
382451121311701	DELTA RMP SACR-022	Inactive	unavailable
382939121332101	DELTA RMP SACR-023	Inactive	unavailable
382046121323601	DELTA RMP SACR-026	Inactive	unavailable
382813121302401	DELTA RMP SACR-027	Inactive	unavailable
384010121090601	HUMBUG C A E BIDWELL ST NR FOLSOM CA	Inactive	2003–2003
382702121300501	SACRAMENTO R 0.35 MI DS OF FREEPORT BR A FREEPORT	Inactive	2018–2018
11447810	SACRAMENTO R A GREENS LANDING CA	Inactive	1971–2018
382740121301201	SACRAMENTO R A R MILE 46.4 A FREEPORT CA	Inactive	2016–2018
383155121314101	SACRAMENTO R A SHERWOOD HARBOR NR W SACRAMENTO CA	Inactive	2017–2018
383430121302001	SACRAMENTO R AT TOWER BRIDGE AT SACRAMENTO CA	Inactive	1931–2003
383859121110701	WILLOW C 0.1 MI US LK NATOMA NR FOLSOM CA	Inactive	2003–2003
384006121084601	WILLOW C A E BIDWELL ST NR FOLSOM CA	Inactive	2003–2003
384030121063601	WILLOW C A GOLF LINKS DRIVE NR FOLSOM CA	Inactive	2003–2003
383927121100201	WILLOW C A SIBLEY RD NR FOLSOM CA	Inactive	2003–2003

Figure Exported: 12/14/2020 By: vobanda Using: \\woodandcurran-net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GA.GSP.G - GIS12\_MXD13 - Figure 2-13 Surface Water Quality Monitoring.mxd



Sources: DWR - California Data Exchange Center (CDEC)  
 DWR - Water Data Library (WDL)  
 USGS - National Water Information System (NWIS)

**South American Subbasin GSP**  
**Surface Water Quality Monitoring**

Figure 2.1-13

*Legend*

- South American Subbasin
- Stream Gages**
- CDEC (23)
- DWR WDL (64)
- USGS NWIS - active (17)
- USGS NWIS - inactive (48)

0 1.25 2.5 5 Miles



**South American SUBBASIN**

Project #: 0011575.00  
 Map Created: June 2020

#### **2.1.4.2.2 DWR—Water Data Library**

The DWR Water Data Library (WDL) contains data on chemical and physical parameters found in drinking water, groundwater, and surface water throughout the state collected via discrete grab-type water quality sampling stations (DWR, 2020a). The SASb has 65 surface water quality stations distributed in the American River, Buffalo Creek, Cosumnes River, Mokelumne River, Morrison Creek, Sacramento River, Snodgrass Slough, and Willow Creek. Data are available from 1951 through 2020 (locations shown in **Figure 2.1-13**). Additional surface water quality stations outside of the SASb are west in the Sacramento River, east in Carson and Deer Creeks, and south in Snodgrass Slough and the Mokelumne River.

### **2.1.5 Groundwater Monitoring**

SCGA and DWR collect groundwater elevation monitoring data in the SASb on a semi-annual basis from 29 California Statewide Groundwater Elevation Monitoring Program (CASGEM Program) wells. DWR, the California Department of Pesticide Regulation (CDPR), the Sacramento County Department of Health Services, and various contamination cleanup sites report groundwater quality monitoring information for the SASb. Municipal water purveyors also collect and report water quality data that are compiled by the State Water Board Division of Drinking Water (DDW), which regulates public drinking water systems. Historical and current groundwater elevation and quality monitoring in the SASb are described below.

#### **2.1.5.1 Groundwater Elevation Monitoring**

Groundwater elevation monitoring in the SASb began prior to the 1950s. Groundwater elevation wells in the basin are shown in **Figure 2.1-14**. In 2012, SCGA formed a monitoring network of 29 wells, including two wells in the Cosumnes Subbasin, as part of the original CASGEM Program to improve the overall quality of data being collected. The CASGEM monitoring network has been revised to 30 wells, including three additional wells in the western SASb area and excluding the two wells in the Cosumnes Subbasin. While there are multiple monitoring entities that may include state and federal agencies, private well owners, and public universities, SCGA is the agency responsible for the CASGEM Program in the SASb (SCGA, 2020).

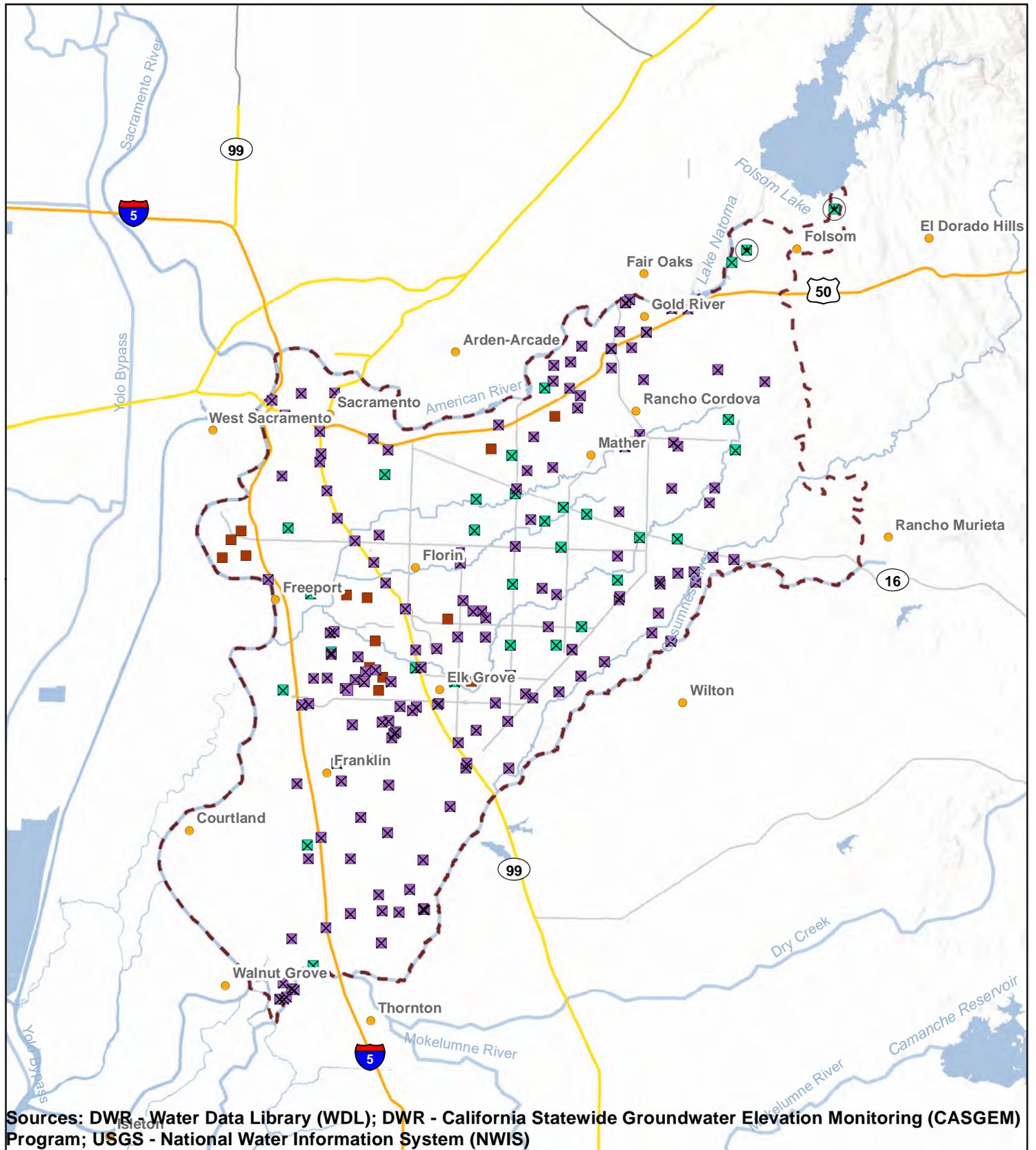
#### **DWR—Water Data Library**

DWR's Water Data Library (WDL)<sup>1</sup> reports groundwater data collected from a variety of well types including irrigation, stock, domestic, and public supply wells. There are two wells that record continuous groundwater elevation measurements and 185 wells that have periodically reported groundwater elevation measurements in the SASb. Continuous groundwater elevation readings are taken at 15-minute and 1-hour intervals from automated recorders operated by DWR (California Natural Resources Agency [CNRA], 2020a). Periodic groundwater elevation readings are taken manually twice per year during the spring and fall which are typically the respective high and low elevations, but may be recorded more frequently (CNRA, 2020b). These readings are reported to the WDL by the SCGA, Sacramento Groundwater Authority, and Sacramento County. The DWR dataset also includes data collected through the CASGEM Program.

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<sup>1</sup> <https://wdl.water.ca.gov/>

Figure Exported: 12/14/2020. By: vobanda. Using: \\woodandcurran.net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\00115715.00-SC.GA.GSP.G - GIS12.MXD\14. Figure 2-14 Groundwater Elevation Monitoring.mxd



Sources: DWR - Water Data Library (WDL); DWR - California Statewide Groundwater Elevation Monitoring (CASGEM) Program; USGS - National Water Information System (NWIS)

<p style="text-align: center;"><b>South American Subbasin GSP</b></p> <p style="text-align: center;"><b>Groundwater Elevation Monitoring</b></p> <p style="text-align: center;">Figure 2.1-14</p>	<p style="text-align: center;"><i>Legend</i></p> <ul style="list-style-type: none"> <li><span style="border-bottom: 1px dashed red; width: 20px; display: inline-block; margin-right: 5px;"></span> South American Subbasin</li> <li><b>Groundwater Wells</b></li> <li><span style="color: green;">■</span> DWR - CASGEM well (30)</li> <li><span style="color: purple;">■</span> DWR - Voluntary well (156)</li> <li><span style="border: 1px solid black; border-radius: 50%; padding: 2px;">★</span> DWR WDL - continuous (2)</li> <li><span style="color: purple;">×</span> DWR WDL - periodic (185)</li> <li><span style="color: brown;">■</span> USGS NWIS - active (15)</li> </ul>	<div style="text-align: right;"> <p>0 1.25 2.5 5 Miles</p> </div> <div style="text-align: center;"> <p>N</p> </div> <div style="text-align: center;"> <p><b>South American SUBBASIN</b></p> <p>Project #: 0011575.00 Map Created: June 2020</p> </div>
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**USGS—National Water Information System**

The USGS's National Water Information System contains measurements of depth to water in wells throughout California. In the SASb there are 15 active and 518 inactive groundwater monitoring wells. **Table 2.1-9** lists active wells in the SASb.

**Table 2.1-9: USGS Water Elevation Monitoring Wells**

Reporting Agency	Gage	Status	Years of Record
USGS	382906121322201	Active	1998–2019
USGS	382941121320601	Active	2008–2019
USGS	382911121312301	Active	1997–2019
USGS	382718121224901	Active	2006–2019
USGS	382757121261101	Active	1998–2019
USGS	382800121270701	Active	1998 - 2019
USGS	382629121254801	Active	1998–2019
USGS	382537121260001	Active	1998–2019
USGS	382515121262501	Active	1998–2019
USGS	382450121253601	Active	1998–2019
USGS	382517121252601	Active	1998–2019
USGS	382515121214401	Active	2006–2019
USGS	383000121313601	Active	1997–2019
USGS	383410121183401	Active	2006–2019
USGS	383301121211301	Active	2006–2019

Source: USGS, nd

**DWR –CASGEM Program**

The CASGEM Program collects monitoring data to track seasonal and long-term groundwater elevation trends in collaboration with local monitoring entities. There are 30 CASGEM Program wells and 156 additional voluntary wells in the SASb; although one CASGEM Program well (385541N1211812W001) was reported destroyed during the spring-to-fall reporting period in 2012 (SCGA, 2020). The 29 active CASGEM Program wells are shown in **Table 2.1-10**. Data for some of these wells are available from the 1930s through 2020. Monitoring frequencies for the groundwater elevation monitoring network vary from a minimum of bi-annual seasonal spring and fall measurements taken manually each year, to monthly measurements, often taken by private well owners and researchers for various studies (SCGA, 2016).

**Table 2.1-10: CASGEM Program Wells in the SASb**

Local Designation	State Well Number	Well Usage	Total Well Depth (feet)
06N05E31L003M	06N05E31L003M	Residential	125
COSAC1	--	Stockwatering	175
ND2	05N05E30A004M	Observation	20
SCGA 1	07N05E18C001M	Irrigation	Unknown
SCGA 10	08N04E36L001M	Residential	172
SCGA 11	08N05E21H002M	Unknown	72
SCGA 12	08N06E17H001M	Residential	236
SCGA 13	08N06E20R001M	Residential	101
SCGA 14	08N06E26K001M	Residential	160
SCGA 15	08N06E27H002M	Irrigation	425
SCGA 16	08N06E27N001M	Residential	Unknown
SCGA 17	08N06E30C001M	Residential	164
SCGA 18	08N06E31F001M	Residential	132
SCGA 19	08N06E34R001M	Irrigation	300
SCGA 2	07N05E26P002M	Residential	Unknown
SCGA 20	08N07E02N001M	Irrigation	675
SCGA 21 <sup>a</sup>	08N07E14C001M	Stockwatering	208
SCGA 22	08N07E31J001M	Irrigation	300
SCGA 23	08N07E33E001M	Residential	130
SCGA 24	09N06E33R001M	Residential	85
SCGA 27	09N07E02N001M	Observation	170
SCGA 28	09N07E02G001M	Observation	101
SCGA 29	10N08E29J001M	Observation	85
SCGA 3	07N05E29D001M	Irrigation	170
SCGA 4	07N05E36A001M	Other	508
SCGA 5	07N06E08H001M	Residential	225
SCGA 6	07N06E12A001M	Irrigation	340
SCGA 7	07N06E14Q001M	Irrigation	300
SCGA 8	07N06E20J001M	Irrigation	Unknown
SCGA #9	07N06E22R002M	Residential	210

**Notes:**

<sup>a</sup> Denotes well was reported destroyed.

Source: DWR, 2019

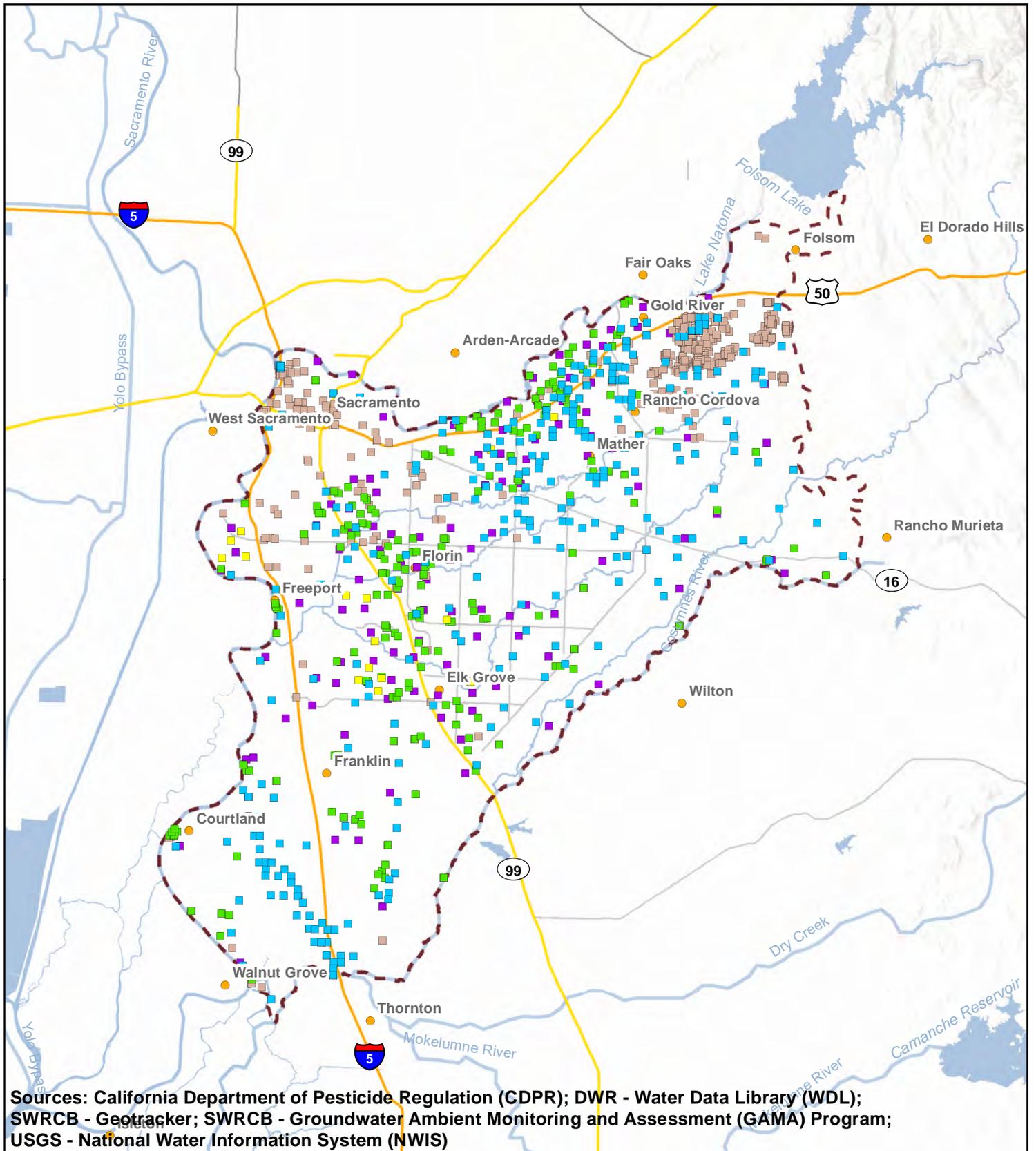
### 2.1.5.2 Existing Groundwater Quality Monitoring Programs

DWR, USGS, and water purveyors in the SASb maintain a record of water quality data. Groundwater quality wells in the basin are shown in **Figure 2.1-15**. Historical and current groundwater quality monitoring in the SASb is described below.

#### California Department of Drinking Water, Title 22

Water purveyors have compiled available historical water quality data for constituents monitored as required under the California Code of Regulations Title 22. Testing occurs at wells operated for public water supply. The current level of groundwater quality monitoring is sufficient under existing regulatory guidelines to ensure that the public is provided with a safe and reliable drinking water supply (MWH, Water Forum & SCWA, 2006).

Figure Exported: 12/14/2020 By: vdeanda Using: \\woodandcurran-net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\00115715-00-SC.GA.GSP.MXD - GIS12.MXD\15- Figure 2-15 Groundwater Quality Monitoring.mxd



**Sources: California Department of Pesticide Regulation (CDPR); DWR - Water Data Library (WDL); SWRCB - GeoTracker; SWRCB - Groundwater Ambient Monitoring and Assessment (GAMA) Program; USGS - National Water Information System (NWIS)**

<p><b>South American Subbasin GSP</b></p> <p><b>Groundwater Quality Monitoring</b></p> <p>Figure 2.1-15</p>	<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>Legend</b></p> <ul style="list-style-type: none"> <li><span style="border-bottom: 1px dashed brown; width: 20px; display: inline-block;"></span> South American Subbasin</li> <li><span style="color: purple;">■</span> CDPR (131)</li> <li><span style="color: green;">■</span> SWRCB - GAMA (216)</li> <li><span style="color: brown;">■</span> SWRCB - GeoTracker (462)</li> <li><span style="color: yellow;">■</span> USGS - NWIS (15)</li> <li><span style="color: blue;">■</span> DWR - WDL (316)</li> </ul>	<p>0 1.25 2.5 5 Miles</p>	<p style="text-align: center;">N</p> <p style="text-align: center;"><b>South American SUBBASIN</b></p> <p>Project #: 0011575.00 Map Created: June 2020</p>
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**DWR—WDL**

The WDL contains data on chemical and physical parameters found in drinking water, groundwater, and surface water throughout the state collected via discrete grab-type water quality sampling stations (DWR, 2020a). There are 316 groundwater quality stations throughout the SASb. Data are available for various periods from 1951 through 2021.

**State Water Resources Control Board—GeoTracker**

The State Water Resources Control Board’s (State Water Board’s) GeoTracker database contains records for sites that impact, or have the potential to impact, groundwater quality. There are 45 leaking underground storage tank (LUST) sites and 417 Cleanup Program sites with an open status in the SASb. **Table 2.1-11** shows the status of the sites.

**Table 2.1-11: GeoTracker Sites in the Subbasin**

<b>Status</b>	<b>Cleanup Site</b>	<b>LUST Site</b>	<b>Total</b>
Open—Assessment and Interim Remedial Action	78	4	82
Open—Assessment and Interim Remedial Action (Land Use Restrictions)	1		1
Open—Eligible for Closure	4	6	10
Open—Inactive	15	5	20
Open—Remediation	110	2	112
Open—Remediation (Land Use Restrictions)	9		9
Open—Site Assessment	192	15	207
Open—Verification Monitoring	7	13	20
Open—Verification Monitoring (Land Use Restrictions)	1		1
<b>Total</b>	<b>417</b>	<b>45</b>	<b>462</b>

Source: State Water Board, 2020

**State Water Board—Groundwater Ambient Monitoring and Assessment Program**

The State Water Board’s Groundwater Ambient Monitoring and Assessment (GAMA) Program was established in 2000 to create a comprehensive groundwater monitoring program throughout California and increase public availability and access to groundwater quality and contamination information (State Water Board, 2018). A total of 216 wells in the SASb report data to the GAMA Program. **Table 2.1-12** shows the number of GAMA Program wells by database source.

**Table 2.1-12: GAMA Program Wells in the SASB**

<b>Source</b>	<b>Reported Wells</b>
California Department of Pesticide Regulation	40
Sacramento County Department of Health Services	170
GAMA Domestic	1
GeoTracker	5
<b>Total</b>	<b>216</b>

Source: State Water Board, nd

### **USGS—National Water Information System**

USGS’s National Water Information System contains extensive groundwater quality data collected from wells throughout California. In the SASb, there are 15 active monitoring wells with data available since 1997 and 381 inactive groundwater monitoring wells.

### **CDPR**

The CDPR well inventory dataset is used to monitor pesticides and compile sample data as part of its Groundwater Protection Program. The goal of this program is to improve understanding of the environmental impact and behavior of pesticides and develop pesticide-use practices that reduce threats to groundwater. There are 131 wells in the SASb with data reported by CDPR from 1985 through 2018 (CDPR, 2020).

### **2.1.6 Interconnected Surface Water Monitoring**

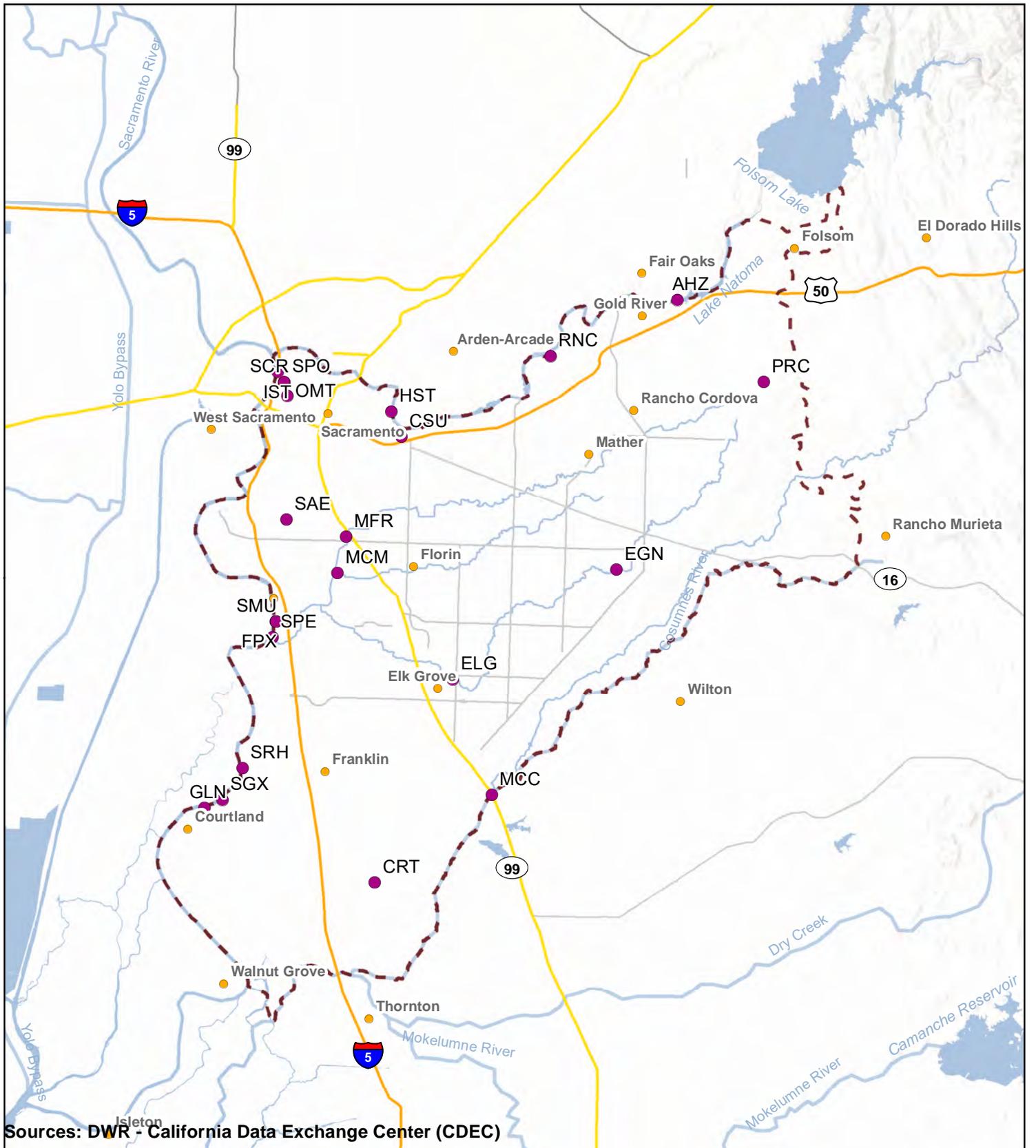
Surface water and groundwater interconnectedness was monitored at the Cosumnes River near Grant Line Road and State Route 99 (SR 99). Monitoring has continued at near-levee groundwater elevations along the American River to establish correlations between river stage and groundwater elevations at varying depths (SCGA, 2020). Developing a greater understanding of the surface water and groundwater interconnection along the American, Cosumnes, and Sacramento Rivers is a goal of the *Central Sacramento County Groundwater Management Plan* (CSCGMP) monitoring program (MWH, Water Forum & SCWA, 2006).

Municipal monitoring in the SASb includes the State Water Board monitoring and the regulated wastewater discharges from El Dorado Irrigation District into Deer Creek, and the Cosumnes River. Increased state water quality requirements for discharge to surface waters have reduced discharges to Deer Creek and have unavoidably impacted the SASb. However, regulation of surface water quality is outside the control of the SCGA GSA or any other GSA in the SASb (SCGA, 2016).

#### **2.1.6.1 California Data Exchange Center**

CDEC collects applicable data in the SASb, including air temperature, flow, precipitation, and river stage. **Figure 2.1-16** shows the location of these stations within the Basin.

Figure Exported: 12/14/2020 By: vobanda Using: \\woodandcurran.net\shared\Projects\FMCSAC\0509 Sac Central Groundwater Authority\0011575.00-SC.GAG.SPAG - GIS2\_MXD16: Figure 2-16 Interconnected Surface and Ground Water.mxd



Sources: DWR - California Data Exchange Center (CDEC)

<p><b>South American Subbasin GSP</b> Interconnected Surface Water and Groundwater Monitoring Figure 2.1-16</p>	<p><b>Legend</b></p> <ul style="list-style-type: none"> <li><span style="border-bottom: 1px dashed red; width: 20px; display: inline-block;"></span> South American Subbasin</li> <li><span style="color: blue;">—</span> Stream Gages</li> <li><span style="color: purple;">●</span> CDEC (23)</li> </ul>	<p>0 1.25 2.5 5 Miles</p> <p><b>South American SUBBASIN</b></p> <p>Project #: 0011575.00 Map Created: June 2020</p>
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### 2.1.7 Subsidence Monitoring

Subsidence monitoring data in the SASb are collected using a continuous global positioning system (cGPS) station installed in the southwest portion of the SASb along Interstate 5 (I--5) as shown in **Figure 2.1-17**. This station is maintained by the University Navstar Consortium's (UNAVCO's) Plate Boundary Observatory (PBO) program. Additional UNAVCO cGPS stations are also located nearby, outside of the SASb. The National Aeronautics and Space Administration's (NASA's) Jet Propulsion Laboratory (JPL) also provides interferometric synthetic aperture radar (InSAR) data for the Sacramento County region. Extensometers have not been installed in the SASb, although one existing extensometer is located in the Yolo Subbasin, to the east of Woodland.

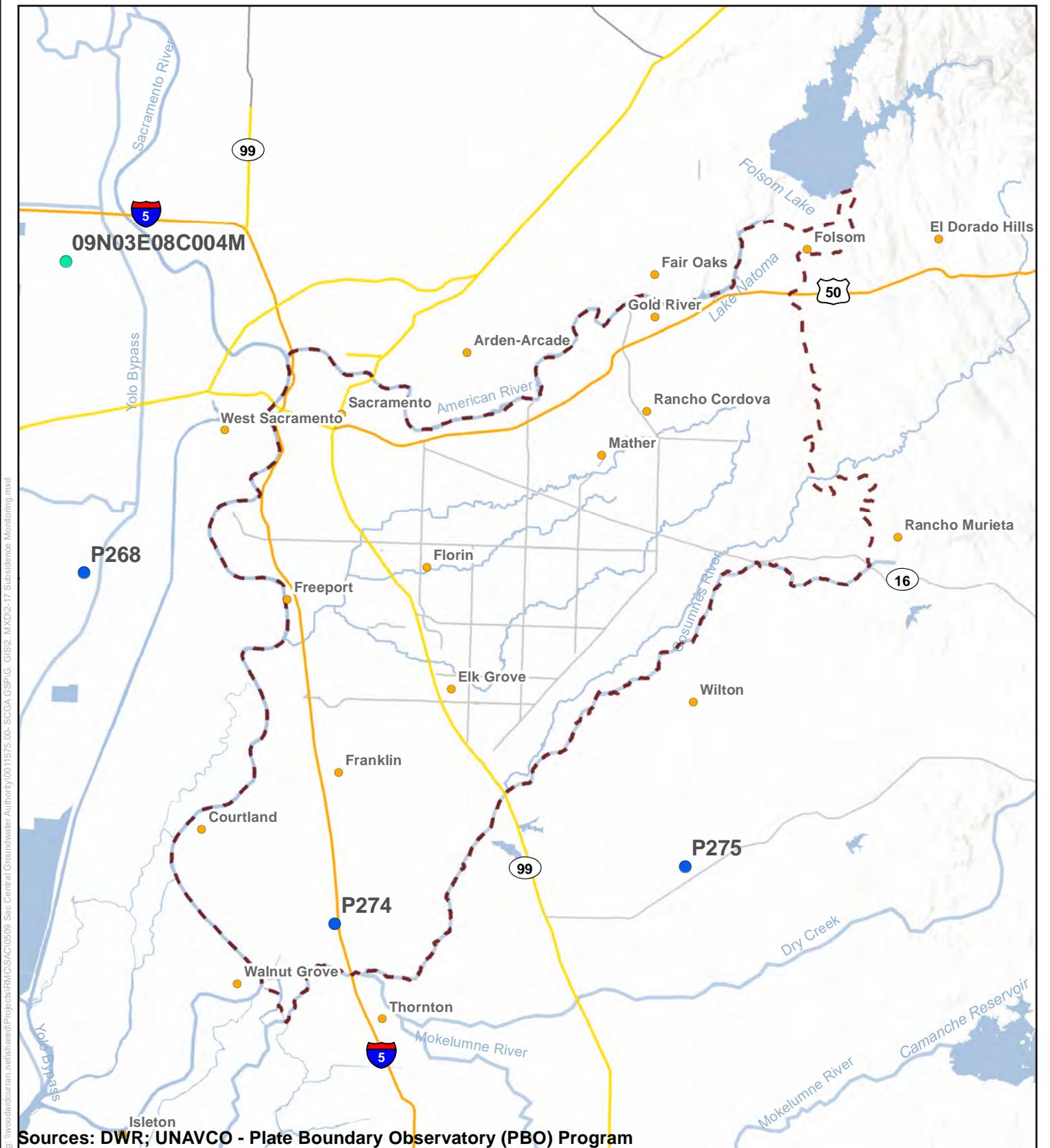
In 2008, and again in 2017, SCGA participated in the Sacramento Valley Subsidence Project conducted by DWR and the U.S. Department of the Interior's Bureau of Reclamation, and eight stations were monitored in the northern portion of the SASb. The project's findings indicated little to no significant subsidence in Sacramento County during the period 2008-2017 (SCGA, 2020).

#### 2.1.7.1 University Navstar Consortium Plate Boundary Observatory Data

The UNAVCO PBO network consists of nearly 1,100 cGPS stations in the western U.S. that monitor subsidence. There is one cGPS station in the SASb in the southern portion near the intersection of the I-5 and Twin Cities Road in the Stone Lakes National Wildlife Reserve. Additional cGPS stations are located east of the SASb near Herald, , and immediately west of the SASb on farmland (UNAVCO, 2019).

#### 2.1.7.2 NASA JPL InSAR Data

This dataset represents measurements of vertical ground displacement rates derived from InSAR data that are collected by the European Space Agency Sentinel-1A satellite and processed by the NASA JPL, under contract with DWR. The data cover April 2015 through September 2020.



Sources: DWR; UNAVCO - Plate Boundary Observatory (PBO) Program

### South American Subbasin GSP

**Subsidence Monitoring**

Figure 2.1-17

*Legend*

- South American Subbasin
- DWR Extensometers
- UNAVCO Continuous GPS Sites

0 1.25 2.5 5 Miles



**South American SUBBASIN**

Project #: 0011575.00  
Map Created: October 2021

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Figure Exposed: 10/4/2021 By: nmeyer Using: \\woodandcurran.net\share\Projects\RM\C\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G\_GIS2\_MXD\2-17 Subsidence Monitoring.mxd

### 2.1.8 Municipal and Remediation Monitoring

Groundwater remediation is necessary for the protection of drinking water supplies in the SASb. Known contaminant plumes and sites in the SASb are shown on **Figure 2.1-18**. Cleanup extractions of contaminated groundwater take place under various state and federal regulatory programs and through orders for the protection of human health (SCGA, 2020). Local groundwater management agencies have no jurisdiction over extractions and cleanup activities and must adaptively manage groundwater conditions as changes in the cleanup programs occur over time (SCGA, 2016).

**Table 2.1-13** shows estimated groundwater remediation pumping for the 2018 water year. Extractions were reported or estimated for the Boeing Inactive Rancho Cordova Test Site, Aerojet Superfund Site, Mather Air Force Base (Mather AFB), Kiefer Landfill, Sacramento Army Depot, Union Pacific Downtown railyard, and the former Union Pacific Curtis Park railyard. Although other contamination such as cleanup programs and LUST sites exist in the SASb, these plumes are the largest and have the greatest impact on existing groundwater use.

**Table 2.1-13: Estimated Remediation Water Use**

Remediation Site	2018 Water Year (AF/year)
Boeing Inactive Rancho Cordova Test Site	5,067
Aerojet Superfund Site	26,075
Mather AFB	2,232
Kiefer Landfill	621
Sacramento Army Depot	24
Union Pacific Downtown	240
Union Pacific Curtis Park	192
<b>Total</b>	<b>34,451</b>

Source: SCGA, 2020

Industrial, manufacturing, and defense industries have been a key part of the development of the greater Sacramento area since the early 1900s along with aerospace industries since the late 1950s. Many of these industries developed large sites to produce industrial chemicals, rocket-fuel, and other hazardous substances and have a long history of environmental pollution. Sites such as military bases, large aerospace operations, and chemical manufacturing facilities, disposed of vast quantities of toxic and unknown substances on site. Due to a lack of regulations and public awareness, these adverse waste disposal activities continued unchecked for decades until the 1980s.

Awareness of remediation activities has increased since the 1980s as groundwater supplies have been compromised, and as contaminant plumes continued to migrate downgradient. Groundwater extractions for the purpose of remediation have also increased over the years.

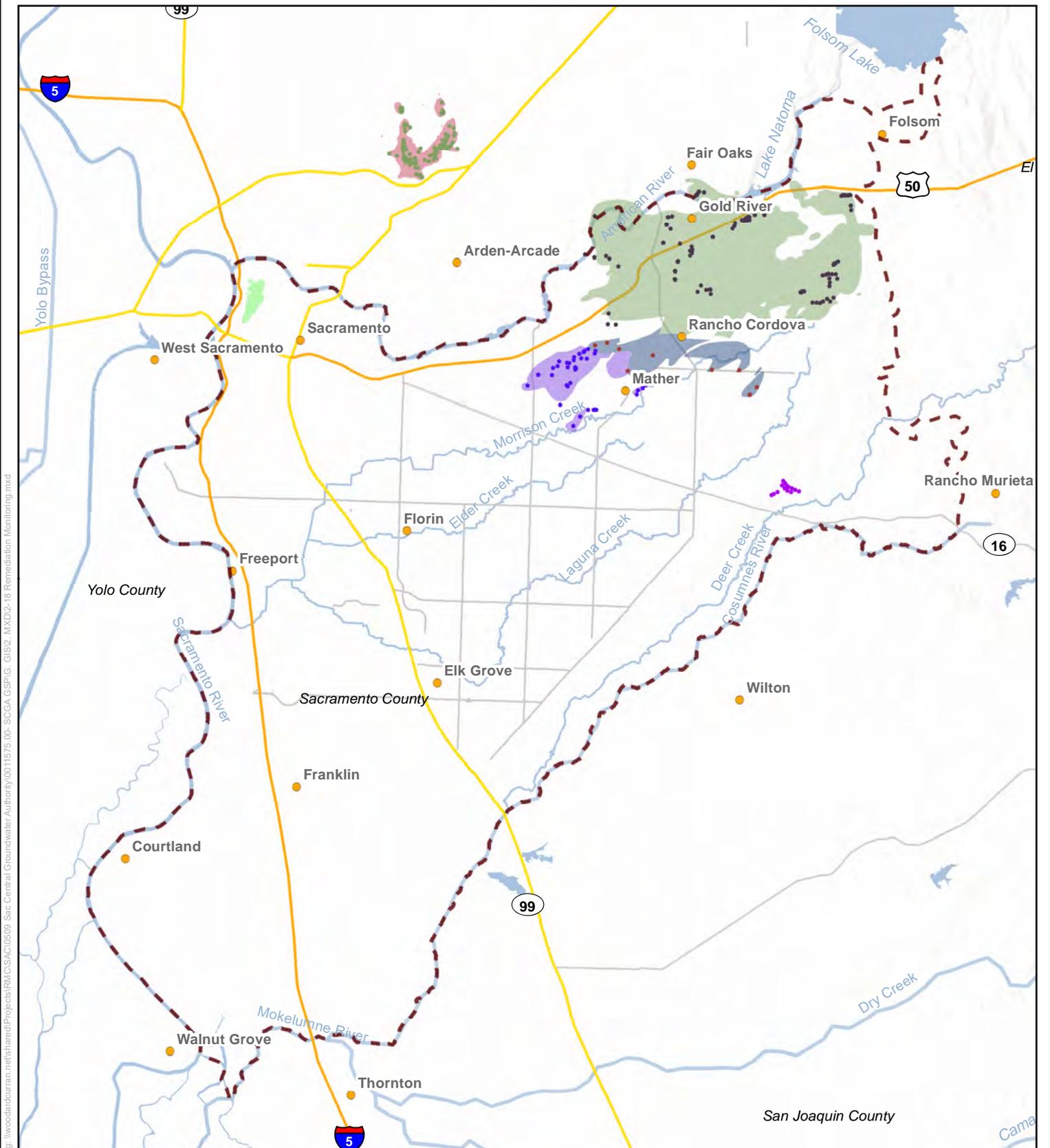


Figure Exposed: 10/5/2021, By: nmeyer, Using: \\woodandcurran.net\share\Projects\RM\C\SAC\0509\_Sac\_Central\_Groundwater\_Authority\0011575\_00-SCGA\_GSP\G\_GIS2\_MXD\2-18\_Remediation\_Monitoring.mxd

<p style="text-align: center;"><b>South American Subbasin GSP</b></p> <p style="text-align: center;"><b>Contamination Plumes and Remediation Wells (2008)</b></p> <p style="text-align: center;">Figure 2.1-18</p>	<p><b>Legend</b></p>	<p><b>Remediation Wells</b></p> <ul style="list-style-type: none"> <li>• Aerojet</li> <li>• Boeing</li> <li>• Mather</li> <li>• McClellan</li> <li>• Kiefer</li> </ul>	<p><b>Contamination Plume</b></p> <ul style="list-style-type: none"> <li>■ Aerojet</li> <li>■ Boeing</li> <li>■ Mather</li> <li>■ McClellan</li> <li>■ Union Pacific Downtown / Curtis Park</li> </ul>	<p>0 1 2 4 Miles</p>	<p>N</p>	<p><b>South American SUBBASIN</b></p> <p>Project #: 0011575.00 Map Created: October 2021</p>
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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. **Note:** Remediation well data was not available for UPRR or Sacramento Army Depot. Contamination plume data was not available for Sacramento Army Depot or Kiefer Landfill.

Groundwater remediation is a necessary operation to protect drinking water quality for the region and take precedence over the potential risk of groundwater depletion. Remediation also helps to protect the environment, including the American River, creeks, flora and fauna, and individuals who live in communities located near them. SCGA and other GSAs have worked with regulators and responsible parties of these sites for education, reporting, and developing strategies to negate the impact of remediation on groundwater resources in the basin. This GSP acknowledges the necessity to adaptively manage these resources while recognizing that remediation activities will be conducted according to other regulatory requirements, beyond the GSP's control, until groundwater conditions reach a steady-state condition.

Other County and State cleanup programs also extract groundwater for treatment with discharge to sewer systems or evaporation ponds. While most are small in scope compared to larger state and federal programs, the overall result is a loss of water to the basin and slight lowering of groundwater levels in the SASb.

Major sources of contamination within the SASb are primarily from the Aerojet Superfund Site, the McDonnell Douglas Inactive Rancho Cordova Test Site (IRCTS), and Mather AFB, and other lesser sites. The extent of the groundwater contaminant plumes emanating from the major sources are shown in **Figure 2.1-18**. Localized contamination by industrial and commercial point sources, such as dry-cleaning facilities and numerous petroleum fuel stations, throughout the basin are also of concern. While the GSA governance bodies do not have the authority or responsibility for remediation of this contamination, it is committed to coordinating with responsible parties and regulatory agencies to stay informed on the status and disposition of known contamination in the basin.

Most areas of the water level decline have occurred on the eastern side of the subbasin and are situated in close proximity to multiple groundwater remediation programs. These remediation projects are intended to contain the migration of contaminated groundwater by drawing groundwater levels down and increasing flow gradients toward the remediation wells. The expectation is that additional remediation systems will be installed to address the currently untreated source areas within the center of the Aerojet Superfund Site. Thus, the objective of these remediation projects is to intentionally cause declining water levels (below basin-wide thresholds) and steeper gradients in these discrete areas of the SASb.

### **2.1.8.1 Mather Air Force Base**

The U.S. Environmental Protection Agency (EPA) designated Mather AFB as a Superfund Site. Additional information can be found here: <https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=0902793#bkground>

The Mather AFB was a former 5,845-acre Air Force Base located along the northern boundary of the South American Subbasin. Mather AFB was built in 1918 as a flight training school and served as an active air base for training of military personnel until 1993, when it closed under the Base Realignment and Closure Act. Following the base closure, the majority of the base was leased to various entities. In 1995, Mather Airport opened as a 2,675-acre cargo airport, while an additional 1,432 acres were developed for housing, business parks, a VA Medical Center, and the Federal Aviation Administration's TRACON Facility.

In 1982, environmental investigations began to find areas with significant soil/sediment contamination from fire training areas, drainage ditches, waste pits, oil/water separators sites, spill sites, landfills, and a wastewater treatment plant. Soils were contaminated with toxic and hazardous materials such as petroleum, oils, lubricants, solvents, and protective coatings used during routine operation and maintenance of Mather AFB. Five contaminated groundwater plumes were identified. One of the plumes at the Aircraft Control and Warning (AC&W) Disposal Area, contains Trichloroethylene (TCE). Another plume, associated with the Site 7 Disposal Area, contains chlorinated solvents thought to have come from neighboring landfills. The plume with the greatest concern is the Main Base/Strategic Air Command (SAC) Area Plume, which is two plumes that have commingled and migrated over a mile off base to residential areas.

### **2.1.8.1.1 Historical, Current, and Future Operations**

The AC&W Disposal Area was listed on the USEPA National Priorities List in 1987 and the entire base was listed in 1989. Mather AFB began participating in the Installation Restoration Program (IRP), a specially funded program established by the Department of Defense in 1978 to identify, investigate, and control the migration of hazardous contaminants at military and other Department of Defense facilities.

Remedial investigations and cleanup activities were implemented under this program for environmentally affected IRP sites. These activities included the installation of groundwater monitoring wells to evaluate groundwater contamination both on the former base and beyond the Mather property. Approximately 570 groundwater wells and 27 operating extractions were included in the groundwater monitoring program. The site has been addressed in five stages, immediate actions and four long-term remedial phases focusing on the cleanup of the AC&W Disposal Area, the landfills, groundwater, and soils.

Immediate action began with the US Air Force clean up of three soil areas and provision for alternate sources of drinking water to residents along the western boundary of the Mather AFB where drinking water wells had been contaminated by base operations. Initially, this response included delivery of bottled water, but later involved connection to a nearby drinking water system.

The AC&W Disposal Area resulted from disposal of solvents in a waste disposal pipe or dry well from 1958 to 1966. A groundwater extraction and treatment system was selected as the remedy in 1993. This system became operational in 1995 and includes four extraction wells and one air stripper treatment system. From 1998 to 2003, up to 50 gpm of the treated water was used by Sacramento County for irrigation near Mather Lake. Mather changed to discharge of treated groundwater to Lake Mather in 1997. Since then, the AC&W plume has been contained and contaminant concentrations are declining.

The source area for the Site 7 plume was a gravel borrow pit used as a landfill into which waste was disposed from 1953 to 1966. The borrow pit was used to dispose of petroleum, oil, and lubricant wastes, empty drums, sludge from plating shops, absorbent sand used for cleaning oil and solvent spills, and at least one load of transformer oil that may have contained PCBs. The Site 7 groundwater extraction and treatment system has operated intermittently since 1998. The system was shut down for short periods to accommodate for off-base mining and reclamation activities. The groundwater extraction and treatment system used air stripping to remove volatile contaminants and, in 1997, a granular activated carbon (GAC) system was installed to treat

PFAS contamination. The discharge water has been reinjected into the groundwater system. The northeast plume at Site 7 is being monitored to determine if contaminant concentrations are decreasing over time.

The Main Base/SAC Area (MBSA) comingled plume resulted from industrial activities, equipment maintenance, dry cleaning, and fuel storage and delivery at several sites. The comingled plume has a groundwater extraction and treatment system with air stripping technology and a GAC system to remove PFAS contamination. The discharge water is being reinjected into the groundwater system.

The off-base area includes portions of the MBSA and Site 7 plumes that have migrated beyond the property boundaries. Mather AFB is monitoring large water supply wells, nearby monitoring wells, and smaller, private-owned supply wells downgradient from the plumes.

The potential exposure to contaminated groundwater has been eliminated at Mather AFB. Groundwater pumping and treatment will continue to operate until all groundwater cleanup levels are achieved. Discharges will continue into Lake Mather and the groundwater basin.

**2.1.8.1.2 Effects on subbasin supply**

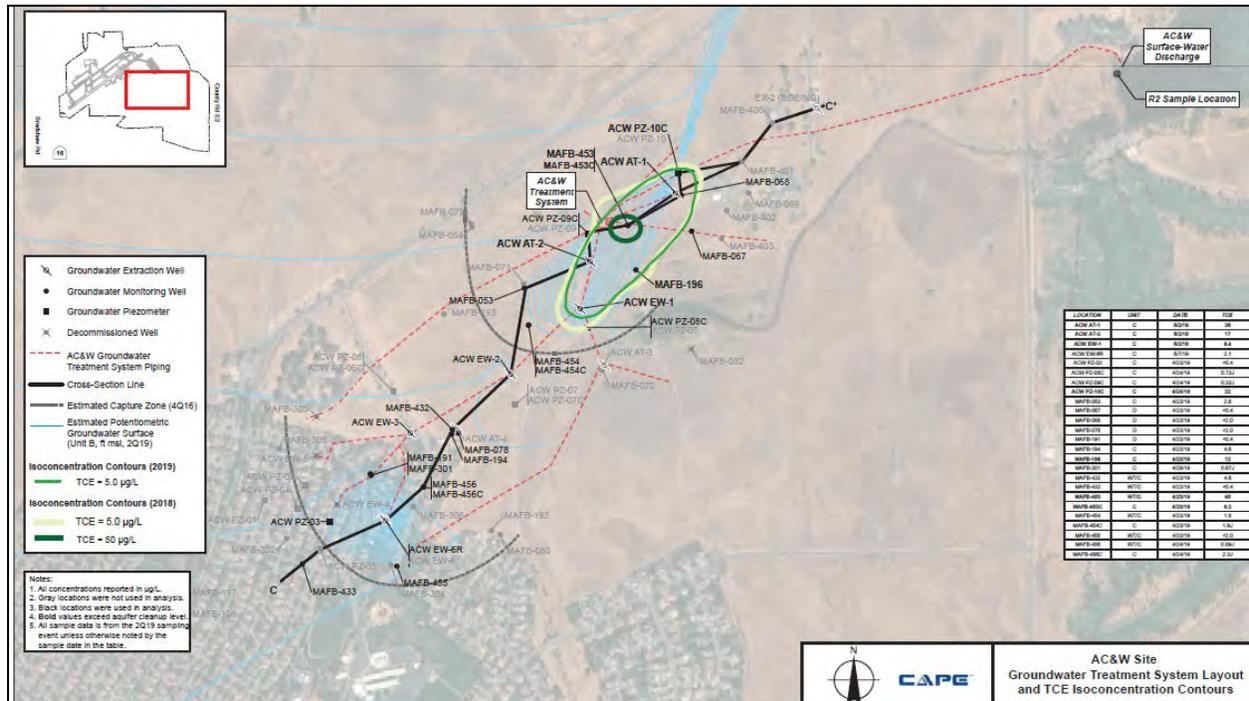
Pumping data was only available for Mather Air Force Base during the period from 2017-2019. During this period, an average of 1,221 AFY of water was pumped and discharged, as displayed in **Table 2.1-14**.

**Table 2.1-14: Mather Air Force Base Groundwater Pumping**

<b>Year</b>	<b>Amount (AFY)</b>
2017	1,683
2018	1,218
2019	763
<b>Average</b>	<b>1,221</b>

### 2.1.8.1.3 Migration of Contaminated Water

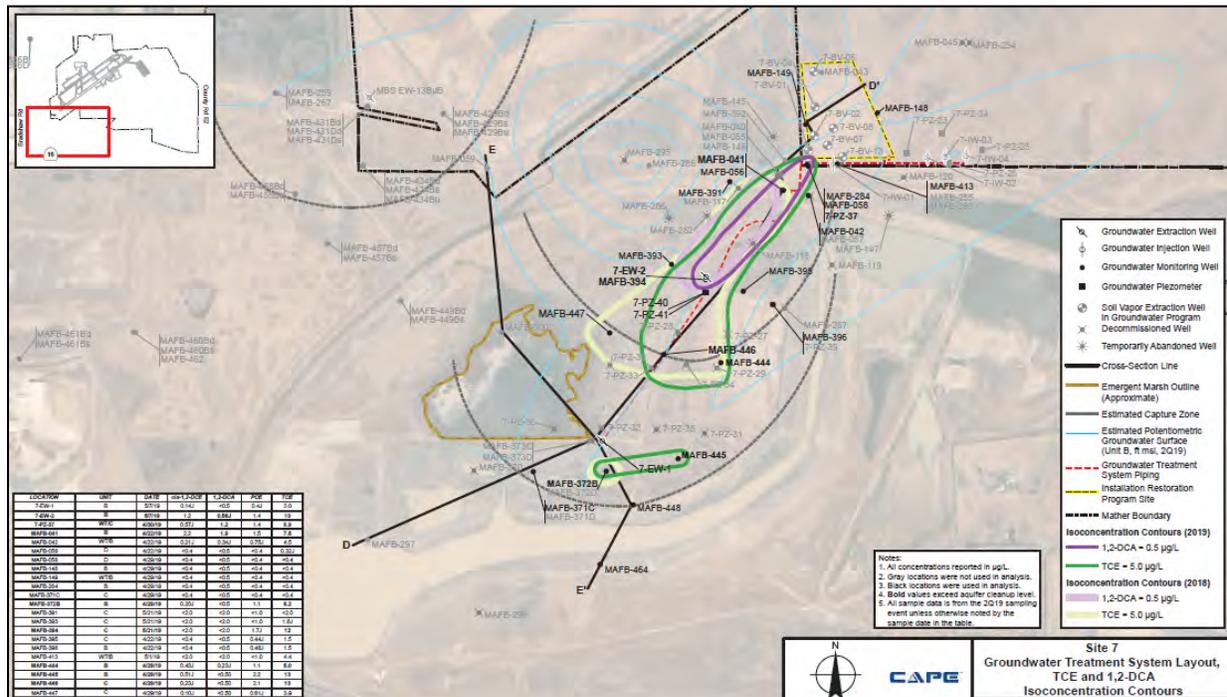
The AC&W groundwater extraction and treatment system successfully operated to remove mass from the groundwater contamination plume. Approximately 1.95 pounds of TCE were removed in 2019. Monitoring has demonstrated that the plume has not increased in concentration. Monitoring of TCE concentration trends in the upgradient portion of the plume will continue. Water level and concentration data have been used to define the TCE plume and conclude that the plume is captured by the extraction wells as demonstrated in **Figure 2.1-19**.



**Figure 2.1-19: Mather AC&W Site TCE Concentrations**

Source: Mather Annual and Fourth Quarter 2019 Groundwater Monitoring Report\_Figure 4-1\_pg210

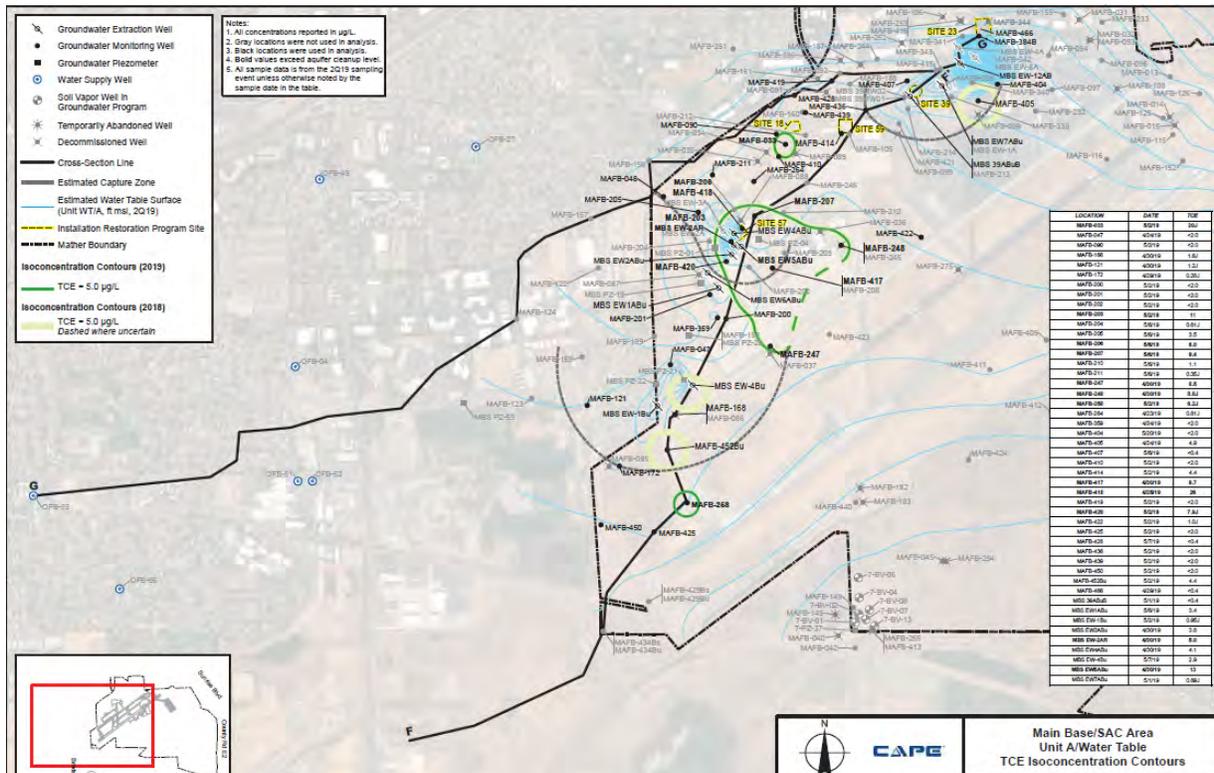
The Site 7 groundwater extraction and treatment system successfully removed mass from the groundwater contamination plume in 2019. Contaminant concentrations in wells generally increased to include more wells with concentration above the action cleanup level (ACL) than 2018. This is likely due to higher water levels which could indicate that the groundwater has come into contact with soils having some residual contamination. Water level and concentration data have been used to define the plume and show that it is being captured by the extraction wells (Figure 2.1-20). Progress is being made toward achieving the objectives of the remedial action at this site.



**Figure 2.1-20: Mather Site 7 TCE Concentrations**

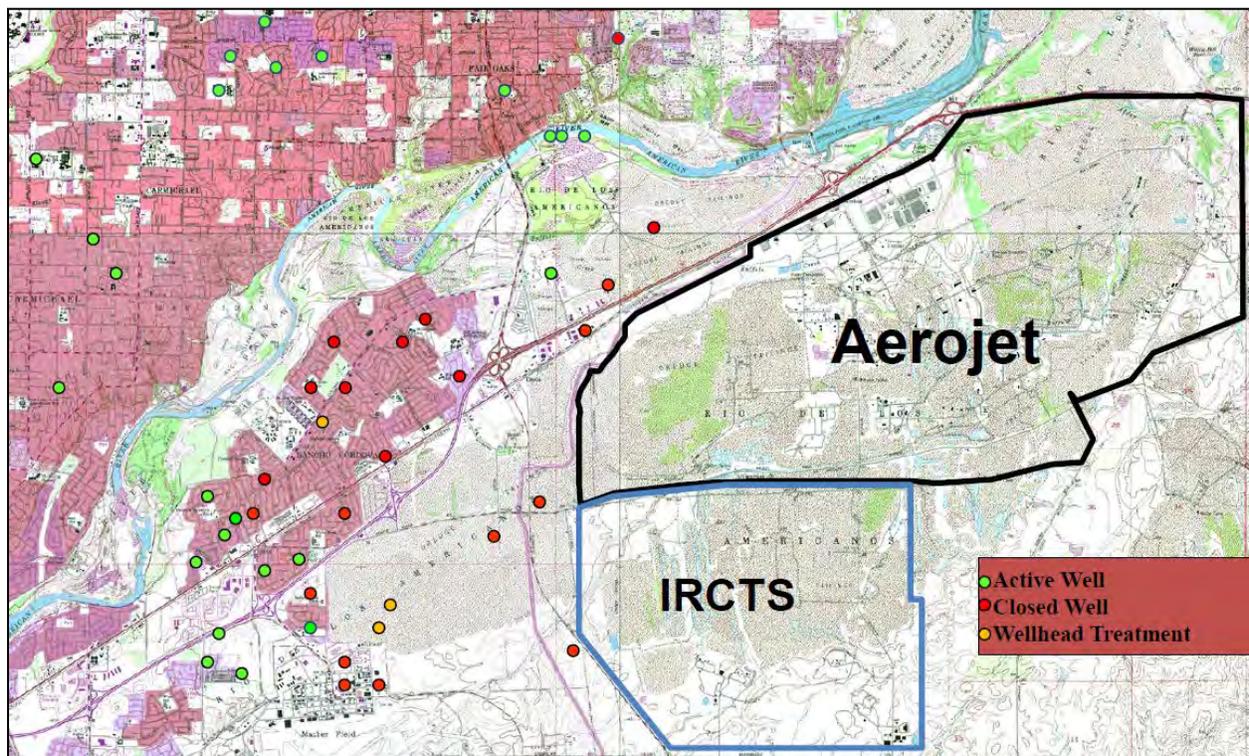
Source: Mather Annual and Fourth Quarter 2019 Groundwater Monitoring Report\_Figure 5-1\_pg213

The MBSA plume areas and TCE and Tetrachloroethylene (PCE) concentrations have remained the same over the past year. See **Figure 2.1-21**. The MBSA groundwater extraction and treatment system is achieving the objectives of the remedial action plan. Extraction well flow rates will continue to be evaluated to improve capture and optimize remediation of the MBSA plume. In 2020, communications systems at the extractions wells will be upgraded to improve operational efficiency.



Aerojet began operations at the site in 1953. Its operations also included the production of liquid and solid propellants for rocket engines and motors for military and commercial use. The formulation of chemicals included rocket propellant agents, pesticides, medical intermediaries, and other industrial chemicals. Aerojet and others disposed of unknown quantities of hazardous waste and chemicals, including TCE, and other waste in surface impoundments, landfills, leachate fields, open burning, and other adverse waste disposal mechanisms. Most of the toxic waste was left unregulated until the late 1970s and early 1980s when environmental investigations began. These former activities at Aerojet resulted in extensive soil and groundwater contamination in the South American Subbasin.

Volatile organic compounds (VOCs), primarily trichloroethylene (TCE), were found off-site in private wells. Perchlorate, a component of solid rocket fuel, was found in drinking water wells off-site in 1997. Nitrosodimethylamine (NDMA) is a contaminant in liquid hypergolic rocket fuels and a combustion byproduct, and was addressed by the 1980s groundwater remediation systems on east side of the site. During the 2000s, NDMA was detected in offsite monitoring wells at 30 times the new Maximum Contaminant Level (MCL).



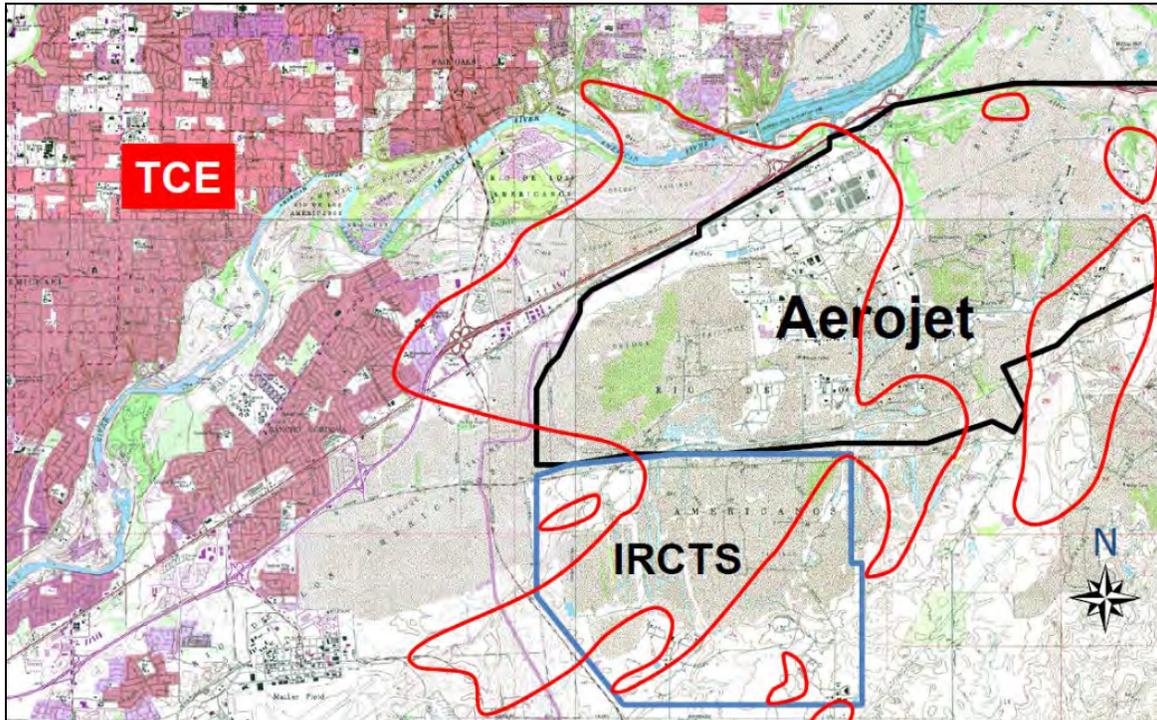
**Figure 2.1-22: Aerojet Site Location Map**

*Source: Central Basin Groundwater Presentation 2019\_Pg 3*

**2.1.8.2.1 Historical, Current, and Future Operations**

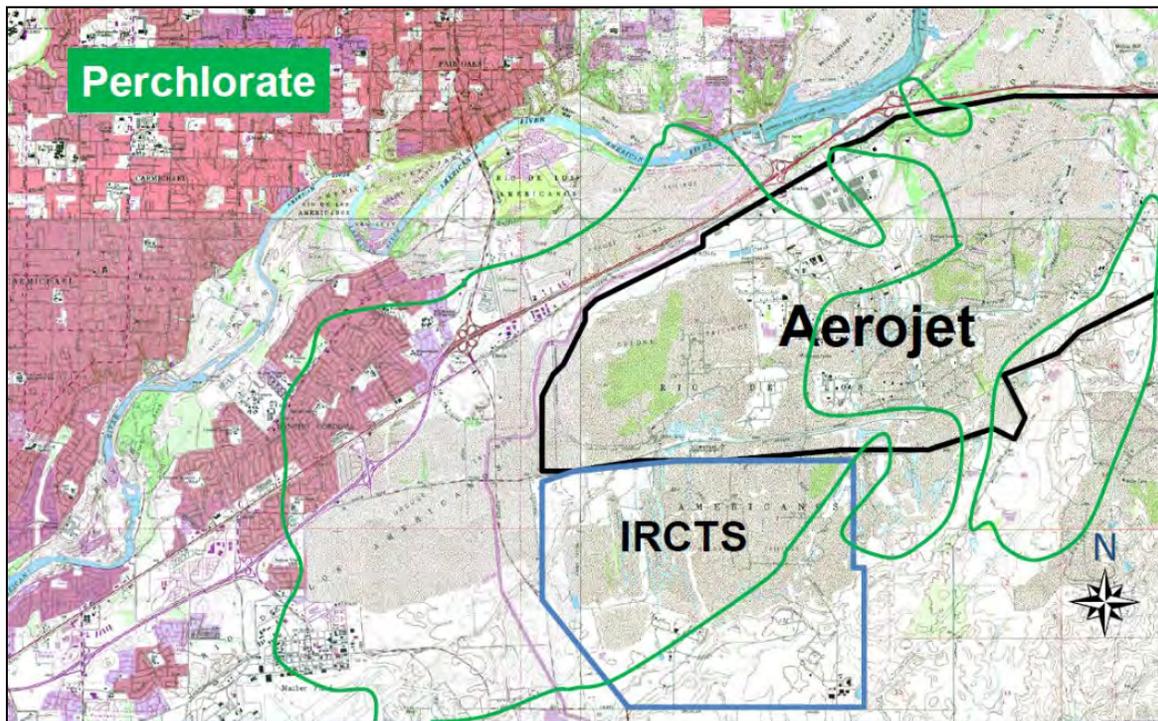
The Aerojet Superfund Site was one of the first sites added to the USEPA's National Priorities in 1983 and is one of the largest and most extensive Superfund groundwater cleanups in California. Over the past 37 years, multiple cleanup efforts have been mandated under the direction of the U.S. Environmental Protection Agency (EPA), the California Regional Water Quality Control Board, Central Valley Region (Regional Board), and California Department of Toxic Substances Control (DTSC).

The site sits atop a large miles-long groundwater plume that is polluted with various chemicals of concern, including TCE (**Figure 2.1-23**), Perchlorate (**Figure 2.1-24**), and/or NDMA (**Figure 2.1-25**). The aquifer beneath the site has been divided into six hydrostratigraphic layers (Layers A through F). In general, the layers thicken and deepen from east to west. Various constituents are located throughout Layers A-E, depending on the location on the Aerojet Site. Concentrations occur in all layers but are primarily in Layers C, D, and E.



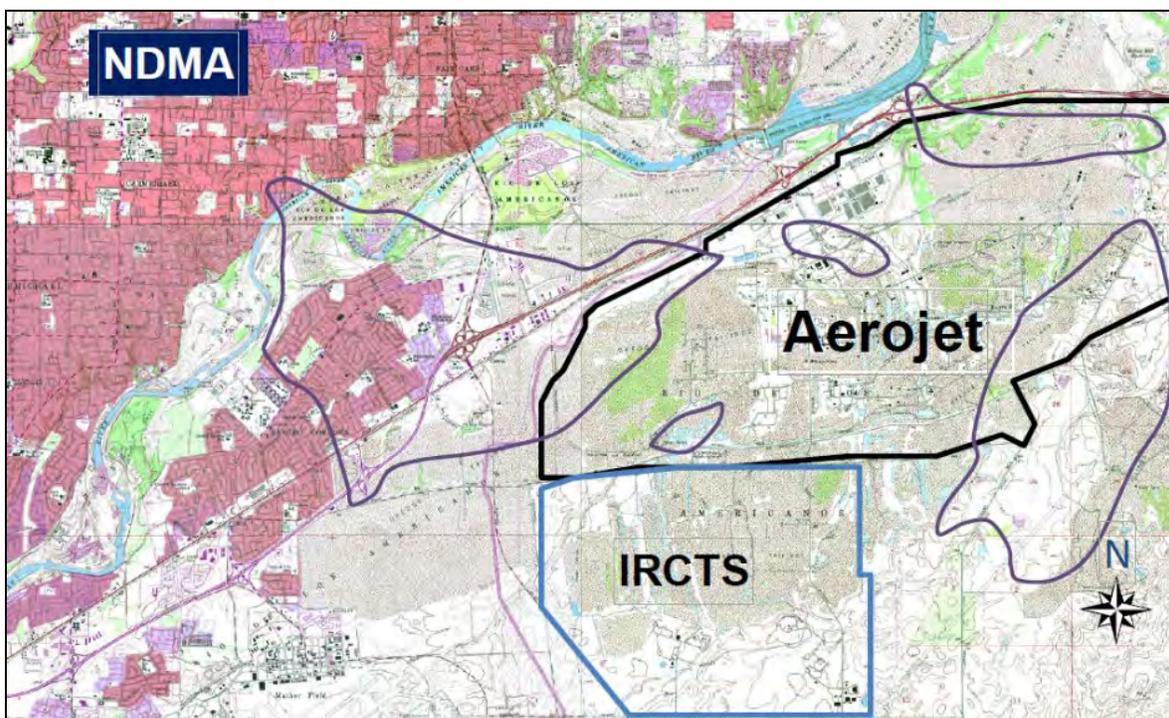
**Figure 2.1-23: Aerojet and IRCTS TCE Plumes 2019**

*Source: Central Basin Groundwater Presentation 2019\_Pg 4*



**Figure 2.1-24: Aerojet and IRCTS Perchlorate Plume**

*Source: Central Basin Groundwater Presentation 2019\_Pg 5*

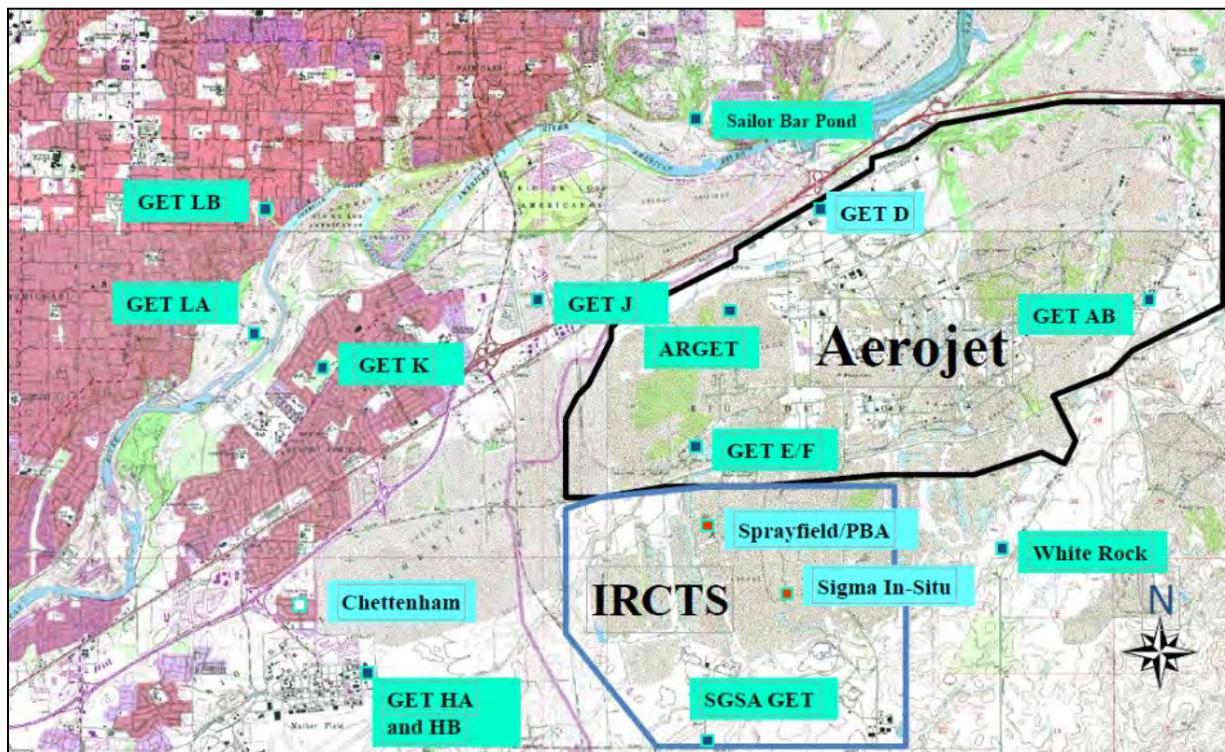


**Figure 2.1-25: Aerojet NDMA Plume**

*Source: Central Basin Groundwater Presentation 2019\_Pg 6*

Aerojet has installed several groundwater extraction and treatment systems (GETs) (see **Figure 2.1-26**) to contain the contaminated groundwater plume, which was originally delineated by Aerojet at a total of 8,600 acres. The site was originally divided into seven sectors (A-G) and then into four zones prioritizing the cleanup schedule. During the early 2000s, the site was reorganized into 12 operable units (OUs) to facilitate the remedial activities, including three mostly offsite groundwater OUs, six mostly interior soil and groundwater OUs, and three sitewide OUs.

In 1982, Aerojet installed the first GET (D) to begin control of the flux of pollutants in groundwater at the site boundary. Between 1982 – 1987, four additional GETs (A, B, E, F) were constructed on the property. In 1997, ARGET began operations with a wellfield on the northside of the American River. Five additional GETs were installed off-property between 2004 and 2010 to control and cleanup the toes of off-site plumes to the west, southwest, and northwest of the site.



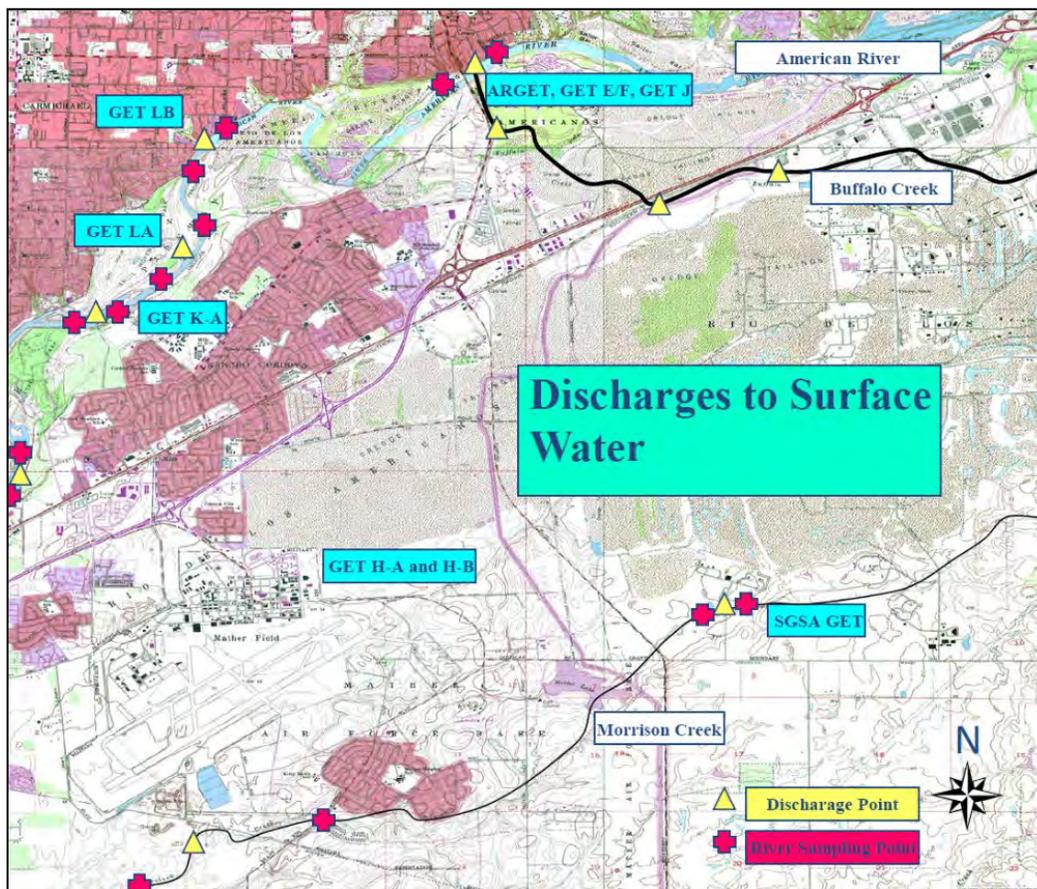
**Figure 2.1-26: Aerojet and IRCTS Groundwater Extraction and Treatment Systems**

*Source: Central Basin Groundwater Presentation 2019\_Pg 7*

During the 1980s and 1990s, Aerojet was discharging remediated water via recharge wells intended to facilitate a capture zone and reduce further plume migration or by discharging the water onto porous dredge tailings. This capture and recharge approach did not remove much groundwater from the subbasin. However, the first perchlorate treatment facility (fluidized bed bioreactor) produced biosolids that, in 1998, clogged the recharge wells, and the discharge of treated groundwater shifted to Buffalo Creek (American River). Over time, Aerojet phased out the use of other recharge wells and the dredge tailings. Aerojet discharges a majority of its remediated groundwater to the American River and to Morrison Creek under a permit from the National Pollutant Discharge Elimination System (NPDES).

The IRCTS is located on the south side of the Aerojet Site and is the origin for several TCE or perchlorate plumes due to aerospace activities by the McDonnell Douglas Corporation (MDC) and to some extent by Aerojet. Aerojet plumes along its southwestern boundary have commingled with the IRCTS plumes. The Boeing Company, as the successor to MDC, has install several GETs at the IRCTS and at Mather Field.

Aerojet claims ownership of its groundwater discharges (**Figure 2.1-27**) to the American River and to Morrison Creek and, during the early 2000s, began seeking partners to perfect these claims. Golden State Water Company (GSWC) is currently authorized to withdraw an annual volume of 5,000 AF/year of Aerojet water from the river. Beginning in 2017, in conjunction with Carmichael Water District (CWD), a pipeline was installed beneath the American River to connect GSWC to CWD so that Aerojet water can be conveyed to GSWC in the SASb. CWD utilizes its existing Ranney Collector to capture river underflows and treat the water via a pressurized filtration plant before conveying the water via the pipeline to GSWC south of the American River and back into the SASb. This collaboration allows GSWC to reduce its SASb groundwater extractions. Similarly, Sacramento County Water Agency (SCWA) is authorized to withdraw an annual volume of 8,900 AF/year of Aerojet water at the Freeport Intake along the Sacramento River, less the loss factor (10%) of recharge via the river. This water is then conveyed to the eastern side of the SCWA service area and treated at the Vineyard Surface Water Treatment Plant for distribution in the SCWA service area in the SASb. Aerojet has reserved the remainder of its treated water for use as municipal water for its planned development of property in Rancho Cordova. In addition, Aerojet has considered various options to change its discharge from Morrison Creek (GET H-A) to the American River.



**Figure 2.1-27: Aerojet and IRCTS Surface Water Discharges**

*Source: Central Basin Groundwater Presentation 2019\_Pg 11*

The Aerojet GET operations are subject to quarterly reporting and their effectiveness is evaluated annually. To further reduce contamination, additional extraction wells have been added periodically. The presence of Per- and Poly-fluoroalkyl Substances (PFAS) was evaluated at each GET and while detected in the parts per trillion range at some GETs, was not found to be a significant issue. The Aerojet and IRCTS monitoring network consists of over 2,000 monitoring wells but only a few hundred are monitoring on a quarterly or semiannual frequency.

The Aerojet groundwater model is mostly complete and addresses contaminant concentrations in Layers A-F and extends into the NASb since the plumes have migrated north beneath the American River.

Current activities include increasing plume capture, developing contingency plans, and installing 10 to 12 monitoring well clusters to further define the plumes. Additional extraction wells are not currently planned. Future remediation activities will focus on the interior of the Aerojet Site and the continued evaluation of reusing treated groundwater.

Aerojet operated two wastewater disposal wells under a CVRWQCB permit between 1963 and 1985 and injected 85 million gallons of a dense aqueous phase brine into the upper lone

Formation. The brine exhibits a sodium-chloride/sulfate character and includes volatile organic chemicals. The wells were destroyed in 1994 under the oversight of EPA and the DTSC, and post-closure monitoring is conducted under a RCRA Post-Closure Permit.

### 2.1.8.2.2 Effects on subbasin supply

The Aerojet and IRCTS GETs discharge to various outfalls leading to the American River and Morrison Creek. Since 2010, Aerojet has pumped an average of 27,075 AFY of contaminated water as displayed in **Table 2.1-15**.

**Table 2.1-15: Aerojet and IRCTS Groundwater Pumping**

<b>Year</b>	<b>Amount (AFY)</b>
2010	24,938
2011	26,809
2012	28,391
2013	20,311
2014	24,228
2015	22,179
2016	30,836
2017	32,025
2018	31,267
2019	29,766
<b>Average</b>	<b>27,075</b>

**Note:**

*AIRCTS = Inactive Rancho Cordova Test Site*

### 2.1.8.2.3 Migration of Contaminated Groundwater

The GETs currently have a permitted total flow capacity of 30,200 gpm but averages 14,000 gpm. To date, 171 billion gallons of water have been treated and over 1,517,000 pounds of contaminants have been removed. The system removes approximately 130 pounds of chemicals per day. Aerojet continues to install additional monitoring wells at various GETs to help refine the plume definition. Aerojet is also evaluating the potential for additional extraction wells along the west central part of the plume to increase capture and speed up cleanup time. According to the EPA, due to the complexity of the hydrogeology and extent of contamination, the cleanup time for the Western Groundwater OU is estimated at 200 years.

### 2.1.8.3 Kiefer Landfill

Sacramento County conducts remedial activities at the Kiefer Landfill under CVRWQCB WDR Order R5-2016-0013. Additional information can be found here:

[https://www.waterboards.ca.gov/centralvalley/board\\_decisions/adopted\\_orders/sacramento/r5-2016-0013.pdf](https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/sacramento/r5-2016-0013.pdf)

The Kiefer Landfill is a 1,084-acre facility with an active class III, 300-acre solid waste disposal site that is owned and operated by Sacramento County (**Figure 2.1-28**). The site is located 20 miles east of Sacramento in the southeast quadrant of the SASb. The Kiefer Landfill has accepted household waste from the public, businesses, and private waste haulers since 1967. The landfill also accepts recyclable materials and other special waste. Groundwater

contamination was discovered in 1987 through a Solid Wastewater Quality Assessment Test, and discovered several VOCs: TCE, PCE, 1,2-dichloroethene, and vinyl chloride. The County of Sacramento was directed to remediate the groundwater under an approved Correction Action Plan required under California Water Quality Control Board Cleanup and Abatement Order No. 91-725. Sacramento County was issued Order No. 89 to install a network of monitoring wells.



**Figure 2.1-28: Kiefer Landfill Site Map**

Source: 2011 Kiefer Landfill Groundwater Remediation Status Presentation by Sacramento County Department of Waste Management and Recycling

### **2.1.8.3.1 Historical, Current, and Future Operations**

The landfill sits atop valley alluvium bearing three groundwater zones. Zone A, middle sands in the upper Mehrten Formation, sits at approximately 30 feet MSL. Zone B, deep sands in the upper Mehrten Formation, sits between 0 and -50 feet MSL. Zone C in the lower Mehrten Formation sits between -150 and -200 feet MSL. Ninety percent of the contamination was found in the shallow Zone A with concentrations of VOCs over 20 ppb. Zone B contained less than 5 ppb. Contamination has not been found in the deeper Zone C.

Groundwater remediation activities began in the 1990s to prevent contamination from migrating into Zone C, which supplies regional drinking water. In order to remediate the groundwater plume, Sacramento County began a groundwater remediation program. Sacramento County

achieved hydraulic containment of the plume and reduced concentrations with groundwater extraction wells and a treatment plant, which began operation in 1995. The plant includes 15 extraction wells that withdraw contaminated water from Zone A and Zone B and remove contaminants with air-stripping technology. Approximately 650,000 gallons of water are treated per day. Through a NPDES permit, treated water was discharged at a rate of up to 1,000 gallons per minute (gpm) to nearby Deer Creek, a tributary to the Cosumnes River, until 2018. Since then, on-site infiltration basins have been placed into service as part of an approved pilot program to manage effluent from the treatment plant.

The groundwater remediation program includes source abatement with the operation of the landfill gas (LFG) extraction system, and leachate collections and removal systems (LCRS). The County does consistent monitoring of groundwater parameters and LFG control to track the progress of the remedial program and for compliance with Water Quality Protection Standards (WQPS) at detection monitoring sites located beyond the perimeter of the plume. Currently, the monitoring network at Kiefer consists of 65 monitoring wells.

Sacramento County has made significant progress on groundwater remediation. The infiltration basin pilot study was successful, and the County has received approval for permanent use. The County of Sacramento will continue the remediation program long-term until the Regional Board approves modification.

#### **2.1.8.3.2 Effects on subbasin supply**

Since 2010, an average of 1,457 AFY have been pumped by the groundwater treatment system at the Kiefer Landfill (see **Table 2.1-16**). Since 2018, the treated water has been discharged at onsite infiltration basins and returned to the subbasin. Remediation activities at the Kiefer Landfill do not have a significant impact to the subbasin supply.

**Table 2.1-16: Kiefer Groundwater Pumping**

<b>Year</b>	<b>Amount (AFY)</b>
2010	1,099
2011	1,142
2012	391
2013	518
2014	507
2015	460
2016	380
2017	475
2018	599
2019	650
<b>Average</b>	<b>622</b>

#### **2.1.8.3.3 Migration of Contaminated Groundwater**

The plume at the Kiefer Landfill is contained and under hydraulic control. Total VOC concentrations in the plume have significantly decreased with the groundwater extraction and treatment systems. Contamination in Zones A and B have decreased by 86 percent and 76 percent respectively, while Zone C and drinking water wells have not been impacted by contamination from the landfill. In 1995, total VOCs in Zone A were estimated at 663 pounds.

Today, concentrations are estimated at less than 90 pounds. Total VOCs in Zone B were estimated at 54 pounds in 1995 and are estimated at less than 13 pounds today. Overall, the groundwater extraction and treatment system has helped cleanup over 80 percent of groundwater contamination since 1995.

#### 2.1.8.4 Other Groundwater Remediation Sites

Other known groundwater contaminant plumes within of near the SASb are:

- McDonnell-Douglas (Boeing) IRCTS site: The Boeing Company, in coordination with Aerojet, conducts remediation at the IRCTS under CVRWQCB Waste Discharge Requirement (WDR) Order R5-2010-0126. Additional information can be found here: [https://www.waterboards.ca.gov/centralvalley/board\\_decisions/adopted\\_orders/sacramento/r5-2010-0126.pdf](https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/sacramento/r5-2010-0126.pdf).
- Sacramento Army Depot site: The EPA has designated the Sacramento Army Depot site as a Superfund Site. Additional information can be found here: <https://cumulis.epa.gov/supercpad/CurSites/csitinfo.cfm?id=0902715&msspp=med>.
- Union Pacific Downtown site. Additional information can be found here: <https://cumulis.epa.gov/supercpad/CurSites/csitinfo.cfm?id=0903909>.
- Union Pacific Curtis Park site. Additional information can be found here: <https://cumulis.epa.gov/supercpad/CurSites/csitinfo.cfm?id=0903909>.

In addition to the Kiefer Landfill, the following other landfills located in the subbasin that are subject to RWQCB orders for contaminant concerns:

- 28th Street Landfill: PFAS have been detected in groundwater.
- Dixon Pit Landfill: contains minimal VOCs and inorganics in groundwater.
- Elk Grove Landfill: has low-level VOCs.
- Gerber Road Landfill: has a low concentration of organics in groundwater.
- L&D Landfill: contains minimal VOCs and inorganics in groundwater.

#### 2.1.8.5 Effects on Subbasin Supply

Remediation activities at the Aerojet Site, IRCTS, Mather Field, and Kiefer Landfill have resulted in a small increase in extraction of groundwater associated with cleanup actions. Four sites are pumping nearly 30,000 AFY as shown in **Table 2.1-17**. While the Mather AFB and Kiefer Landfill sites extraction have remained steady over time, extractions by the Aerojet Site and IRCTS have increased slightly (<3% per year for 10-year period). . Remediation will continue at all four sites until cleanup levels are obtained. The SASb GSAs will continue working with the responsible parties and CVRWQCB and will adaptively and sustainably manage the groundwater resources of the basin for beneficial uses well into the future.

**Table 2.1-17: South American Subbasin Remediation Site Groundwater Pumping**

Site	Average Annual Amount (AFY)
Aerojet & IRCTS	27,075
Mather AFB	1,221
Kiefer	1,457
<b>Total</b>	<b>29,753</b>

### 2.1.9 Existing Water Management Programs

Existing water management plans and programs are described below.

#### 2.1.9.1 2000 Water Forum Agreement

As stated in **Section 2.1.4**, Water Forum negotiations began in 1993 between the City of Sacramento and Sacramento County to identify water supply and environmental concerns during a period of regional population growth and declining groundwater levels. On April 24, 2000, the Water Forum Agreement was executed by 40 stakeholder organizations representing business and agricultural leaders, citizen groups, environmentalists, water managers, and local governments. The Water Forum identifies two coequal objectives as follows:

- Provide a reliable and safe water supply for the Sacramento region’s long-term growth and economic health.
- Preserve the fishery, wildlife, recreational, and aesthetic values of the lower American River.

To achieve these two coequal objectives, all signatories to the Water Forum Agreement were required to endorse and, where appropriate, participate in each of the Agreement’s seven elements as listed below:

- Increased surface water diversions.
- Actions to meet customers’ needs while reducing diversion impacts in drier years.
- Support for an improved pattern of fishery flow releases from Folsom Reservoir.
- Lower American River Habitat Management Element.
- Water Conservation Element.
- Groundwater Management Element.
- Water Forum Successor Effort.

The Water Forum Agreement identified the need for a groundwater management organization in the “Central Basin” (ultimately developed by the Groundwater Forum and established as SCGA by adoption of a Joint Powers Agreement in August of 2006) and established a sustainable annual groundwater yield of 273,000 acre-feet. As part of the SASb’s continuing groundwater management, SCGA developed a groundwater level monitoring and reporting program, a groundwater data management system, monitored groundwater contamination/remediation activities, identified improvements to the existing groundwater management plan, and evaluated a potential Well Protection Program. Successful implementation of this GSP will help maintain the Water Forum Agreement’s groundwater management practices as described in the Groundwater Management Element of the Agreement. The Groundwater Management Element provides valuable resources related to potential concepts, projects, and monitoring strategies

that can be incorporated into the SASb GSP. No limitations to operational flexibility in GSP implementation in the SASb are expected due to Water Forum activities.

### **2.1.9.2 Central Sacramento County Groundwater Management Plan**

The *Central Sacramento County Groundwater Management Plan (CSCGMP)* (MWH, Water Forum & SCWA, 2006) created an outline for maintaining sustainable groundwater use in the Sacramento Central Basin. As stated in the CSCGMP, “the Central Basin boundary was defined by the Sacramento County groundwater model that was used in the Water Forum process and took into account the hydrogeologic boundaries and the political boundaries of organized water purveyors/districts, cities (where they retail water within their boundaries), and the County of Sacramento” (MWH, Water Forum & SCWA, 2006). The CSCGMP was developed by approximately 40 stakeholders (Groundwater Forum) representing agricultural interests, agricultural-residential groundwater users, business interests, environment/community organizations, local government/public agencies, and water purveyors. Five basin management objectives (BMOs) provided the foundation of the CSCGMP as listed below:

- Maintain a long-term average groundwater extraction rate of 273,000 AF/year.
- Establish specific minimum groundwater elevations within all areas of the basin consistent with the Water Forum “Solution.”
- Protect against any potential inelastic land surface subsidence.
- Protect against any adverse impacts to surface water flows.
- Develop specific water quality objectives for several constituents of concern.

A monitoring program was identified as one of five CSCGMP program component action items to help achieve the above BMOs as well as developing a greater understanding of the surface water and groundwater interconnection along the American, Cosumnes, and Sacramento Rivers (MWH, Water Forum & SCWA, 2006). Although the CSCGMP will no longer be in place after adoption of the GSP, the GSP will incorporate the existing BMOs and the GSP monitoring program will maintain the existing monitoring network along with additional efforts to achieve sustainability.

### **2.1.9.3 SCGA Groundwater Elevation Monitoring Plan**

The *SCGA Groundwater Elevation Monitoring Plan* (MWH, Water Forum & SCWA, 2006) outlined the objectives and actions required of the SCGA as the responsible CASGEM Program monitoring and reporting entity for the SASb. The CASGEM Program network consists of 29 active wells that have historically been monitored by SCWA and DWR. Identification of future wells would be based on the need to maintain or improve the reliability of the existing network or increase coverage within a data gap area created by loss of an existing monitoring well. The plan also established the monitoring schedule and monitoring and reporting protocol for the CASGEM Program network. Groundwater elevation monitoring will continue to occur semi-annually during April and October, which allows the network to document seasonal high and low groundwater levels. The plan included standard operating procedure for determining depth to water including equipment, preparation, procedures, quality assurance/quality control, and data reporting to the CASGEM Online Submittal System (SCGA, 2012). The scope of this GSP is consistent with the *SCGA Groundwater Elevation Monitoring Plan* and will incorporate the existing groundwater elevation monitoring network of the SASb. Operational flexibility during the

GSP implementation in the SASb will not be limited by the Groundwater Elevation Monitoring Plan.

#### **2.1.9.4 Zone 40 Groundwater Management Plan**

The *Zone 40 Groundwater Management Plan* (SCWA, 2004) was an interim step to developing the CSCGMP and included both required and voluntary components that the SCWA would implement to maintain a sustainable, high-quality groundwater resource. Zone 40 is located in the central portion of Sacramento County and consists of portions of the cities of Elk Grove and Rancho Cordova, the Florin-Vineyard Community Area, the Mather/Sunrise areas of unincorporated Sacramento County, and rural residential and agricultural land. The goal of the *Zone 40 Groundwater Management Plan* was to ensure a viable groundwater resource for beneficial uses including water for adjacent purveyors, agricultural, agricultural-residential, industrial, and municipal supplies that support the Water Forum Agreement's coequal objectives of providing a reliable and safe water supply and preserving the fishery, wildlife, recreational, and aesthetic values of the lower American River.

Five BMOs were adopted to meet the *Zone 40 Groundwater Management Plan* goals as listed below:

- Maintain or improve groundwater quality in the Zone 40 area for the benefit of basin groundwater users.
- Maintain groundwater elevations that result in a net benefit to basin groundwater users.
- Protect against any potential inelastic land surface subsidence.
- Protect against adverse impacts to surface water flows in the American, Cosumnes, and Sacramento Rivers.
- Protect against adverse impacts to water quality resulting from interaction between groundwater in the basin and surface water flows in the American and Sacramento Rivers.

Elements of the Water Forum Agreement included in the BMOs are to reduce lower American River diversions during dry years and not to exceed agreed upon aggregate groundwater extractions of 273,000 AF/year, on average. The monitoring program addressed the five BMOs listed above. The *Zone 40 Groundwater Management Plan* was superseded by the CSCGMP.

The *Zone 40 Groundwater Management Plan* provides valuable resources related to potential concepts, projects and monitoring strategies that can be incorporated into the SASb GSP. The scope of this GSP is consistent with the Zone 40 GMP's groundwater management plan and will incorporate the BMO. Operational flexibility during the GSP implementation in the SASb will not be limited by the *Zone 40 Groundwater Management Plan*.

#### **2.1.9.5 Central Valley Regional Water Quality Control Board—Irrigated Lands Regulatory Program**

The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 to prevent agricultural runoff from impairing surface waters, with regulation of discharges to groundwater added in 2012 (CVRWQCB, nd). On March 12, 2014, the CVRWQCB adopted *Waste Discharge Requirements General Order for Growers within the Sacramento River Watershed that are Members of a Third-Party Group* (General Order WDR R5-2014-0030-R1). The Sacramento

Valley Water Quality Coalition developed and implemented a Monitoring and Reporting Program (MRP) to meet the requirements of the General Order. The MRP analyzes water quality for chemical, physical, and microbiological parameters in surface waters receiving agricultural runoff to identify potentially significant concentrations that exceed ILRP trigger limits. The ILRP trigger limits are established to identify potential sources of contamination and inform potential users of constituents of concern (Sacramento Valley Water Quality Coalition, 2017). The parameters include the following:

- Water column and sediment toxicity
- Physical and conventional parameters
- Organic carbon
- Pathogen indicator organisms
- Trace metals
- Pesticides
- Nitrogen and phosphorous compounds

The SASb is located within the Sacramento River Watershed jurisdictional boundary of the CVRWQCB ILRP, but no ILRP monitoring sites (surface water and groundwater) are located within the SASb. Operational flexibility in GSP implementation in the SASb is not expected to be limited by ILRP activities.

#### **2.1.9.6 Sacramento County Environmental Management Department Wells Program**

The Sacramento County Environmental Management Department Wells Program is responsible for authorizing the construction, modification, repair, inactivation, or destruction of wells in Sacramento County via a permit and inspection process. The Environmental Management Department maintains a database that includes the permitted well information and conducts enforcement actions against persons that violate provisions of the Sacramento County well code (Sacramento County, 2020). Operational flexibility in GSP implementation in the SASb is not expected to be limited by this program.

#### **2.1.9.7 Central Valley Salinity Alternatives for Long-Term Sustainability Initiative**

The Central Valley Salinity Alternatives for Long-Term Sustainability Initiative (CV-SALTS) is a collaborative stakeholder-driven and managed program initiated in 2006 to find solutions to salt and nitrate problems. CV-SALTS is charged with developing sustainable, long-term salinity and nitrate management strategies for the Central Valley (Central Valley Salinity Coalition, 2020). The CV-SALTS process has included a broad group of agricultural, municipal, industrial, non-governmental organizations, and regulatory agencies. Goals adopted for the CV-SALTS program include the following:

- Sustain the Central Valley's lifestyle.
- Support regional economic growth.
- Retain a world-class agricultural economy.
- Maintain a reliable, high-quality water supply.
- Protect and enhance the environment.

The *Central Valley Salt and Nitrate Management Plan* (SNMP) (CV-SALTS, 2016) was completed in December 2016 to address both the ongoing salt and nitrate issue in the

Central Valley and the state's recycled water policy. The SNMP establishes the following three goals:

- Ensure a safe drinking water supply.
- Achieve balanced loadings of nitrate and salt (total dissolved solids / electrical conductivity).
- Implement managed aquifer restoration program.

In May 2018, the CVRWQCB adopted a Basin Plan amendment to codify the key elements of the SNMP. In October 2019, the State Water Resource Control Board conditionally approved this Basin Plan amendment.

While CV-SALTS has identified a temporary monitoring program for the SNMP, a Surveillance and Monitoring Program will be established to monitor water quality and ensure the SNMP helps CV-SALTS achieve its goals (Central Valley Salinity Coalition, 2020).

The SASb has not been listed as a priority basin for nitrate management under the CV-SALTS Basin Plan amendment. Salinity management in the Central Valley (and SASb) will be addressed as a result of the findings of a Prioritization and Optimization Study performed under the direction of the Central Valley Salinity Coalition, which will address long term salinity management plans and occur over the next ten to fifteen years. Operational flexibility in GSP implementation in the SASb is not expected to be limited by CV-SALTS activities.

#### **2.1.9.8 Delta Plan**

The Sacramento-San Joaquin Delta Reform Act of 2009 (Delta Reform Act) established the Delta Stewardship Council to manage the Delta's water and environmental resources. The Delta Stewardship Council's *Delta Plan* (Delta Stewardship Council, 2020) includes 14 regulatory policies and 73 recommendations to achieve the State's coequal goals of a reliable statewide water supply and a protected, restored Delta ecosystem. The *Delta Plan's* policies include the following:

- Develop detailed findings to establish consistency with the *Delta Plan*.
- Reduce reliance on the Delta through improved regional water self-reliance.
- Practice transparency in water contracting.
- Develop Delta flow objectives.
- Restore habitats at appropriate elevations.
- Protect opportunities to restore habitat.
- Expand floodplains and riparian habitats in levee projects.
- Avoid introducing/habitat improvements for invasive nonnative species.
- Locate new urban development wisely.
- Respect local land use when siting water or flood facilities or restoring habitats.
- Prioritize state investments in Delta levees and risk reduction.
- Require flood protection for residential development in rural areas.
- Protect floodways.
- Protect floodplains.

These policies and their associated recommendations address current and future challenges related to the Delta's ecology, flood management, land use, water quality, and water supply reliability (Delta Stewardship Council, 2020). The *Delta Plan* provides resources related to potential concepts, projects, and monitoring strategies that can be incorporated into the SASb GSP during development, and all policies and recommendations will be considered during both project implementation and future GSP updates. Operational flexibility in GSP implementation in the SASb is not expected to be limited by the Delta Plan activities.

### 2.1.9.9 Zone 40 Water Supply Master Plan

The *Zone 40 Water Supply Master Plan* service area extends from Rancho Cordova in the north to Elk Grove in the south and includes portions of the Elk Grove Water District (Elk Grove wholesale area) and portions of the future California American Water Company service area in Rio del Oro (SCWA, 2016). The overall objective of the *Zone 40 Water Supply Master Plan* is to meet future water demands through a conjunctive use program of groundwater, surface water, and recycled water supplies. Specific objectives include:

- Identify assumptions and recommendations from the 1987 *Zone 40 Water Supply Master Plan* that are no longer appropriate.
- Develop a set of water supply alternatives that provide a long-term balance between water demands and available supplies that include demand management, groundwater (including groundwater from the East Sacramento County Replacement Water Supply Project), surface water, and recycled water as the building blocks for water management alternatives.
- Evaluate the engineering, institutional, social, financial, and environmental aspects associated with implementing each of the potential water management alternatives.
- Recommend a water management alternative that is flexible and can be modified as situations change and additional information becomes available.
- Identify an appropriate and flexible means of financing the recommended water management alternative.
- Provide a foundation on which to develop a *Water Supply Infrastructure Plan* to base decisions regarding the acquisition, construction, operation and maintenance of facilities required for the production, transmission, distribution, sale, and demand management of water.
- Maintain consistency with the adopted *Zone 40 Groundwater Management Plan* and the proposed Central Sacramento County Groundwater Basin Groundwater Management Plan.

Although a *Zone 40 Water Supply Master Plan Amendment* was developed in 2013 (Cordova Hills) and 2016 (Newbridge) to address water supply for these projects and to update changes in water demands, the growth rate, and water supplies since the 2005 *Master Plan*, the specific and overall objectives remain the same (SCWA, 2016). *Zone 40 Water Supply Master Plan* objectives will be considered during implementation of this GSP and when developing the monitoring network and plans. Implementation of this GSP will help the *Zone 40 Water Supply Master Plan* continue to promote a reliable and sustainable water supply in Zone 40. Operational flexibility in GSP implementation in the SASb is not expected to limit this program.

### 2.1.9.10 City of Sacramento Water Conservation Plan

The goal of the City of Sacramento's *Water Conservation Plan* (WCP; City of Sacramento Department of Utilities, 2013) is to maximize the City's existing water and fiscal resources through a comprehensive and economically supported approach. The primary objectives of the WCP include the following:

- Deliver cost-effective water conservation and water use efficiency measures to maximize opportunities to sustainably meet the future water needs of the City.
- Offset and/or delay the need to construct additional water production capacity in the future.
- Help reduce ratepayer cost for treatment and delivery of water and treatment of wastewater, and reduce water-related energy consumption.
- Meet state and federal water conservation mandates as follows:
  - Achieve or exceed 20 percent per-capita water use reduction statewide by 2020.
  - Maintain commitments to the California Urban Water Management Council and Water Forum, and initiate measures most likely to achieve targets established in the 2010 *Urban Water Management Plan* (UWMP).
- Demonstrate environmental stewardship as follows:
  - Foster wise, innovative, responsible and efficient practices.
  - Establish a WCP that helps support the health of rivers and groundwater integral to the region's quality of life.

The WCP is comprised of multiple water conservation measures to educate, incentivize, or mandate conservation among residential, commercial, institutional, and irrigation accounts. Estimated water savings in 2020 were planned to come from automatic meter infrastructure and water conservation pricing, system water loss reduction, new and existing plumbing codes and standards, and successful implementation of programs and measures by the Water Conservation Office (City of Sacramento, 2013). Implementation of this GSP will promote efficient use of water to sustain groundwater supply and help the City of Sacramento to achieve its water conservation goals. The primary objectives of the WCP will were considered during GSP plan development. Operational flexibility in GSP implementation in the SASb is not expected to limit this program.

### 2.1.10 General Plans

Sacramento County has the largest jurisdiction in the SASb and encompasses the entire SASb GSP area. The *Sacramento County 2030 General Plan* (Sacramento County, 2017) covers the SASb area outside of the cities of Sacramento, Elk Grove, and Rancho Cordova. The combination of the *Sacramento 2035 General Plan* (City of Sacramento, 2015), the *Folsom 2035 General Plan* (City of Folsom, 2018), the *City of Elk Grove General Plan* (City of Elk Grove, 2019), and the *City of Rancho Cordova General Plan* (City of Rancho Cordova, 2006) ensure the entirety of the SASb is managed through an applicable general plan.

#### 2.1.10.1 Sacramento County 2030 General Plan

The Conservation and Delta Protection Elements of the *Sacramento County 2030 General Plan* (Sacramento County, 2017) are the most relevant sections for development of this GSP because of the interconnection between water resources and aquatic/natural resources. The

Land Use Element is also important. **Table 2.1-18** summarizes the *Sacramento County 2030 General Plan* elements relevant to the GSP.

**Table 2.1-18: Sacramento County 2030 General Plan Elements Relevant to the GSP**

Goal	Objective	Policy
<b>Conservation Element</b>		
Water Resources— Ensure that a safe, reliable water supply is available for existing and planned urban development and agriculture while protecting beneficial uses of Waters of the State of California, including important associated environmental resources.	Optimize the use of available surface water in all types of water years (wet/normal, dry, and driest years)	CO-1 through CO-6
	Manage groundwater to preserve sustainable yield	CO-7 through CO-12
	Ensure the most efficient use of water in urban and agricultural areas.	CO-13 through CO-17
	Manage water supply to protect valuable water-supported ecosystems.	CO-18 through CO-23
	Manage the quality and quantity of urban runoff to protect the beneficial uses of surface water and groundwater	CO-24 through CO-32
	Manage municipal and industrial water supplies efficiently to serve existing and proposed development within the Urban Policy Area.	CO-33 through CO-36
Aquatic Resources— Preserve, protect, and manage the health and integrity of aquatic resources in Sacramento County	Preserve, protect, and enhance natural open space functions of riparian, stream and river corridors	CO-87 through CO-130
<b>Delta Protection Element</b>		
Natural Resources— Preserve and protect the natural resources of the Delta. Promote protection of remnants of riparian habitat and aquatic habitat. Encourage compatibility between agricultural practices and wildlife habitat.	--	DP-25 through DP-34
Water Resources: Protect and enhance long-term water quality in the Delta for agriculture, municipal, industrial, water-contact recreation, and fish and wildlife habitat uses, as well as all other beneficial uses.	--	DP-48 through DP-49
<b>Land Use Element</b>		
Commercial and Industrial Land Use	Commercial and Industrial Land Use	Commercial and Industrial Land Use
Agricultural-Residential Land Uses inside the Urban Services Boundary	Agricultural-Residential Land Uses inside the Urban Services Boundary	Agricultural-Residential Land Uses inside the Urban Services Boundary

<b>Goal</b>	<b>Objective</b>	<b>Policy</b>
A viable rural and recreational economy in all non-metropolitan areas outside of the Urban Service Boundary.	A viable rural and recreational economy in all non-metropolitan areas outside of the Urban Service Boundary.	A viable rural and recreational economy in all non-metropolitan areas outside of the Urban Service Boundary.

Source: Sacramento County, 2017

Goals, objectives, and policies from the *Sacramento County 2030 General Plan* (Sacramento County, 2011) will help shape GSP implementation and were considered during development of the SASb's monitoring network and projects.

The goals of this GSP are aligned with the goals of the *Sacramento County 2030 General Plan* in establishing sustainable management of water resources in the SASb and conservation of land use and agriculture while promoting economic growth. Implementation of this GSP will help achieve the goals, objectives, and policies of the *Sacramento County 2030 General Plan*.

### 2.1.10.2 City of Elk Grove General Plan

The City of Elk Grove *General Plan* (City of Elk Grove, 2019) established a framework for future planning and addresses issues that are considered essential to maintaining and improving the quality of life in Elk Grove. **Table 2.1-19** summarizes City of Elk Grove *General Plan* goals and policies relevant to the GSP.

**Table 2.1-19: City of Elk Grove General Plan Goals and Policies Relevant to the GSP**

<b>Goal</b>	<b>Policy</b>	<b>Action</b>
<b>Natural Resources</b>		
NR-3—Clean and Adequate Water Supply	Water Quality	NR-3-1 through NR-3-3
	Water Supply and Conservation	NR-3-4 through NR-3-14
<b>Disaster and Emergency Risk Reduction</b>		
ER-6—An Adaptable and Resilient Community	Loss of Snowpack and Decreased Water Supplies	ER-6-6 through ER-6-8
<b>Urban Infrastructure</b>		
ER-6—An Adaptable and Resilient Community	Water Service	INF-1-1 through INF-1-3
	Recycled Water	INF-1-4
<b>Rural Area Community Plan</b>		
Context-Sensitive Services	Water Service	RA-2-4 through RA-2-5

Source: City of Elk Grove, 2019

Goals, policies, and actions from the Elk Grove *General Plan* will help shape GSP implementation and were considered during development of the SASb's monitoring network and projects.

The goals of this GSP are aligned with the goals of the Elk Grove *General Plan* in establishing sustainable management of water resources within the SASb and promoting a reliable and safe water supply. Implementation of this GSP will help achieve the goals, objectives, and policies identified in the Elk Grove *General Plan*.

**2.1.10.3 Folsom 2035 General Plan**

The *Folsom 2035 General Plan* (City of Folsom, 2018) provides a framework for physical development of Folsom. The *General Plan* is comprised of seven elements: Land Use, Mobility, Economic Prosperity, Housing, Natural and Cultural Resources, Public Facilities and Services, Parks and Recreation, Safety and Noise. **Table 2.1-20** summarizes *Folsom 2035 General Plan* goals and policies relevant to this GSP.

**Table 2.1-20: Folsom 2035 General Plan Goals and Policies Relevant to the GSP**

Goal	Policy
<b>Natural and Cultural Resources</b>	
NCR 1.1—Protect and enhance Folsom’s natural resources for current and future residents	NCR 1.1.1—Habitat Preservation
	NCR 1.1.2—Preserve Natural Resources
	NCR 1.1.3—Wetland Preservation
NCR 4.1—Preserve and protect water quality in the city’s natural water bodies, drainage systems, and groundwater basin	NCR 4.1.1—Water Quality
	NCR 4.1.3—Protection
<b>Land Use</b>	
LU 1.1—Retain and enhance Folsom’s quality of life, unique identity, and sense of community while continuing to grow and change	LU 1.1.13—Sustainable Building Practices
LU 9.1—Encourage community design that results in a distinctive, high-quality built environment with a character that creates memorable places and enriches the quality of life of Folsom’s residents.	LU 9.1.6—Community Beautification
<b>Public Facilities and Services</b>	
PFS 3.1—Maintain the City’s water system to meet the needs of existing and future development while improving water system efficiency	PFS 3.1.1—Water Master Plan
	PFS 3.1.2—Urban Water Management Plan
	PFS 3.1.3—Water Efficient Landscape Ordinance
	PFS 3.1.4—New Technologies
	PFS 3.1.5—Agency Coordination
	PFS 3.1.6—Water Quality
	PFS 3.1.7—Water Supply
	PFS 3.1.8—Water Resources
	PFS 3.1.9—Water Conservation Programs
	PFS 3.1.10—Water Conservation Standards
	PFS 3.1.11—Resilient System
	PFS 3.1.12—Non-Potable Water

Source: City of Folsom, 2018

Goals and policies from the *Folsom 2035 General Plan* will help shape GSP implementation and were considered during development of the SASb's monitoring network and projects.

The goals of this GSP are aligned with the goals of the *Folsom 2035 General Plan*, including sustainably managing the region's groundwater to maintain water supply reliability, protecting natural resources, and promoting water conservation and system efficiency. Implementation of this GSP will help achieve the goals, objectives, and policies of the *Folsom 2035 General Plan*.

#### **2.1.10.4 City of Rancho Cordova General Plan**

The Rancho Cordova *General Plan* (City of Rancho Cordova, 2006) is the first general plan adopted by the City of Rancho Cordova. The *General Plan* contains policies and programs designed to provide decision makers with a solid foundation for land use and development decisions. The *General Plan* consists of the following elements: Land Use; Urban Design; Economic Development; Housing; Circulation; Open Space, Parks and Trails; Infrastructure, Services, and Finance; Natural Resources; Cultural and Historic Resources; Safety; Air Quality; and Noise. **Table 2.1-21** summarizes City of Rancho Cordova *General Plan* goals and policies relevant to the GSP.

**Table 2.1-21: City of Rancho Cordova *General Plan* Goals and Policies Relevant to the GSP**

Goal	Policy
<b>Land Use</b>	
LU.2—Establish growth patterns based on smart growth principles and the city building blocks concepts	Policy LU2.7—Promote sustainable development that reduces the impact of projects on energy, water, and transportation systems. Encourage sustainable development to occur in ways that complement the built form
<b>Natural Resources</b>	
NR.5—Protect the quantity and quality of the City’s water resources	Policy NR.5.1—Promote water conservation within existing and future urban uses.
	Policy NR.5.2—Encourage the use of treated wastewater to irrigate parks, golf courses, and landscaping.
	Policy NR.5.3—Protect surface and groundwater from major sources of pollution, including hazardous materials contamination and urban runoff.
	Policy NR.5.4—Prevent contamination of the groundwater table and surface water, and remedy existing contamination to the extent practicable.
	Policy NR.5.5—Minimize erosion to stream channels resulting from new development in urban areas consistent with State law.
	Policy NR.5.6—Incorporate Storm Water, Urban Runoff, and Wetland Mosquito Management Guidelines and Best Management Practices into the design of water retention structures, drainage ditches, swales, and the construction of mitigated wetlands in order to reduce the potential for mosquito-borne disease transmission.
	Policy NR.5.7—Continue to cooperate and participate with the County, other cities, and the Regional Water Quality Control Board regarding compliance with the joint National Pollutant Discharge Elimination System (NPDES) Permit CAS082597 or any subsequent permit and support water quality improvement projects in order to maintain compliance with regional, state and federal water quality requirements.
	Policy NR.5.8—The City shall require groundwater impact evaluations be conducted for the Grant Line West, Rio Del Oro, Westborough, Glenborough, Aerojet, Mather and Jackson Planning Areas to determine whether urbanization of these areas would adversely impact groundwater remediation activities associated with Mather, Aerojet, or Boeing prior to the approval of large-scale development. Should an adverse impact be determined, a mitigation program shall be developed in consultation with applicable local, state, and federal agencies to ensure remediation activities are not impacted. This may include the provision of land areas for groundwater remediation facilities, installation/extension of necessary infrastructure, or other appropriate measures.

Source: *City of Rancho Cordova, 2006*

The goals and policies identified in the City of Rancho Cordova *General Plan* will help shape GSP implementation and were considered during development of SASb’s monitoring network and projects.

The goals of this GSP are aligned with the goals of the City of Rancho Cordova *General Plan* in protecting the quality and quantity of Rancho Cordova’s water resources. Implementation of this GSP will help achieve the goals and policies of the City of Rancho Cordova *General Plan*.

### 2.1.10.5 City of Sacramento 2035 General Plan

The City of Sacramento *2035 General Plan* (City of Sacramento, 2015) provides an outline for the City of Sacramento’s development. The *2035 General Plan*’s citywide goals and policies are detailed in 10 elements: Land Use and Urban Design, Historic and Cultural Resources, Economic Development, Housing, Mobility, Utilities, Education, Recreation, Culture, Public Health and Safety, Environmental Resources, Environmental Constraints. The *2035 General Plan* goals and policies that are relevant to the GSP are summarized in **Table 2.1-22**.

**Table 2.1-22: City of Sacramento 2035 General Plan Goals and Policies Relevant to the GSP**

Goal	Policy
<b>Citywide Land Use and Urban Design</b>	
LU 2.2 City of Rivers—Preserve and enhance Sacramento’s riverfronts as signature features and destinations within the city and maximize riverfront access from adjoining neighborhoods to facilitate public enjoyment of this unique open space resource.	LU 2.2.2—Waterway Conservation
LU 9.1 Open Space, Parks, and Recreation—Protect open space for its recreational, agricultural, safety, and environmental value and provide adequate parks and open space areas throughout the city	LU 9.1.1—Open Space Preservation LU 9.1.1—New Parks and Open Spaces
<b>Utilities: Water Systems</b>	
U 2.1 High-Quality and Reliable Water Supply—Provide water supply facilities to meet future growth within the city’s Place of Use and assure a high-quality and reliable supply of water to existing and future residents	U 2.1.1—Exercise and Protect Water Rights
	U 2.1.2—Increase water supply sustainability
	U 2.1.3—Water Treatment Capacity and Infrastructure
	U 2.1.4—Priority for Water Infrastructure
	U 2.1.5—Comprehensive Water Supply Plans
	U 2.1.7—Water Supply During Emergencies
	U 2.1.8—Emergency Water Conservation
	U 2.1.10—Water Conservation Standards
	U 2.1.11—Water Conservation Programs
	U 2.1.12—Water Conservation Enforcement
	U 2.1.13—Recycled Water
	U 2.1.17—Water Conservation Outreach
	U 2.1.18—Future Water Supply
<b>Environmental Resources: Water Resources</b>	
ER 1.1 Water Quality Protection—Protect local watersheds, water bodies and groundwater resources, including creeks, reservoirs, the Sacramento and American Rivers, and their shorelines	ER 1.1.2—Regional Planning
	ER 1.1.8—Clean Watershed
	ER 1.1.9—Groundwater Recharge
	ER 1.1.10—Watershed Education

Source: *City of Sacramento, 2015*

The goals and policies identified in the *2035 General Plan* will help shape GSP implementation and were considered during development of the SASb’s monitoring network and projects.

The goals of this GSP are aligned with the goals of the *2035 General Plan* in maintaining high-quality water in both distribution infrastructure and the environment. Implementation of this GSP will help achieve the goals and policies of the *2035 General Plan*.

## 2.1.11 Community Plans and Special Projects

### 2.1.11.1 Cordova Community Area

The Cordova Community Area includes properties outside of the City of Rancho Cordova boundary but within the Cordova planning area (Sacramento County, 2003). The *Cordova Community Plan* was adopted through Resolution 2003-0551 by the Sacramento County Board of Supervisors. Although the *Cordova Community Plan* does not include any SGMA-related policies, implementation of the GSP will promote sustainable groundwater use in the area.

### 2.1.11.2 Delta Community Area Plan

The Delta Community Area is bound by the Sacramento City limits on the north, I-5 on the east, and the Sacramento County line on the south and west. While the *Sacramento County 2030 General Plan* (Sacramento County, 2011) covers this area, the goals and policies of the *Delta Community Area Plan* (Sacramento County Board of Supervisors, 1983) provide specific direction for implementation in the area. The *Delta Community Area Plan* cover the following topics:

- Natural hazards
- Natural resources
- Agriculture
- Residential development
- Commercial and economic development
- Public services and facilities
- Mineral resources

Policies in the *Delta Community Area Plan* were considered during the development of the monitoring network and projects and will be considered during the implementation of the GSP as appropriate.

The goals of this GSP are aligned with the policies of the *Delta Community Area Plan*. Implementation of this GSP will help achieve the goals and policies of the *Delta Community Area Plan*.

### 2.1.11.3 Florin-Vineyard Community Plan

The Florin-Vineyard Community Area is generally bound by Elder Creek Road on the north, Bradshaw Road on the east, the Churchill Downs neighborhood to the south, and the Union Pacific Railroad tracks on the west. The *Florin-Vineyard Community Plan* (Sacramento County Board of Supervisors, 2010) was adopted through Resolution 2010-1004 by the Sacramento County Board of Supervisors. The community plan includes policies relating to residential, commercial, industrial, open space, streetscape, and public facilities resources.

Policies identified in the *Florin-Vineyard Community Plan* were considered during GSP development of the SASb's monitoring network and projects and will be considered during GSP implementation as appropriate.

Implementation of this GSP will help achieve the policies of the *Florin-Vineyard Community Plan*.

#### 2.1.11.4 South Sacramento Area Community Plan

The *South Sacramento Area Community Plan* (Sacramento County Board of Supervisors, 1978) was adopted through Resolution 78-1431 by the Sacramento County Board of Supervisors. The *South Sacramento Area Community Plan* includes policies relating to 10 elements: Land Use, Economic, Social, Transportation, Environmental, Housing, Schools, Parks and Recreation, Community Aesthetics and Open Space, and Public Services.

The policies identified in the *South Sacramento Area Community Plan* were considered during GSP development of the SASb's monitoring network and projects and will be considered during GSP implementation as appropriate.

The goals of this GSP are aligned with the policies of the *South Sacramento Area Community Plan*. Implementation of this GSP will help achieve the goals and policies of the *South Sacramento Area Community Plan*.

#### 2.1.11.5 Vineyard Community Plan

The Vineyard Community Area is generally bound by Jackson Highway and Kiefer Boulevard on the north, Sunrise Boulevard and Grant Line Road on the east, Calvine Road on the south, and Elk Grove-Florin Road on the west. The *Vineyard Community Plan* (Sacramento County Board of Supervisors, 1985) was adopted through Resolution 85-899 by the Sacramento County Board of Supervisors. Although the *Vineyard Community Plan* does not include any SGMA-related policies, Implementation of the GSP will promote sustainable groundwater use in the Vineyard Community Area.

#### 2.1.12 Urban Water Management Plans

Urban Water Management Plans (UWMPs) are prepared by urban water suppliers every 5 years to ensure that adequate water supplies are available to meet existing and projected water needs (DWR, 2020d). The UWMPs not only promote efficient use of water supply but will support GSP goals of providing a long-term sustainable supply of groundwater for beneficial uses. In their respective UWMPs, urban water suppliers must do the following:

- Assess the reliability of water sources over a 20-year planning horizon.
- Describe demand management measures and water shortage contingency plans.
- Report progress toward meeting a targeted 20 percent reduction in per-capita urban water consumption by 2020.
- Discuss the use and planned use of recycled water.

UWMPs describe water purveyors' existing and planned water systems, supplies and demands, and water conservation measures. UWMPs also address Senate Bill X7-7, which required a statewide per-capita water use reduction of 20 percent by 2020. **Table 2.1-23** describes the seven UWMPs submitted by agencies within the SASb GSP area and their 2015 and 2020 actual and 2020 target gallons per-capita per day use.

**Table 2.1-23: UWMPs in the GSP**

Reporting Agency	Senate Bill X7-7 2020 Target				
	10-Year Baseline (GPCD)	10-Year Baseline (Years)	Actual 2015 (GPCD)	Actual 2020 (GPCD)	Target 2020 (GPCD)
California American Water Company–Sacramento District <sup>1</sup>	216	1999–2008	130	125	173
Elk Grove Water District	239	1999–2008	111	137	191
Folsom, City of	426	1999–2008	261	256	352
Fruitridge Vista Water Company (now part of the California American Water Company)	154	2010–2020	N/A	N/A	123
Golden State Water Company–Cordova	400	1999–2008	235	288	320
Sacramento, City of	282	1996–2005	158	169	225
SCWA	295	1995–2004	153	229	236

**Notes:**

<sup>1</sup> Includes the Antelope, Arden, Dunnigan, Isleton, Lincoln Oaks, Parkway, Security Park, Suburban-Rosemont, Walnut Grove, and West Placer service areas

<sup>2</sup> Since 2020 data were not available at the time of development of the CoSANA model, water budget estimates are based on reported 2015 values from UWMPs (see Section 2.4)

Source: DWR, 2020c

Implementation of the GSP will help maintain sustainable groundwater management in each water supplier’s service area and will generate more robust and comprehensive data for surface water and groundwater resources in the SASb and promote the efficient use of water.

### 2.1.13 Plan Elements from California Water Code Section 10727.4

Per Water Code Section 10727.4, the following plan elements can be found in the following sections:

- Control of saline water intrusion. **(Section 2.3.3)**
- Wellhead protection areas and recharge areas. **(Appendix 3-C), (Section 2.2.8.4)**
- Migration of contaminated groundwater. **(Section 2.1.8)**
- A well abandonment and well destruction program. **(Section 4.7.1)**
- Replenishment of groundwater extractions. **(Section 4)**
- Activities implementing, opportunities for, and removing impediments to, conjunctive use or underground storage. **(Section 4)**
- Well construction policies. **(Section 4.7.1)**
- Measures addressing groundwater contamination cleanup, groundwater recharge, in-lieu use, diversions to storage, conservation, water recycling, conveyance, and extraction projects. **(Section 2.1.8)**

- 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. **(Section 4)**
- Efforts to develop relationships with state and federal regulatory agencies. **(Section 5)**
- 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. **(Section 5)**
- Impacts on groundwater dependent ecosystems. **(Section 2.3.7)**

## 2.2 Hydrogeologic Conceptual Model

This section describes the Hydrogeologic Conceptual Model (HCM) for the South American Subbasin (SASb). The HCM is developed in the Groundwater Sustainability Plan (GSP) to understand and convey the physical conditions by which water moves through the basin and is foundational for the development of the water budget and the sustainable management criteria, the monitoring networks, and projects and management actions.

Consistent with the Sustainable Groundwater Management Act (SGMA) regulations, the HCM:

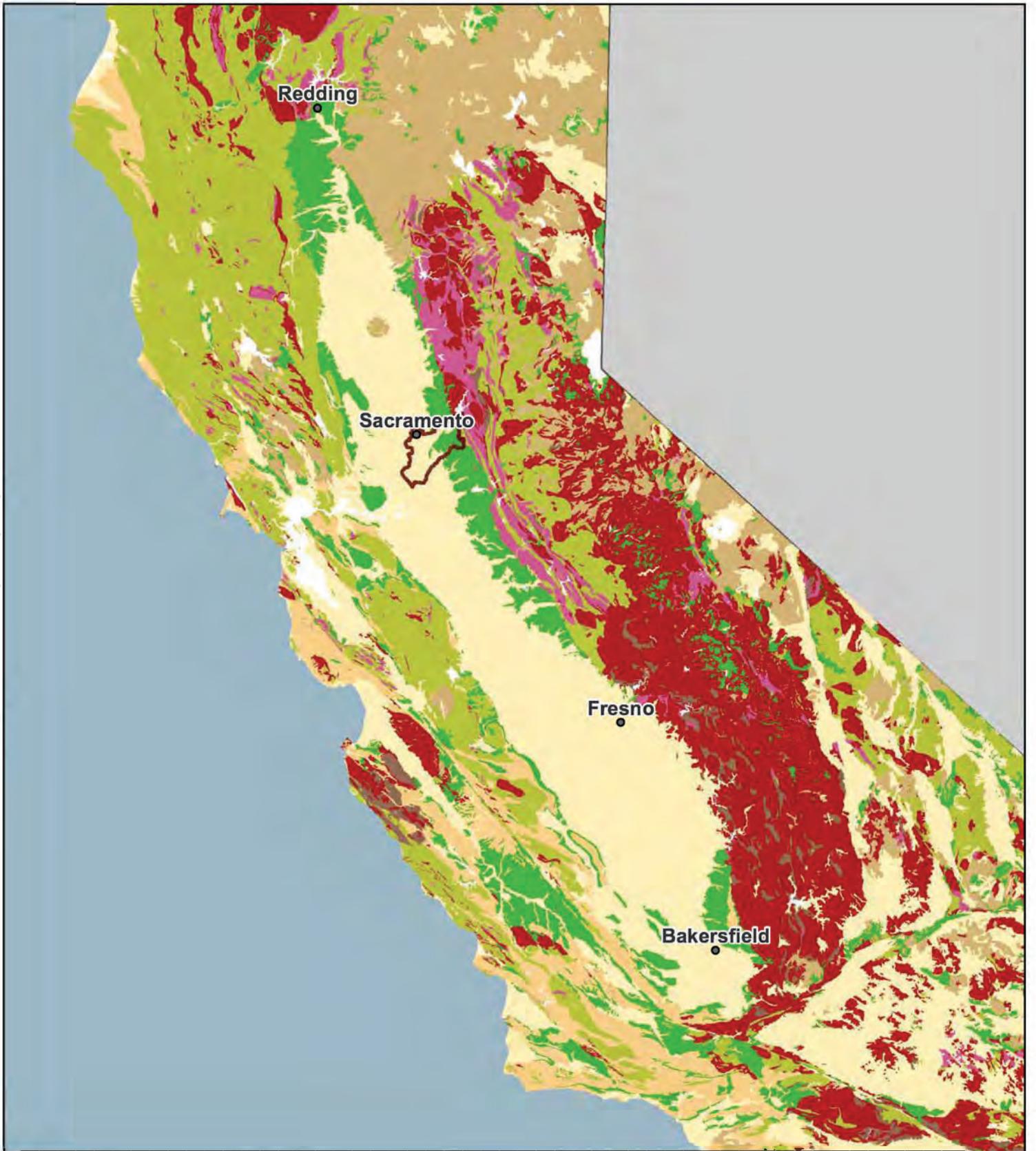
- Provides an understanding of the general physical characteristics related to regional hydrology, land use, geology and geologic structure, water quality, principal aquifers, and principal aquitards of the basin.
- Provides the context to develop water budgets, mathematical (analytical or numerical) models, including an accounting for the effects of climate change.
- Provides the context to develop monitoring networks for the sustainability indicators.

### 2.2.1 Regional Geologic and Structural Setting

The SASb is in the southeastern portion of the Sacramento Valley abutting the Sierra Nevada foothills (**Figure 2.2-29**). The Sacramento Valley is the northern portion of the California Central Valley, a broad, northwest-trending asymmetrical syncline, with a more gently dipping eastern limb. The synclinal trough is bounded by the eastern Sierra Nevada and California Coast Ranges, forming a depositional basin that has accumulated a thick sequence of sedimentary deposits. It is the upper portions of those sedimentary deposits that provides the framework for the aquifer system being managed through this GSP.

The subsurface of the Sacramento Valley is composed of marine and continental sedimentary deposits ranging in age from the Cretaceous to Quaternary (see **Appendix 2-A** for a geologic time scale). Marine sedimentary deposits range in age from the mid-Cretaceous to the Eocene and continental sedimentary deposits range in age from the Eocene to Quaternary (California Department of Water Resources [DWR], 1974). The eastern portion of the SASb consists of steeper topography, exposing outcrops of Eocene to Miocene-age sedimentary rock. Sedimentary deposits are underlain by an older, Mesozoic-age crystalline basement that is similar to outcrops found in the Sierra Nevada (DWR, 1974). The crystalline basement dips gradually to the west, resulting in an increasingly thick sedimentary wedge from east to west.

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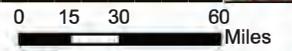
# South American Subbasin GSP

## Regional Geologic Setting

Figure 2.2-29

Legend

- |  |   |
|--|---|
|  South American                                       |  Marine Sedimentary Rocks                  |
| <b>Generalized Rock Types</b>  |  Metavolcanic Rocks                        |
|  Marine and Nonmarine (Continental) Sedimentary Rocks |  Mixed Rocks                               |
|  Marine Sedimentary and Metasedimentary Rocks         |  Nonmarine (Continental) Sedimentary Rocks |
|  |  Plutonic Rocks                            |
|  |  Volcanic Rocks                            |



South American SUBBASIN

Project #: 0011575.00  
Map Created: June 2020

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## 2.2.2 Geologic History

The Sacramento Valley (and consequently the SASb) was primarily formed from the late Jurassic through the Quaternary through a complex combination of orogenic events, sea-level transgressions and regressions, volcanic activity and glaciation.

The first important geologic event with respect to the Sacramento Valley was formation of the ancestral Sierra Nevada during the Nevadan Orogeny, which occurred during the late Jurassic and early Cretaceous. These events formed the mountain range through a process of folding, faulting and igneous intrusion (DWR, 1974).

In the Cretaceous period, the ancestral Sierra Nevada was heavily eroded, and the detrital material was deposited in marine sediments in the Cretaceous Sea west of the Sierra Nevada. The sea gradually transgressed over the eroded surface of the ancestral Sierra Nevada and Cretaceous-age marine sediments were deposited on top of the granitic rocks formed during the Nevadan Orogeny. This transgression was accompanied by a gradual subsidence of the ancestral Sierra Nevada (Olmsted and Davis, 1961). Marine sediments were deposited from the Paleocene into the Eocene epoch, with a north-south shoreline spanning the eastern portion of the Sacramento Valley (DWR, 1974).

From the middle or late Eocene, continuing intermittently into the Miocene, volcanic eruptions deposited pyroclastic and flow material at the crest of the Sierra Nevada. Subsequent erosion of these volcanic rocks resulted in the westward deposition of volcanic sediments. By the middle Miocene, the sea had regressed from the Sacramento Valley and volcanic activity renewed along the crest of the Sierra Nevada after a relatively brief period of inactivity (DWR, 1974). Volcanic activity continued into the middle to late Pliocene, covering much of the Sierra Nevada and Sierra Nevada foothills in andesitic volcanic debris. At the same time, the Sierra Nevada was being uplifted and tilted westward. By the middle to late Pliocene, volcanic activity ceased, and the Sierra Nevada underwent a period of erosion and where large quantities of sediment were deposited into the Central Valley (DWR, 1974).

Glaciation in the Sierra Nevada during the Pleistocene formed deep cut canyons into underlying bedrock of the Sierra Nevada. The sediment eroded from these canyons deposited an extensive gravel pediment on the valley floor, covering much of the Sacramento Valley (DWR, 1974). During the Pleistocene, sea levels fluctuated by hundreds of feet between glacial and interglacial periods. During interglacial periods, the sea level was approximately 100 feet higher than the current sea level and shorelines were as far inland as the central part of Sacramento County. Along these historical shorelines, widespread deposits of near-shore sediments have accumulated (Olmsted and Davis, 1961).

At present, streams are eroding the low-lying alluvial plains and dissected uplands, aggrading the river flood plains and channels and flood basins (Olmsted and Davis, 1961).

### 2.2.3 Geologic Formations/Stratigraphy

Stratigraphy in the SASb consists of a sequence of unconsolidated to partly consolidated continental deposits of Eocene to Quaternary age overlying older marine sedimentary rocks of late Cretaceous to Eocene age. These marine and continental deposits overly Mesozoic crystalline granitic and metamorphic bedrock (Olmsted and Davis, 1961). Individual geologic units found in the Basin are described in detail below, in order of youngest to oldest in deposition.

Geologic units mapped at the surface are shown in **Figure 2.2-30A**. The associated geologic map legend is shown in **Figure 2.2-30B**. A generalized stratigraphic column of geologic formations in the SASb is shown in **Figure 2.2-31**, and is based on older literature with formation names that are no longer in use: the Victor and Fair Oaks Formations. The Victor Formation is generally correlated with the modern Modesto and Riverbank formations and the Fair Oaks Formation is generally correlated with the modern Turlock Lake Formation (Marchand and Allwardt, 1981).

#### 2.2.3.1 Water Bearing Stratigraphic Units of the South American Subbasin

Stratigraphic units in this section are presented from youngest to oldest. DWR prepared a generalized cross section of the SASb and surrounding area in 1974. Additionally, cross sections were prepared from the CoSANA model layers which are described in detail in report documenting the development of the model (**Appendix 2-B**). **Figure 2.2-32** shows the DWR cross section locations and well sample locations discussed in **Section 2.2.7**. **Figure 2.2-33** shows the location of cross sections derived from the CoSANA model layers.

The geologic cross sections are shown individually in **Figure 2.2-34** and **Figure 2.2-35**. The DWR cross sections show the relationship of the Victor, Fair Oaks, Laguna, and Mehrten Formations and the older/deeper sediments and basement rocks in and near the SASb. As noted above, **Figure 2.2-34** and **Figure 2.2-35** display formation names (= Victor and Fair Oaks) that are no longer in use. The cross sections also show approximate well sample locations and the associated Stiff diagrams that are discussed in **Section 2.2.7**.

The cross sections derived from the CoSANA model layers are shown individually in **Figure 2.2-36** to **Figure 2.2-39**. Note that the Alluvium model layer (orange) is correlated with the Modesto Formation, Riverbank Formation and Arroyo Seco Gravels. The Laguna model layer (yellow) is correlated with the Turlock Lake and Laguna Formations. The Mehrten, Valley Springs and Lone model layers (green, blue, purple, respectively) are correlated with the Mehrten, Valley Springs and Lone Formations, respectively.

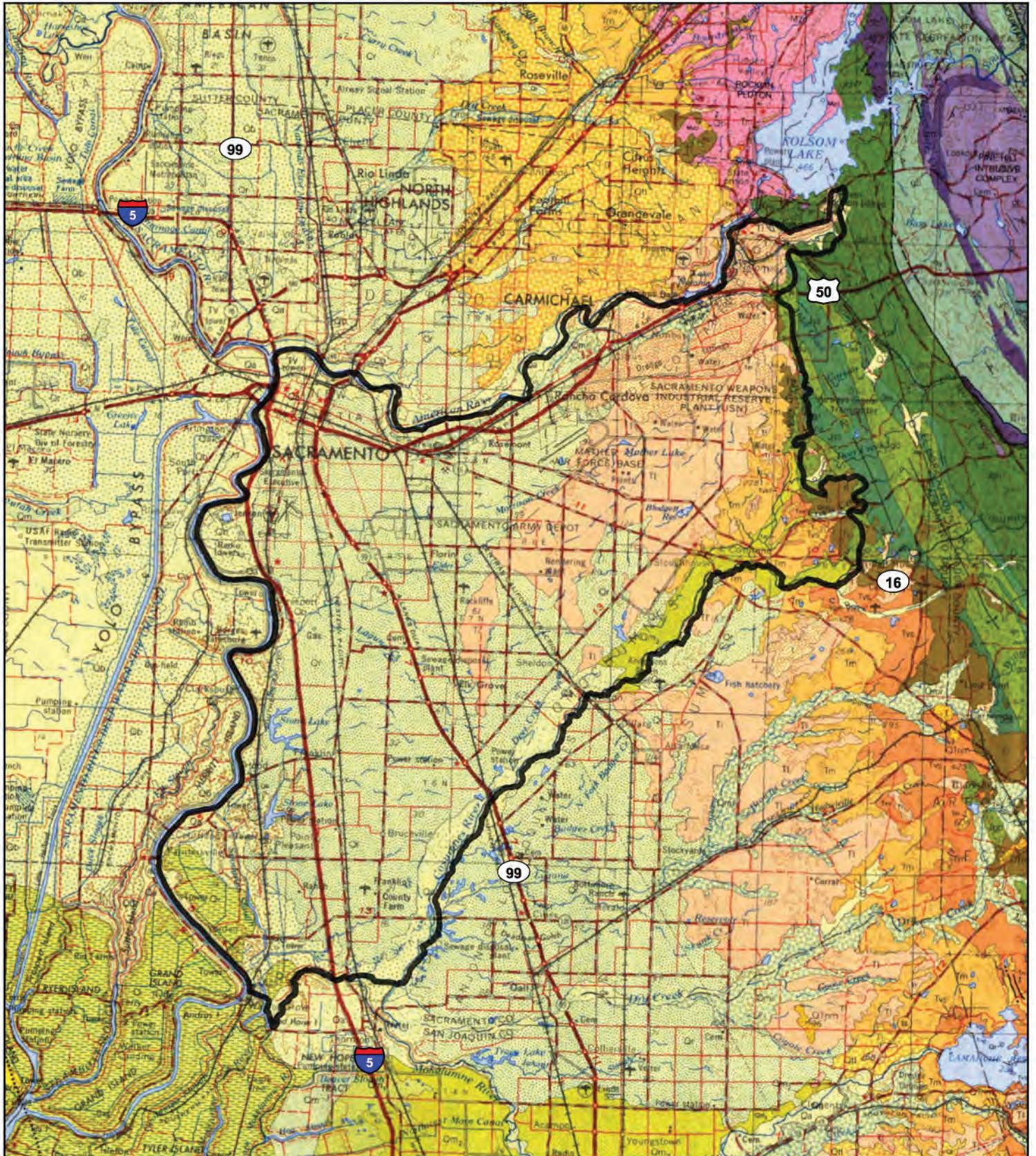


Figure Exported: 12/14/2020 By: vdelanda Using: ArcSWATSWATrun (unpublished)Project\FMCI\SAC\06508 Sac Central Groundwater Authority\0011575.Dr. SCGA.GSP.KG. GIS\2. AKDI\Geology\_V2.mxd

# South American Subbasin GSP

Geologic Map

Figure 2.2-30A

Legend

South American Subbasin

0 1.25 2.5 5 Miles



South American  
**SUBBASIN**

Project #: 0011575.00  
Map Created: June 2020



COSANA Model Layer	Old Literature's Formation Names <sup>1,2</sup>	Formation <sup>2,3</sup>	Thickness <sup>1,2</sup>	Physical Characteristics <sup>1,2</sup>	Aquifer <sup>1</sup>
Alluvium	-	Alluvium	0-100	Unconsolidated sand, gravel, silt and clay	Upper Portion
	Victor Formation	Modesto Formation	0-100	Unconsolidated sand, silt, and clay, some hardpan	Upper Portion
		Riverbank Formation	0-100	Unconsolidated sand, silt, and clay, some hardpan	Upper Portion
	-	Arroyo Seco Gravel	20-50	Sand and gravel, iron-cemented clay matrix	Upper Portion
Laguna	Fair Oaks Formation	Turlock Lake Formation	0-225	sand, silt, and clay with hardpan, mostly present north of American River	Upper Portion
		Laguna Formation	125-200	Bedded silts, clays, and sands	Upper Portion
Mehrten	-	Mehrten Formation	200-1200	Beds of black volcanic sand, brown clay and sand, andesitic origin	Lower Portion
Valley Springs	-	Valley Springs Formation	75-125	Beds of light colored sand and ash, greenish brown silty sand, rhyolitic origin	Lower Portion
Ione	-	Ione Formation	100-400	medium grained quartz sandstone, thick beds of clay	Below Aquifer
Basement	-	Chico Formation	200-15,000	brown marine fossiliferous sandstone and shale	Below Aquifer
	-	Basement	-	Slate, sandstone, greenstone, schist, metavolcanics, granodiorite	Below Aquifer

1 : Adapted from DWR, 1974

2 : Adapted from Marchand and Allwardt, 1981

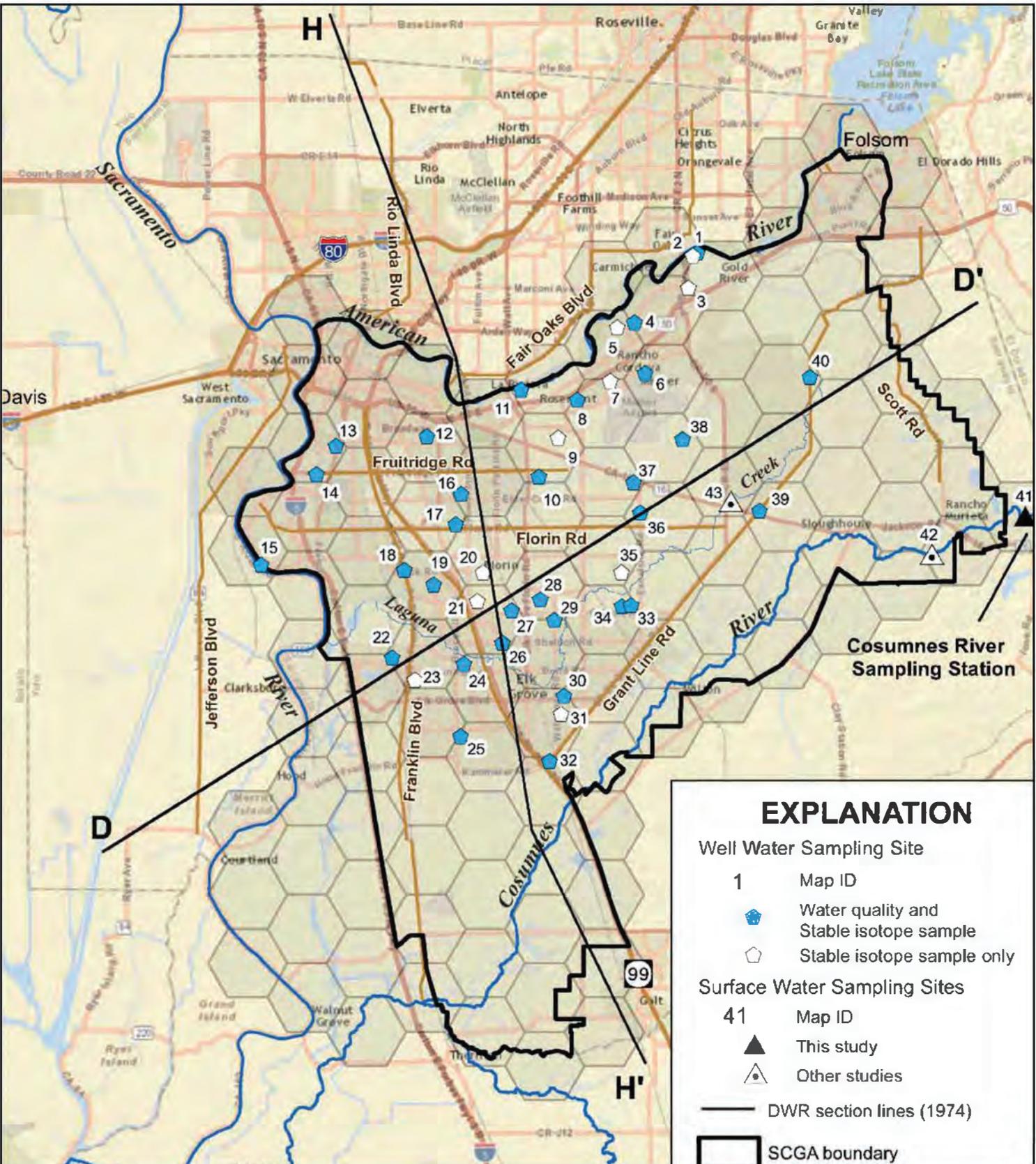
3 : Adapted from Helley and Hardwood, 1985

**South American Subbasin GSP**  
**Stratigraphic Column**  
 Figure 2.2-31

South American  
**SUBBASIN**

Map Created: June 2020

Figure Exported: 12/14/2020 By: vdsanda Using: \\woodland\rcm\rcm\Projects\RMC\SAC\06508 Sac Central Groundwater Authority\0011575-00- SCGA GSP.MXD MXD\Cross Section and Sampling Locations.mxd



### EXPLANATION

Well Water Sampling Site

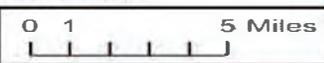
- 1 Map ID
- Water quality and Stable isotope sample
- Stable isotope sample only

Surface Water Sampling Sites

- 41 Map ID
- This study
- Other studies

DWR section lines (1974)

SCGA boundary



N

**South American  
SUBBASIN**

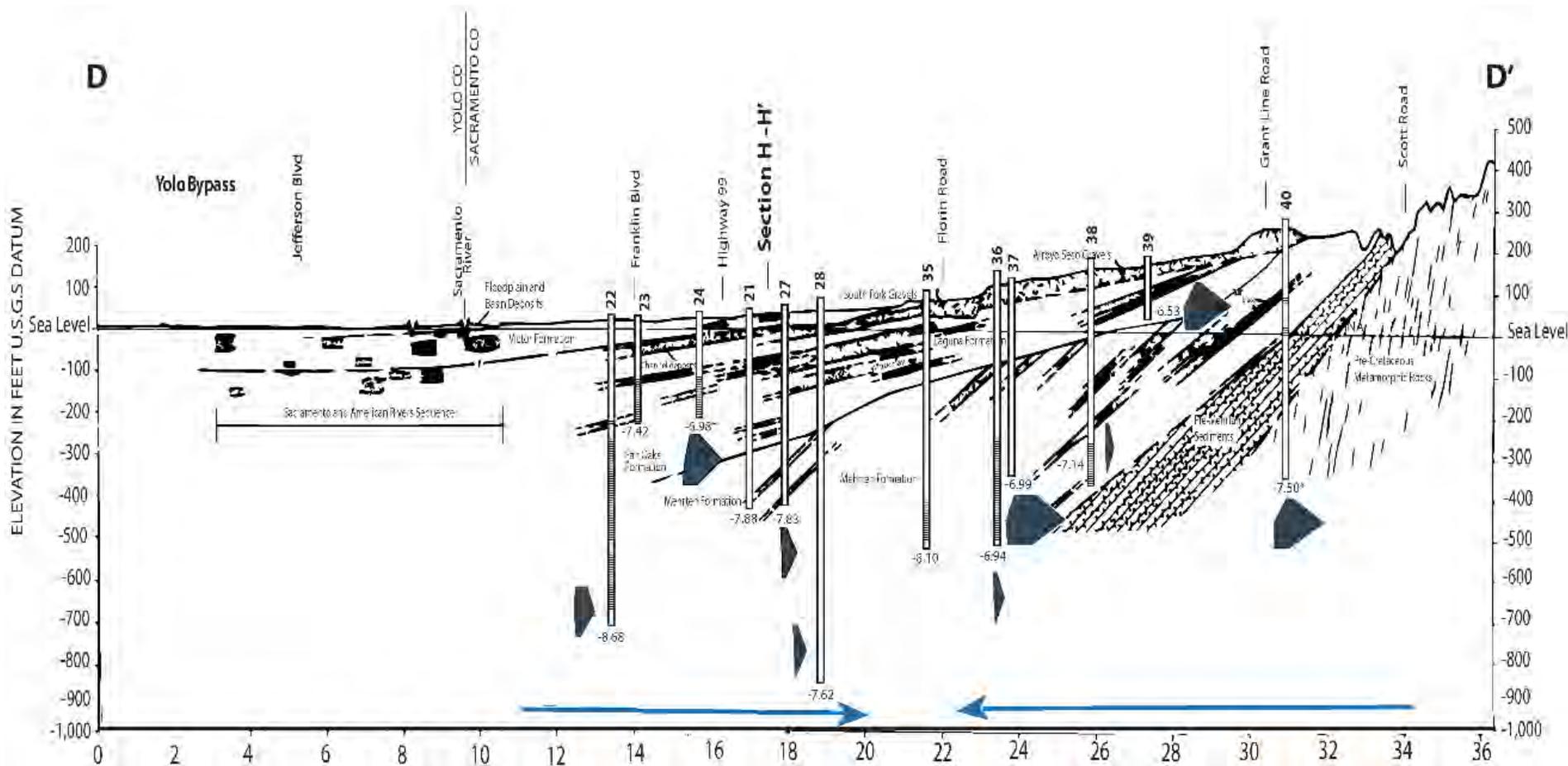
Project #: 0011575.00  
Map Created: June 2020

**South American Subbasin GSP Cross Sections and Water Sampling Locations**  
Figure 2.2-32

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Figure Exported: 12/14/2020 By: vdeanda - Using: \\woodland\curran\net\shared\Projects\RMC\SAO\0509 Sac Central Groundwater Authority\0011575-00- SCGA GSP.GIS2\_MXD\8-63-7 Cross Section\_Template.mxd

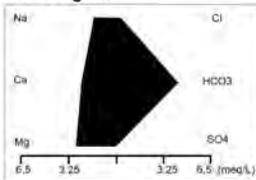


**South American Subbasin GSP**  
**Cross Section D-D'**  
 Figure 2.2-34

*Legend*

→ Inferred groundwater direction

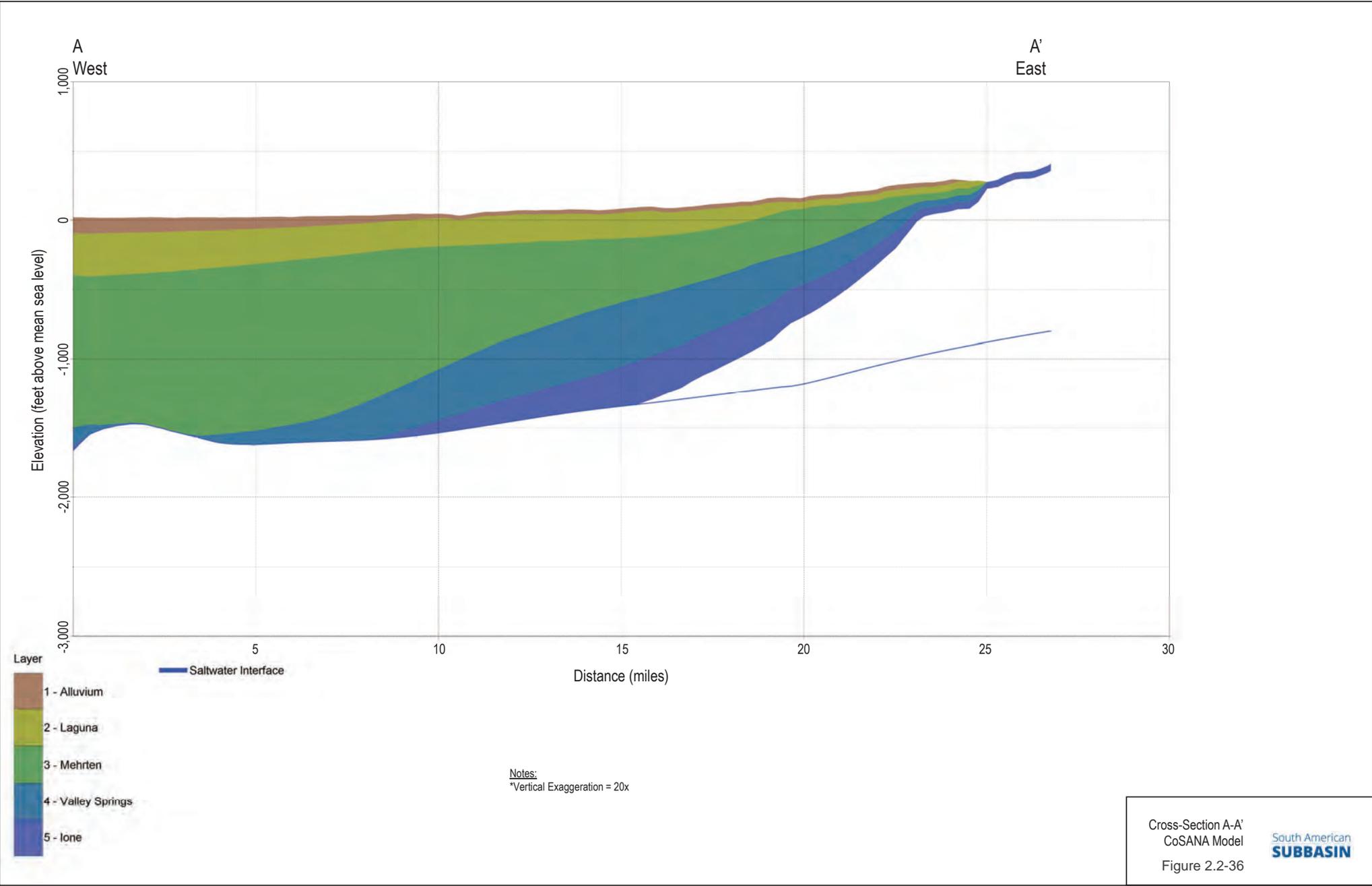
**Stiff Diagram**



**South American SUBBASIN**

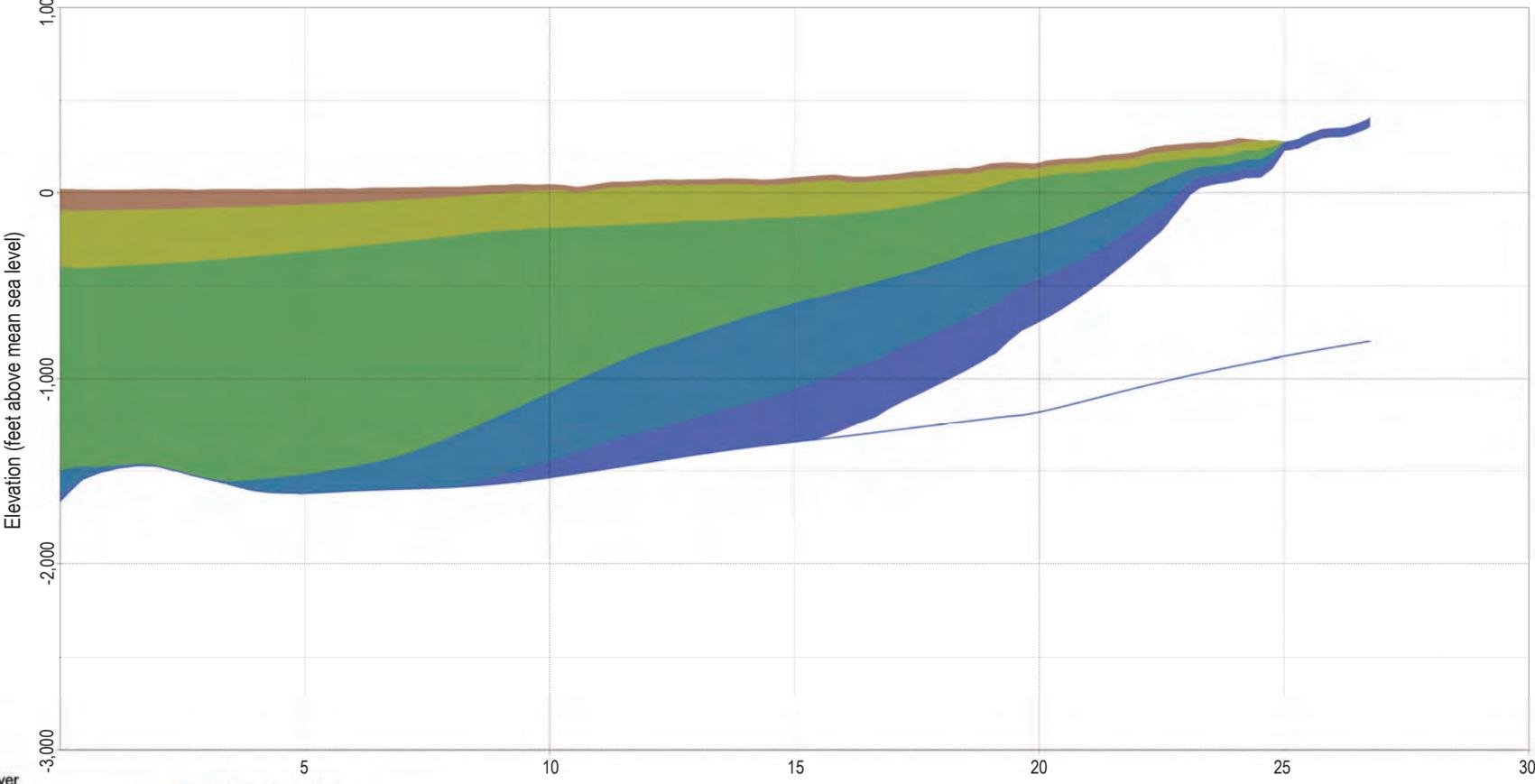
Map Created: October 2021





A  
West

A'  
East

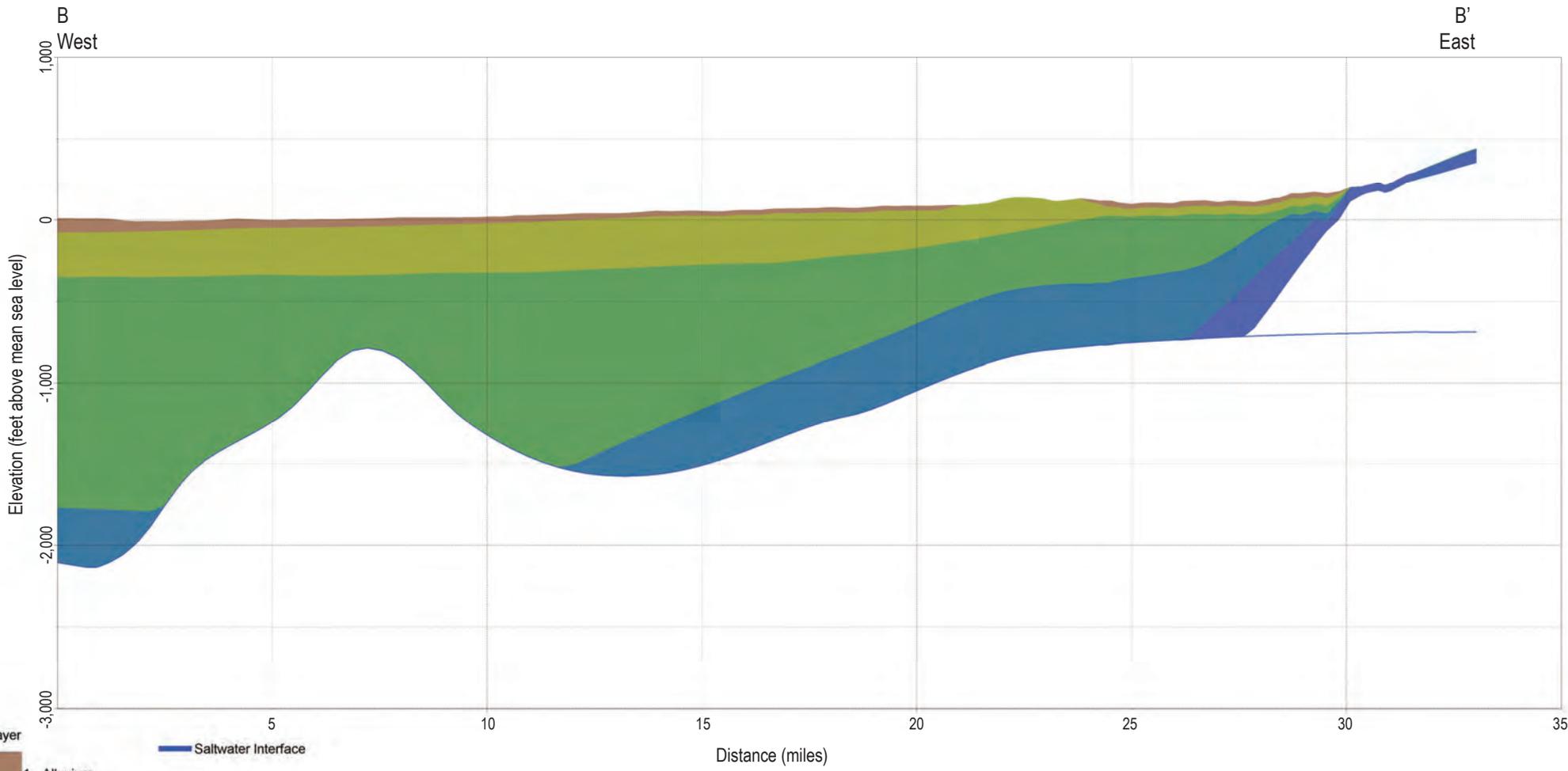


— Saltwater Interface

Distance (miles)

Cross-Section A-A'  
CoSANA Model  
Figure 2.2-36

South American  
**SUBBASIN**



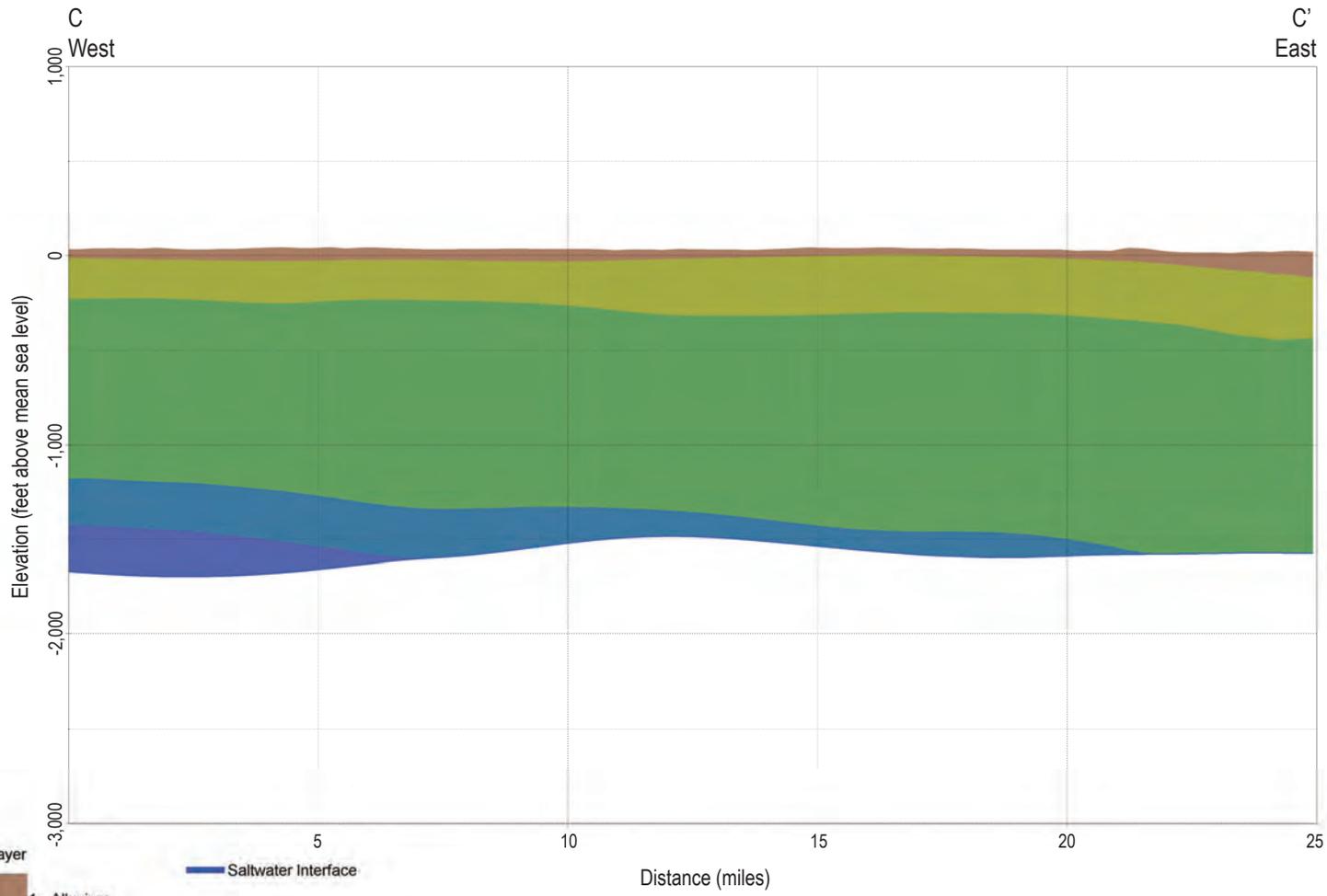
- Layer
- 1 - Alluvium
  - 2 - Laguna
  - 3 - Mehrten
  - 4 - Valley Springs
  - 5 - Ione

— Saltwater Interface

Notes:  
\*Vertical Exaggeration = 20x

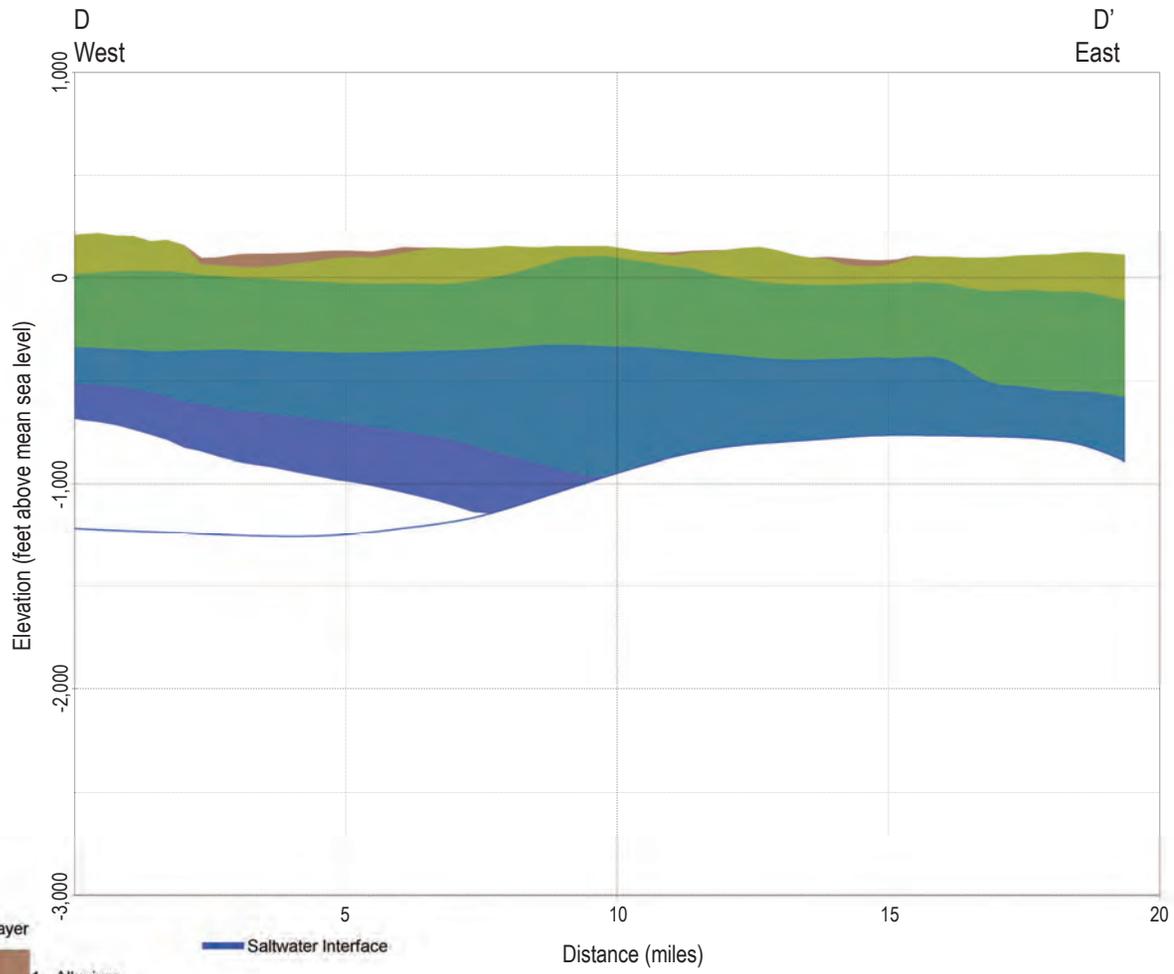
Cross-Section B-B'  
CoSANA Model  
Figure 2.2-37

**South American**  
**SUBBASIN**



Cross-Section C-C'  
CoSANA Model  
Figure 2.2-38

South American  
**SUBBASIN**



- Layer
- 1 - Alluvium
  - 2 - Laguna
  - 3 - Mehrten
  - 4 - Valley Springs
  - 5 - Ione

— Saltwater Interface

Notes:  
 \*Vertical Exaggeration = 20x  
 Layer 1 includes all sediments deposited after the Laguna Formation

Cross-Section D-D'  
 CoSANA Model  
 Figure 2.2-39



### ***Dredge Tailings***

Dredge tailings are exposed primarily along the American River in the northeastern portion of the SASb. They consist of surficial deposits of alternating ridges and valleys resulting from the activities of gold dredging operations. The ridges are composed of sand, gravel, cobbles, and boulders while the valleys are composed of fine sand, silt, and clay (slickens). The larger dredges could reach depths of more than 100 feet below the ground surface. Tailings cover an area of approximately 12,000 acres and are an important groundwater recharge area given their high hydraulic conductivities (DWR, 1974), drainage is internal (little or no runoff), and the tailings are located in the higher precipitation areas.

### ***Flood Basin Deposits***

Flood basin deposits occur along the western margin of the SASb adjacent to the Sacramento River. These deposits consist primarily of silts and clays but may be interbedded with stream channel deposits of the Sacramento River (DWR, 2004).

### ***Stream Channel Deposits***

Stream channel deposits consist of unconsolidated sand and gravel occurring in streambed deposits and point bar deposits. These deposits are primarily transported by present-day streams and river systems and overlie the Modesto and Riverbank Formations (formerly the Victor Formation) (DWR, 1974).

### **Quaternary Alluvium**

Quaternary alluvium consists of un-weathered gravel, sand and silt deposited by present-day stream and river systems of the Sierra Nevada. These deposits outlie stream channel deposits but are inside the first low terraces flanking modern stream channels (Helley and Hardwood, 1985). Permeabilities in these units range from high to low, and, in certain areas, the alluvium acts as a recharge area for percolating surface water to infiltrate into groundwater (DWR, 1974). Thickness of the alluvium varies from up to 30 feet deep (Helley and Hardwood, 1985).

### **Modesto Formation**

The Modesto Formation is the youngest unit comprising the Pleistocene alluvium and forms distinct alluvial terraces and some alluvial fans and abandoned channel ridges. The formation is composed of tan and light-gray gravel, sand, silt and clay in unconsolidated, unweathered deposits and unconsolidated, slightly weathered deposits (Helley and Hardwood, 1985). The Modesto Formation was deposited by present-day rivers and streams because the deposits typically border existing rivers and streams.

### **Riverbank Formation**

The Pleistocene-age Riverbank Formation forms distinct alluvial terraces and fans and is composed of reddish weathered gravel, sand, silt, and minor amounts of clay and semi-consolidated gravel, sand and silt. The Riverbank Formation typically contains fragments of mafic igneous rocks (Helley and Hardwood, 1985).

### **South Fork Gravels**

South Fork Gravels are a discontinuous belt of partially cemented channel gravel deposits that extend from Mormon Island Dam to Elk Grove. These deposits are about one mile wide. The gravels are composed of rounded pebbles and cobbles in a granitic sand matrix with some micaceous clays present that serves to bind the larger fragments (DWR, 1974). The South Fork Gravels dip southwest at a gradient of 5 to 20 feet per mile (DWR, 1974).

### **Arroyo Seco Gravels**

Arroyo Seco Gravels are present as a thin veneer capping hills in the east-central portion of Sacramento County (DWR, 1974). These gravels are present as a series of discontinuous beds and lenticular deposits of stream-laid detritus. The Arroyo Seco Gravels were deposited as a pediment by many rivers and streams that drained the Sierra Nevada during the middle and late Pleistocene. These deposits are typically composed of well-rounded pebbles, weathered andesite with lesser amounts of quartz, chert and occasional fragments of weathered granitic rock. These rock fragments are cemented in a matrix of red, iron-rich, granitic sand and clay. The Arroyo Seco Gravels dip southwest at a gradient of 20 feet per mile. The estimated thickness of the pediment ranges from 20 to 50 feet (DWR, 1974).

### **Turlock Lake Formation**

The Turlock Lake Formation occurs in the SASb as low gravel deposits along the ancestral American River channel (i.e., south of the present American River). The Turlock Lake Formation is composed of deeply weathered and dissected arkosic gravels with metamorphic rock fragments and quartz pebbles with sand and silt present along the south and east sides of the Sacramento Valley (Helley and Hardwood, 1985). The Turlock Lake Formation is located topographically higher than younger alluvial fans and terraces and displays as much as 90 feet of erosional relief. The Turlock Lake Formation represents eroded alluvial fans derived from primarily plutonic rock of the Sierra Nevada to the east (Helley and Hardwood, 1985).

### **Laguna Formation**

The Laguna Formation is exposed in the eastern portion of Sacramento County, where it comprises much of the foothills, and extends from Deer Creek to approximately one mile south of Highway 50. The Pliocene to early Pleistocene-age Laguna Formation is composed of a heterogeneous assemblage of silt, clay and sand with lenticular gravels deposited by slow, meandering streams (Olmsted and Davis, 1961). Sediments in the Laguna Formation are locally variable, with some areas consisting of compacted silt, clay with lenses of poorly sorted gravel, sand and silt, while other areas of the formation are predominantly sand with few interbeds of clay and silt (DWR, 1974). The Laguna Formation has a gradational contact with the Mehrten Formation, and the lower portion of the Laguna Formation has been named the Laguna-Mehrten Transitional Zone. This zone consists of beds of non-volcanic Laguna Formation sediments interbedded with Mehrten Formation volcanic sediments. The formation dips westward at an average gradient of approximately 90 feet per mile. The estimated thickness of the formation ranges from 200 to 400 feet, thickening from east to west (DWR, 1974).

## Mehrten Formation

The Mehrten Formation outcrops discontinuously in a broad portion of eastern Sacramento County, extending from Cosumnes River to the American River in the eastern portion of the Subbasin. The middle Miocene to middle Pliocene-age Mehrten Formation can be divided into two distinct units. The first unit is composed of gray to black andesitic sands and interbedded blue to brown clay. The second unit is composed of hard gray tuff-breccia (DWR, 1978). The formation dips westward at a gradient of approximately 1 to 2 degrees and becomes essentially horizontal along the axis of the Central Valley. The estimated thickness of the formation ranges from approximately 200 feet up to 1,200 feet, thickening from east to west (DWR, 1974).

DWR discussed the Mehrten Formation extensively in the *Bulletin 118-3* (DWR 1974). DWR describes two distinct units of the Mehrten Formation as follows:

The first unit of the Mehrten Formation is composed of well-sorted black sands, which are a significant water bearing unit often accessed by municipal wells. They were formed as fluvial deposits derived from eroded andesitic material originating in the Sierra Nevada. Beds of black sand are laminated and typically about 5 feet thick but have been observed at over 20 feet thick. These beds commonly exhibit cross bedding and foreset bedding, indicative of deposition in a beach or deltaic environment. Well-rounded pebbles and cobbles of andesite are common in certain horizons. Lenticular beds of stream gravel containing andesitic cobbles and boulders or beds of blue to brown clay and silt are associated with these black sands. Near the base of the first unit, a series of hard, gray sandstone beds are present and coated in authigenic montmorillonite (DWR, 1974).

The second unit of the Mehrten Formation is tuff-breccia, which is very dense, hard and composed of angular pieces of fine-grained to porphyritic andesite. Breccia fragments range from less than an inch to several feet in diameter and are contained in a cemented ground mass composed of andesitic lapilli and ash. The tuff-breccia unit is derived from large quantities of volcanic ash that washed down existing stream channels, acquiring blocks of andesite that were then incorporated into the mass. This material spread out over the sloping plains and solidified as a hard pavement ranging in depth from a few inches to over 30 feet deep (DWR, 1974).

## Valley Springs Formation

The Valley Springs Formation is exposed along the eastern side of Sacramento County from the southeast corner northward to Carson Creek. The Valley Springs Formation is of Miocene age and commonly contains varying amounts of rhyolite ash, vitreous tuff, quartz sand containing glass shards and ashy clays. Many of the clays have a greenish color. The sediments often contain fragments of pumice, up to 0.25 inch in diameter (DWR, 1974).

The Valley Springs Formation unconformably overlies the lone Formation and older metamorphic rocks to the east. The formation dips west at a fairly uniform angle ranging from 1.5 to 2 degrees with a thickness that ranges from 75 to 125 feet. The preserved thickness of the formation may not be the entire thickness deposited during the Miocene as the materials are easily erodible and a large part of the upper formation may have been stripped off prior to deposition of the overlying formation (DWR, 1974). Within the SASb, the Valley Springs Formation is a significant source of water only in the far eastern portions of the subbasin.

## **Lone Formation**

The Lone Formation is exposed in eastern Sacramento County from Carbondale Road north to Folsom. The middle Eocene-age Lone Formation can be divided into three distinct members. The upper member of the formation is primarily composed of uniformly graded, medium to coarse-grained quartz sandstone, containing flakes of anauxite, a micaceous clay derived from the weathering of the Sierra Nevada grandodiorite (DWR, 1978). Below the sandstone member, a thick bed of white clay abundant in anauxite is present, indicating deposition in relatively still waters. In some areas, this clay is stained red to yellow, and in areas of intense staining, is cemented and present as ocher. Staining is primarily derived from the precipitation of limonite from groundwater percolation of heavily weathered bedrock. The lower member is composed of blue to gray clay and occasional seams of lignite. At the base of the formation, a zone of gravel composed of quartz and metamorphic fragments is reportedly present (DWR, 1974).

The Lone Formation overlies older metamorphic and marine sedimentary rock to the east and is overlain by younger sediments to the west. The formation has a westward dip of approximately 5 degrees and extends at least as far as the Sacramento River in the subsurface. The Lone Formation has a stratigraphic thickness ranging from 100 to 400 feet. The formation merges along the eastern margin with auriferous gravels of the Sierra Nevada, indicating contemporaneous deposition in a deltaic and littoral environment (DWR, 1974). Within the SASb, the Lone Formation is a significant source of water only in the far eastern portions of the subbasin.

### **2.2.3.2 Stratigraphic Units Below Water Bearing Units**

#### **Chico Formation (Marine Sediments)**

The Chico Formation outcrops northwest of Folsom near Auburn-Folsom Road (DWR, 1974). These Cretaceous-age marine sediments are composed of a tan, yellowish-brown to light-gray marine sandstone with lenticular beds of pebbles to fine-grained cobble conglomerate. Conglomerate clasts include chert, quartz, quartzite, granite and greenstone. Calcite-cemented concretions and layers of fossil fragments are commonly present. The sandstone is composed of fine-grained to medium-coarse, angular to subrounded grains of quartz, plagioclase, alkali feldspar, lithic fragments and detrital chert (Helley and Hardwood, 1985). Due to the marine depositional environment, this formation is typically saline and not used for water supply purposes. These marine sediments unconformably overlie granitic and metamorphic bedrock and underlie Eocene sediments of the Lone Formation (DWR, 1974). The formation has a westward dip and its estimated thickness ranges from 3,000 to 15,000 feet, thickening east to west (DWR, 1978).

#### **Granitic and Metamorphic Rocks**

Metamorphic rocks are exposed east of the Cosumnes River north to the American River near Folsom and are part of the basement complex formed during the Nevadan Orogeny. These metamorphic rocks are typically composed of amphibolite, greenstone, and meta-igneous rocks belonging to the Logtown Ridge Formation of Carboniferous age (DWR, 1974). Outcrops of white quartz occur as sharply dipping veins up to 10 feet thick. Discontinuous belts within the Logtown Ridge Formation are slate and shale that are part of the Mariposa Formation. All of the metamorphic rocks have been deformed into isoclinal folds with a near vertical dip (DWR, 1974). The granitic rocks are a portion of the Sierra Nevada batholith that was formed during the

Jurassic and early Cretaceous. These rocks generally range in composition from granite to peridotite with granodiorite and quartz diorite being the most extensive (Olmsted and Davis, 1961).

This metamorphic and granitic basement forms a relatively impermeable boundary for the groundwater basin. The granitic and metamorphic rock slope gently southwest from the outcrops found in the Sierra Nevada to depths greater than 15,000 feet in the Central Valley (Page, 1986).

## 2.2.4 Faults and Structural Features

Sediments in the SASb do not contain any regional-scale folds or faults (DWR, 1974).

## 2.2.5 Basin Boundaries

### 2.2.5.1 Lateral Boundaries

DWR defined the boundaries for the SASb in the brief report “B118 Basin Boundary Description 2016 – 5\_021\_65 South American Subbasin” (DWR, 2020). This report describes the subbasin boundaries as seven boundary segments, and described with the following text:

The South American Subbasin is a portion of the Sacramento Valley Groundwater Basin located in the Northern Region of California. The northern boundary is the American River, beginning at its confluence with the Sacramento River, and extending northeasterly, upstream to the City of Folsom where the boundary becomes the geologic contact between sediments and fractured bedrock for a short distance further northeast. The eastern boundary is the geologic contact between sedimentary rock and fractured bedrock. The southern boundary extends southwesterly along the Cosumnes River to the confluence with the Mokelumne River and continues southwesterly to Dead Horse Cut (canal). The western boundary includes a short segment for Dead Horse Cut, Snodgrass Slough, and the Delta Cross Channel and then follows the Sacramento River north to its confluence with the American River. (DWR, 2020)

The seven segments described by DWR include five segments that are groundwater divides, one segment that is a boundary with impermeable bedrock, and one boundary segment identified by the political boundary between Yolo and Sacramento Counties, which is coincident with the Sacramento River. The types of basin and subbasin boundaries that DWR uses to establish groundwater basins and subbasins are described in 2003 Bulletin 118 update, Appendix H, and summarized below.

Bulletin 118 update 2003 defined a groundwater divide as:

A groundwater divide is generally considered a barrier to groundwater movement from one basin to another for practical purposes. Groundwater divides have noticeably divergent groundwater flow directions on either side of the divide. The location of the divide may change as water levels in either one of the basins change, making such a “divide” less useful. Such a boundary is often used for Subbasins. (DWR, 2003) In many areas, including the SASb, groundwater divides may provide only a limited barrier to groundwater movement. This barrier may be more pronounced for near-surface groundwater, where rivers and streams have more

influence, but may not substantially limit deeper interbasin flow as evidenced by the Aerojet plume migration into NASb and the flow of water between the SASb and CoSb.

An impermeable bedrock boundary is defined as: “Impermeable bedrock with lower water yielding capacity. These include consolidated rocks of continental and marine origin and crystalline/or metamorphic rock” (DWR, 2003).

### **2.2.5.2 Boundaries with Neighboring Basins**

Boundaries with neighboring subbasins are hydrologic divides as defined above, with a portion of the boundary with the Yolo Subbasin being defined as a political boundary matching the boundary between Yolo and Sacramento Counties which is coincident with the Sacramento River.

### **2.2.5.3 Bottom of the South American Subbasin**

The bottom of the SASb is the shallower of either the base of fresh water or the bottom of the Valley Springs Formation. The base of fresh water is considered the depth at which the specific conductivity of groundwater is 3,000 micromhos per centimeter, which corresponds to a total dissolved solids (TDS) concentration of approximately 2,000 mg/L (Berkstresser, 1973), and is approximately 1400 feet bgs in the central part of SASb.

## **2.2.6 Principal Aquifers and Aquitards**

The SASb is underlain by one principal aquifer, primarily composed of post-Eocene sedimentary deposits. Principal aquifers are defined in the GSP regulations as “aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems.” The aquifer system composing the principal aquifer in the SASb is typically divided into an upper zone and a lower zone. The upper zone is contained in Pleistocene to Quaternary-age sediments including the Modesto, Riverbank, and Laguna Formations, South Fork Gravels and Arroyo Seco Gravels. The lower zone is contained in Miocene to Pliocene-age volcanic sediments, including the Mehrten Formation and portions of the underlying Valley Springs and Ione Formations (DWR, 1974). These zones are partially separated by a discontinuous clay layer in the lower portion of the Laguna Formation that can act as a semi-confining layer for the lower zone of the aquifer (Sacramento Central Groundwater Authority [SCGA], 2012).

### **2.2.6.1 Upper Zone of the Primary Aquifer**

The upper zone of the primary aquifer in the SASb is unconfined that consists of alluvium that extends approximately 200 to 300 feet below the ground surface (SCGA, 2012; DWR, 2003). Quaternary deposits consist of flood basin deposits, dredge tailings, alluvium and stream channel deposits. Pliocene to Pleistocene-age deposits consists of compacted sand, silt and gravel that include the Modesto, Riverbank, Turlock Lake and Laguna Formations, Arroyo Seco Gravels and South Fork Gravels (DWR, 2004; Marchand and Allwardt, 1981). Permeable sand and gravel deposits are typically enclosed by less permeable silt and clay, resulting in a network of tabular water-bearing zones (DWR, 1974). The upper zone groundwater is typically of high quality and is often used for private domestic and/or irrigation wells in SASb (SCGA, 2012).

### 2.2.6.2 Lower Zone of the Primary Aquifer

The lower zone of the primary aquifer in the SASb primarily consists of volcanic deposits that include the Mehrten Formation and portions of the underlying Valley Springs and Lone formations (DWR, 1974; DWR, 2003). The Mehrten Formation is composed of units of andesitic sand, stream gravel, silt and clay interbedded with tuff-breccia. The andesitic sand and gravel unit is highly permeable and is capable of producing high yields, while the tuff-breccia units are relatively impermeable and act as confining layers. (DWR, 2004). The Valley Springs Formation contains varying amounts of rhyolite ash, vitreous tuff, quartz sand containing glass shards and ashy clays. The Lone Formation is composed of three distinct layers: quartz sandstone, white clay and blue to brown clay (DWR, 1974). The base of freshwater in the lower zone of the aquifer is at an average approximate depth of 1,400 feet below ground surface (bgs), as defined by TDS exceeding 2,000 mg/L. In areas where interference with domestic wells could occur, larger municipal supply wells often target the deeper black sand of the Mehrten Formation where high production rates can be achieved with minimal impacts to domestic wells screened in the upper zone of the aquifer (SCGA, 2012).

### 2.2.6.3 Hydraulic Conductivity

Hydraulic conductivity is defined as the “measure of the capacity for a rock or soil to transmit water” (DWR, 2003). Hydraulic conductivity within the SASb is variable in the principal aquifer, varying laterally, vertically, and among the two zones of the aquifer. In general, hydraulic conductivities are highest near the margins of the American and Sacramento Rivers, and are lowest near the margins of the Sierra Nevada foothills. In 1978, DWR, in coordination with the U.S. Geological Survey (USGS), mapped average hydraulic conductivity values in a nodal grid pattern throughout the Sacramento Valley, based on available drillers’ logs in sections of the Public Lands Survey System (PLSS) (DWR, 1978). Hydraulic conductivity values ranged from approximately 20 to 260 gallons per day per square foot (2.7 to 35 feet per day [ft/d]) at varying depths up to 550 feet bgs in the approximate SASb area. Average hydraulic conductivities were typically higher in wells assumed to be in the Modesto, Riverbank and Laguna Formation, and were variable in wells assumed to be in the Mehrten Formation. Lower hydraulic conductivities in the Mehrten Formation are observed in the relatively impermeable tuff-breccia units, while higher hydraulic conductivities are observed in the black sand units. (DWR, 1978).

**Table 2.3-1** shows the range and average hydraulic conductivity for each layer in the CoSANA model.

**Table 2.2-1: Estimated Hydraulic Conductivity (feet per day) for each CoSANA Model Layer**

<b>Layer</b>	<b>Minimum</b>	<b>Average</b>	<b>Maximum</b>
1 – Alluvium	2.1	34	108
2 – Laguna	2.2	26	87
3 – Mehrten	0.7	17	50
4 – Valley Springs	0.9	15	42
5 – lone	0.3	11	38

#### 2.2.6.4 Transmissivity

Transmissivity is defined as an aquifer’s “ability to transmit groundwater horizontally through its entire saturated thickness” and is “the product of hydraulic conductivity and aquifer thickness”. (DWR, 2003). In 1978, DWR, in coordination with USGS, mapped aquifer transmissivity in post-Eocene deposits for the Sacramento Valley using information from drillers’ logs in PLSS sections of the Sacramento Valley (DWR, 1978). Transmissivity values mapped in the SASb area ranged from 10,700 to 26,100 square feet per day. Transmissivity values were highest along the Sacramento River, decreasing toward the Sierra Nevada foothills (DWR, 1978).

**Table 2.2-2** shows the range and average transmissivity for each layer included in the CoSANA model.

**Table 2.2-2: Estimated Transmissivity (square feet per day) for each CoSANA Model Layer**

Layer	Minimum	Average	Maximum
1 – Alluvium	64	1,930	12,955
2 – Laguna	123	5,199	20,770
3 – Mehrten	204	11,303	69,562
4 – Valley Springs	27	2,578	14,984
5 – lone	0.2	599	3,736

#### 2.2.6.5 Specific Yield and Specific Storage

Specific yield is defined as the “ratio of the volume of water a rock or soil will yield by gravity drainage to the total volume of the rock or soil” (DWR, 2003). Specific yield is a measurement specific to unconfined aquifers, such as the upper zone of the primary aquifer in the SASb. USGS calculated a specific yield for the low plains south of the American River (from a depth of 20 to 200 feet bgs) of 0.07. Calculated specific yields range from 0.054 in flood plain deposits to 0.1 in stream channel deposits (Olmsted and Davis, 1961).

In 1978, DWR, in coordination with USGS, mapped storage coefficient values in post-Eocene deposits for the Sacramento Valley, based on drillers’ logs in PLSS sections of the Sacramento Valley (DWR, 1978). Storage coefficient values mapped in the approximate SASb area range from 0.07 to 0.1 (DWR, 1978).

**Table 2.2-3** and **Table 2.2-4** show the range and average specific yield and specific storage for each layer included in the CoSANA model. Storage coefficient is the product of specific storage and aquifer thickness.

**Table 2.2-3: Estimated Specific Yield (unitless) for each CoSANA Model Layer**

Layer	Minimum	Average	Maximum
1 – Alluvium	0.06	0.12	0.24
2 – Laguna	0.07	0.12	0.22
3 – Mehrten	0.07	0.12	0.20
4 – Valley Springs	0.07	0.12	0.21
5 – lone	0.07	0.10	0.20

**Table 2.2-4: Estimated Specific Storage (1/foot) for each CoSANA Model Layer**

Layer	Minimum	Average	Maximum
1 – Alluvium	0.000003	0.000039	0.000076
2 – Laguna	0.000002	0.000040	0.000070
3 – Mehrten	0.000002	0.000039	0.000073
4 – Valley Springs	0.000005	0.000038	0.000061
5 – Lone	0.000010	0.000050	0.000078

### 2.2.7 Natural Water Quality Characterization

According to the 2006 *Central Sacramento County Groundwater Management Plan*, water quality analyses in the aquifer underlying the SASb have generally shown that groundwater in the upper zone of the aquifer is of higher quality than water in the lower zone of the aquifer with the exception of arsenic detections in a few locations (SCGA, 2006). Water in the lower zone of the aquifer typically has higher concentrations of iron, manganese and TDS. At depths below approximately 1,400 feet bgs (variable throughout the subbasin), the TDS exceeds 2,000 mg/L, making the groundwater unsuitable for potable use and not part of the SASb.

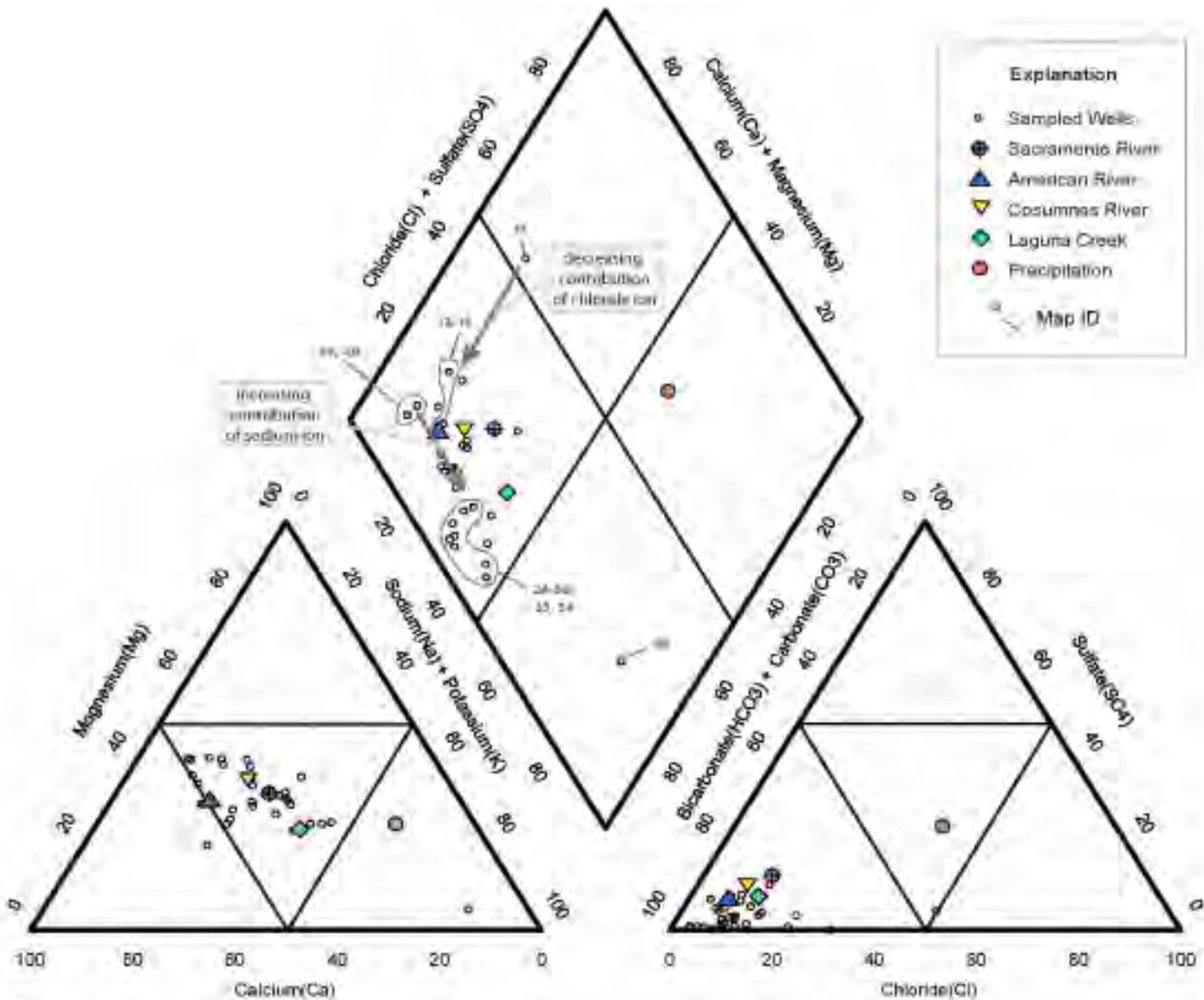
Iron concentrations in the potable region of the lower zone of the aquifer have ranged from less than 10 micrograms per liter ( $\mu\text{g/L}$ ) to 16,000  $\mu\text{g/L}$ , with the majority of wells having an average value of less than 200  $\mu\text{g/L}$ . Manganese concentrations in the potable region of the lower zone of the aquifer range from less than 2 to 1,700  $\mu\text{g/L}$  with the majority of wells having an average value of less than 50  $\mu\text{g/L}$ .

In 2015, RMC Water and Environment prepared the *Sacramento Central Groundwater Authority Recharge Mapping and Field Study Technical Memorandum* for the SCGA that included testing major-ion composition for samples from municipal, park irrigation and domestic water wells throughout the Central Sacramento Groundwater Basin. The test results show that anions were primarily dominated by bicarbonate, and cations were dominated by either calcium, magnesium or sodium. In general, ionic content is relatively low at wells located near the American and Sacramento Rivers. Samples collected more centrally within the study area and from near Laguna Creek show a relative increase in total ionic content (RMC Water and Environment, 2015).

Saline water is present at depths between 1,000 to 2,000 feet (varying throughout the aquifer). The saline water appears to originate from marine deposition as TDS concentrations range between 15,000 to 28,000 mg/L (sea water is typically 34,000 mg/l) and are dominated by a high concentration of sodium and chloride ions (RMC Water and Environment, 2015).

**Figure 2.2-40** shows a Piper diagram for select well chemical data throughout the SASb.

**Figure 2.2-41** shows the location of these select water wells and provides a Stiff diagram of the chemical data.



Surface water data sources (See Figure 2 for sample locations):

Sacramento River data- USGS sampling site Sacramento R A Freeport CA collected on 1/14/2015

American River data- USGS sampling site American R A Sacramento CA collected on 4/16/1998

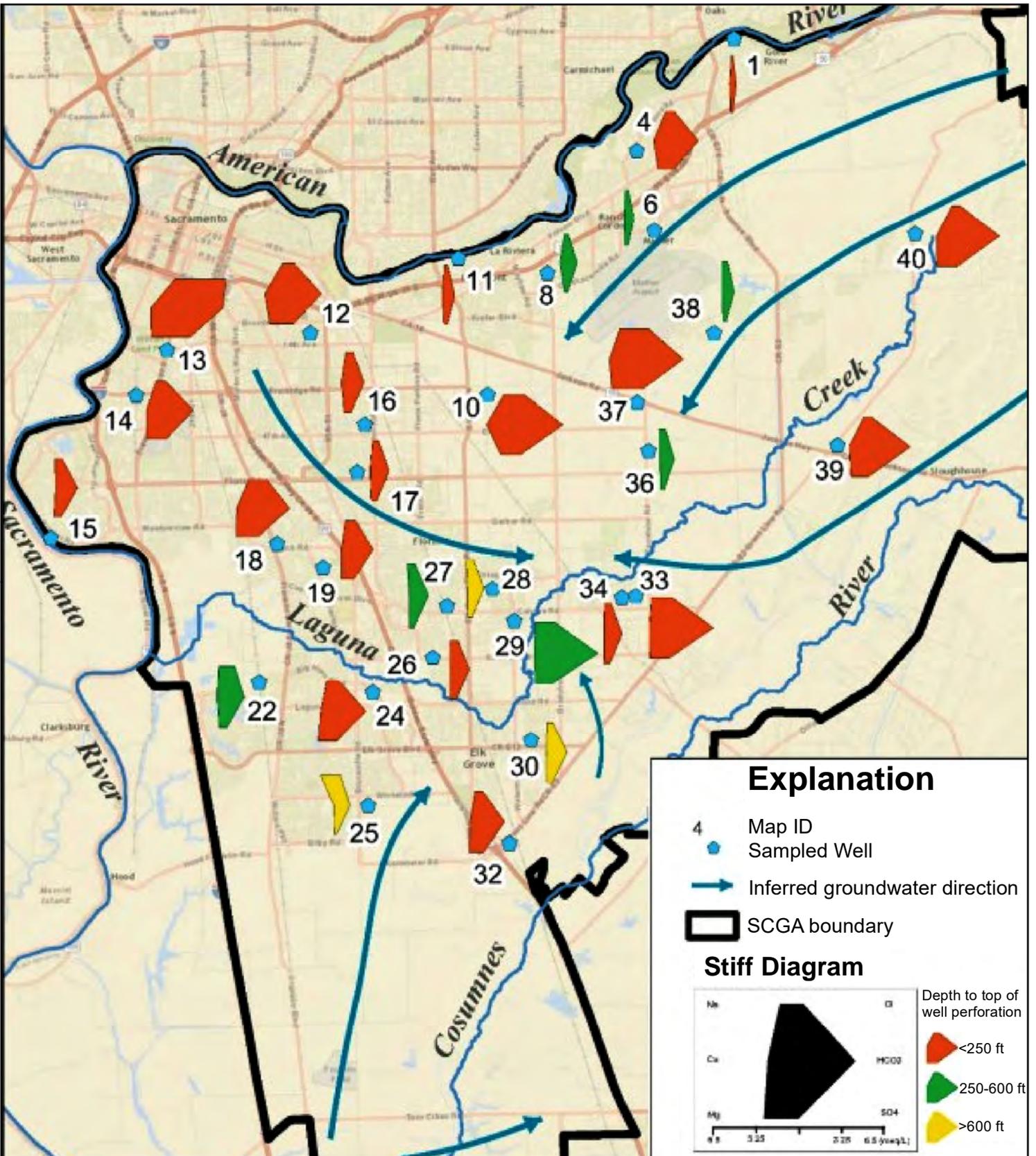
Cosumnes River data- USGS sampling site Cosumnes R A Michigan Bar collected on 10/30/2014

Laguna Creek data- Collected by GEI Consultants on 12/2/2012 just north of Highway 16.

Precipitation data source:

Average rainfall chemistry (1987-2002) for National Atmospheric Deposition Station CA 88 located in Davis California

**Figure 2.2-40: Piper Diagrams**



### Explanation

- 4 Map ID
- Sampled Well
- Inferred groundwater direction
- ▭ SCGA boundary

### Stiff Diagram

Ne	Ca	Depth to top of well perforation
Cu	MCOO	● <250 ft
Mg	SO4	● 250-600 ft
		● >600 ft

Scale: 0 1 5 Miles

**South American Subbasin GSP**

Well Location Map for Data on the Piper Diagram

Figure 2.2.41

Legend

- ▭ South American Subbasin

0 1 5 Miles

N

**South American SUBBASIN**

Project #: 0011575.00  
Map Created: October 2021

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## 2.2.8 Topography, Surface Water and Recharge

This section describes the topography, surface water, soils, and groundwater recharge potential in the SASb. Imported water supplies are not utilized by the SASb and is not discussed further.

### 2.2.8.1 Topography

The lowest elevations are along the southwest boundary, where the Sacramento River enters the Sacramento-San Joaquin Delta (Delta) at approximately sea level, while the highest point in the SASb is approximately 500 feet along the eastern margin of SASb. **Figure 2.2-42** shows the topographic characteristics of the SASb. Topography gradually flattens from the base of the Sierra Nevada foothills toward the western margin of the SASb along the Sacramento River.

### 2.2.8.2 Surface Water Bodies

Several surface water bodies are located in the SASb area, including the Sacramento, American, and Cosumnes Rivers, the Folsom South Canal and Lake Natoma, and the perennial stream tributaries. The rivers and streams in the southwesterly portions of the subbasin are affected by tides, including the Cosumnes River and Sacramento River. The surface water bodies are shown in **Figure 2.2-43** and described below:

- **Sacramento River** – The Sacramento River is located on the western margin of the SASb and flows from an elevation of approximately 10 feet to slightly above sea level from its northern inlet to the SASb to its southern outlet from the SASb. The Sacramento River is a perennial river and drains the Sacramento River Basin. Daily flows recorded at Freeport from 1948 to 2021 range from 4,000 cubic feet per second (cfs) in 1977 to 115,000 cfs in 1986. During high flow periods, a significant portion of flow from the Sacramento River Basin is diverted through the Yolo Bypass west of the Sacramento River and SASb.
- **American River** – The American River is located on the northern margin of the SASb and flows from an elevation of approximately 240 feet to 10 feet from its eastern inlet to the SASb near Folsom Dam to its outlet into the Sacramento River. The American River is a perennial river with recorded daily flows at Fair Oaks from 1904 to 2021. Since Folsom Dam was constructed in 1955, the lowest recorded flow was 215 cfs in 1977 and the highest recorded flow was 131,000 cfs in 1986.
- **Cosumnes River** – The Cosumnes River flows from an elevation of approximately 140 feet at its eastern inlet to the SASb from the Sierra Nevada foothills to approximately sea level as it drains into the Mokelumne River in the Delta. The Cosumnes River is a seasonal stream in the SASb, with recorded flows at Michigan Bar from 1907 to 2019. The lowest flow is zero when portions of the river are dry in most summers, and the highest recorded daily flow was 61,600 cfs in 1997.
- **Folsom South Canal** – Folsom South Canal is a 26.7-mile concrete lined canal that originates at Nimbus Dam on the American River and extends southward into the Cosumnes Subbasin at Clay, California. The canal has a bottom width of 34 feet and a maximum water depth of 17.8 feet. The Folsom South Canal has a capacity of 3,500 cfs. (USBR, 2006)

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### South American Subbasin GSP

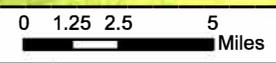
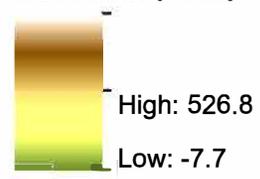
Topography

Figure 2.2-42

Legend

 South American Subbasin

#### Elevation within Subbasin (Feet)



South American SUBBASIN

Map Created: June 2020

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.



- **Lake Natoma** – Lake Natoma is located immediately downstream of Folsom Lake on the northeast side of the SASb. Lake Natoma is an afterbay that regulates flow releases to the American River from Folsom Lake. (USBR, 2005) Lake Natoma was created by the construction of Nimbus Dam in 1955, which is a concrete gravity dam structure measuring 87 feet in height and 1,093 feet in length. Eighteen radial gates, each 40 feet by 24 feet, control flows from Lake Natoma and has a capacity of 8,760 acre-feet and a surface area of 540 acres with an average water depth of 16 feet. (USBR, 2005)
- **Streams** – Laguna Creek and Morrison Creek are perennial streams that are tributary to the Sacramento River and Deer Creek is tributary to the Cosumnes River.

### 2.2.8.3 Surface Waters with Potential to Affect Groundwater Quality

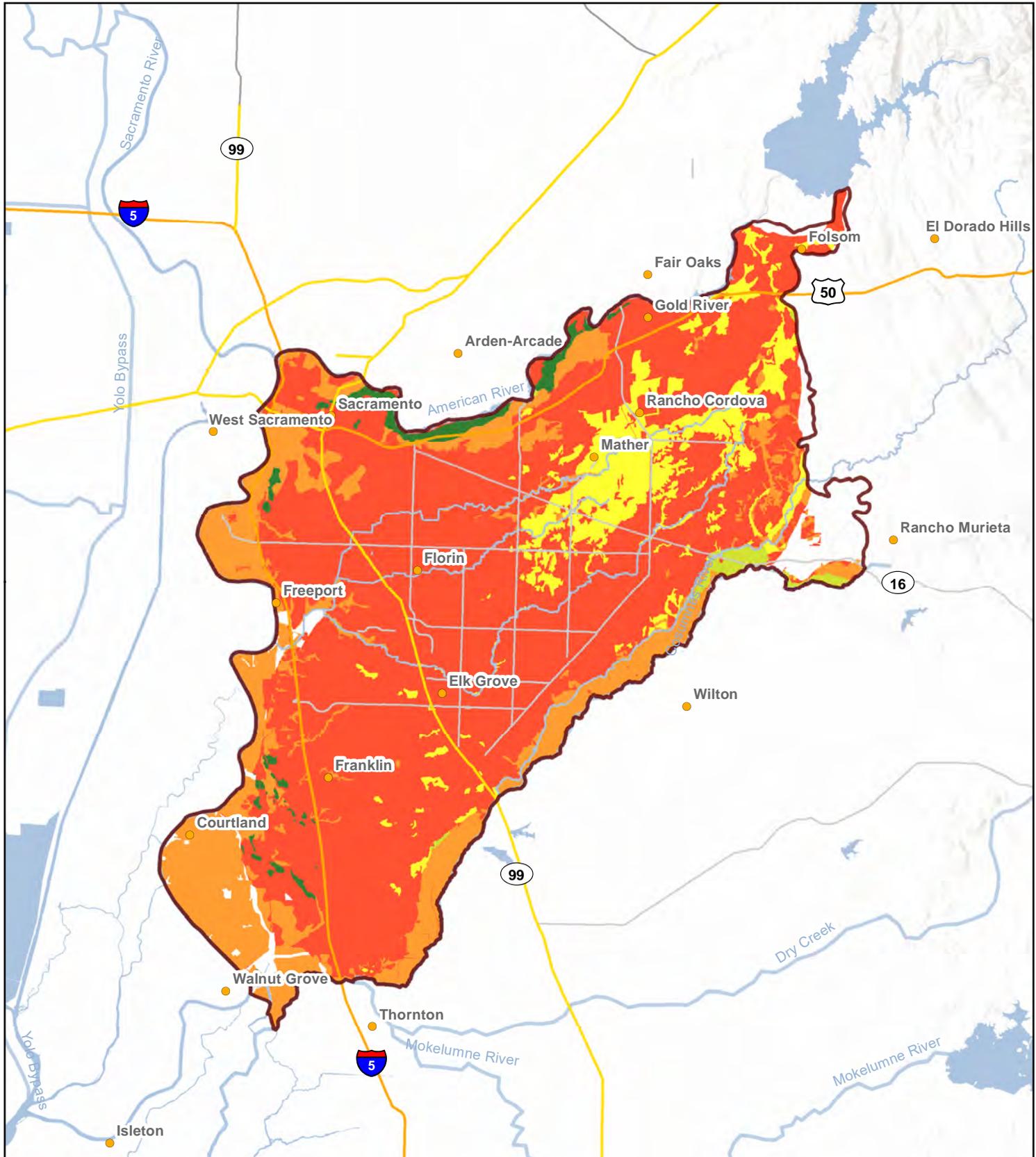
The Subbasin include portions that are located within the Legal Delta and are traversed by Delta waterways that experience tidal influences resulting from the connection to Suisun Bay, San Francisco Bay, and the Pacific Ocean to the west of the Subbasin. Although Delta waterways are tidally influenced, the water quality conditions in these waterways are generally dominated by freshwater outflows from the Sacramento River and San Joaquin River watersheds, as indicated by salinity conditions in these waterways. The historical volumes of freshwater surface outflows have maintained freshwater-dominated conditions in this part of the Subbasin since the 1950s. Any future potential for groundwater quality impacts from salinity intrusion leading to brackish surface waters in the Subbasin are likely more dependent on the surface water outflows conditions from the Sacramento River. Freshwater outflow through the Delta has historically maintained a fresh tidal zone in and adjacent to the Subbasin, although altered surface water flow regimes within the Delta, upstream changes in surface water flows, and/or changing sea level conditions could result in altered salinity conditions. Salinity intrusion tends to be persistent and requires significant freshwater outflows to improve conditions. Consequently, these changes in surface water conditions could affect groundwater directly through salinity intrusion.

### 2.2.8.4 Areas of Recharge, Potential Recharge, and Groundwater Discharge Areas

Areas of recharge and potential recharge are primarily located along the American River, the upper portion of the Cosumnes River (i.e., near the eastern SASb boundary), isolated areas near the Sacramento River and in the central to northeastern portion of the SASb.

**Figure 2.2-44** shows areas with potential for groundwater recharge, as identified by the Soil Agricultural Banking Index (SAGBI). SAGBI indexes the potential rate of groundwater recharge for agricultural lands by considering deep percolation, root zone residence time, topography, chemical limitations, and soil surface condition. While SAGBI is used to describe recharge conditions generally in the subbasin, it should be noted that alternative approaches to recharge may be able to allow for successful recharge efforts in areas noted a poorly suitable in SAGBI.

Analytical results discussed in the *Sacramento Central Groundwater Authority Recharge Mapping and Field Study Technical Memorandum* indicate the majority of recharge occurs in areas where soils are coarse (e.g., southwest of Folsom) and where there is extensive application of agricultural applied water (e.g., south of Elk Grove and between Grant Line Road and the Cosumnes River) (RMC Water and Environment, 2015). The study also indicates that recharge rates were lower from Elk Grove to the northwest, roughly between Morrison Creek and Grant Line Road. This area is largely suburban, rural residential, or undeveloped land on relatively low permeability soils (RMC Water and Environment, 2015)). According to the study, most recharge occurs from streams and rivers and a combination of rainfall and applied water.



**South American Subbasin GSP**  
**Recharge Areas**

Figure 2.2-44

*Legend*

- |   |   |
|---|---|
|  South American Subbasin |  Moderately Good (50-69) |
|  Very Poor (0-14)        |  Good (70-84)            |
|  Poor (15-29)            |  Excellent (85-100)      |
|  Moderately Poor (30-49) |   |

0 1.25 2.5 5 Miles



**South American SUBBASIN**

Project #: 0011575.00  
 Map Created: October 2021

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. **Data Sources:** CA Soil Resource Lab at UC Davis and UC Agriculture and Natural Resources.

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Several potential new recharge projects are currently being considered in the SASb and are described in **Section 4: Projects and Management Actions**.

Discharge from the SASb is from groundwater pumping and extraction and baseflow to streams and rivers. No current or historical springs or seeps are known within the SASb.

## Soils

Surface soils in SASb were mapped, described and categorized by the National Resources Conservation Service STATSGO2 Database. According to NRCS, the SASb is composed mostly of clayey, fine-loamy and sandy soil (NRCS STATSGO2, 2020). Clayey soils generally occur adjacent to the Sacramento River and south of Rancho Cordova to the Cosumnes River. Sandy soils generally occur adjacent to the Sacramento River and south of Folsom to Rancho Cordova. The remaining central portion of the SASb tends to consist of fine loamy soils.

**Figure 2.2-45** shows soils in the SASb by taxonomic soil groups. **Figure 2.2-46** shows soils in the SASb by hydrologic soil groups, which are sorted by permeability, with class A being the most permeable and class D being the least permeable. Most of the soils in the central portion of SASb have moderate to low permeabilities (listed as class C or D) with higher permeabilities (listed as class A or B) located near the American and Cosumnes Rivers, or for dredge tailings in the northeastern area of SASb, and in isolated areas near the Sacramento River. Permeability is generally poorest near the base of the Sierra Nevada foothills and in the flood basin areas of the Sacramento River.

### 2.2.9 Hydrogeologic Conceptual Model Data Gaps

Significant data gaps were not identified for the SASb that would create uncertainty that would affect the ability of the GSP to achieve sustainability by 2042. However, all hydrogeologic conceptual models are uncertain to a limited extent and can be improved with additional data. The following SASb HCM data gaps require additional information and will be updated with future monitoring, modeling, and data refinement efforts.

#### Aquifer Characteristics

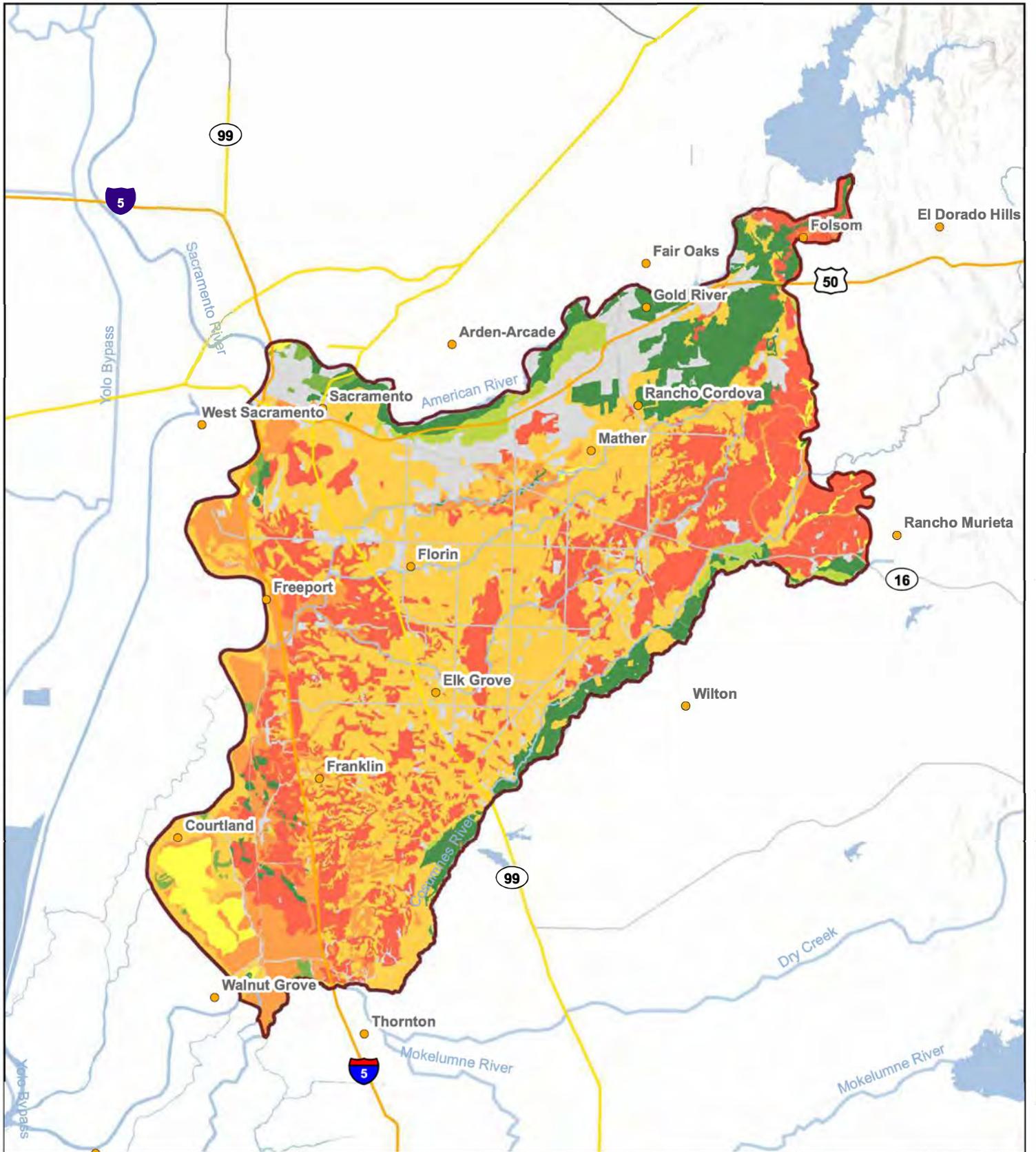
- Further definition of aquifer characteristics (e.g., hydraulic conductivity, transmissivity, and storage parameters) within and near Subbasin boundary areas, including aquifer tests.

#### Groundwater Level Data

- Depth- or zone-specific water levels to assess vertical interconnection, including zones within the principal aquifer.
- Additional shallow groundwater data near surface waters and natural communities commonly associated with groundwater (NCCAGs).
- 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.



Figure Exported: 6/29/2020 By: vdeamda Using: \\wcodandcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\011575.00 - SCGA GSP\G\_GIS\2\_MXD\Soils and Hydraulic Groups.mxd



<h3>South American GSP</h3> <h4>Hydrologic Soil Groups</h4> <p>Figure 2.2-46</p>	<p><b>Legend</b></p> <p>South American Subbasin</p> <p><b>Hydrologic Soil Group</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #4F81BD; border: 1px solid black; margin-right: 5px;"></span> A</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #70AD47; border: 1px solid black; margin-right: 5px;"></span> A/D</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #90C040; border: 1px solid black; margin-right: 5px;"></span> B</li> </ul>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #FFFF00; border: 1px solid black; margin-right: 5px;"></span> B/D</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #FFC000; border: 1px solid black; margin-right: 5px;"></span> C</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #FF8C00; border: 1px solid black; margin-right: 5px;"></span> C/D</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #FF0000; border: 1px solid black; margin-right: 5px;"></span> D</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #CCCCCC; border: 1px solid black; margin-right: 5px;"></span> Not Classified</li> </ul>	<p>0 1.25 2.5 5 Miles</p> <p><b>South American SUBBASIN</b></p> <p>Map Created: June 2020</p>
		<p><b>South American GSP</b></p> <p><b>Hydrologic Soil Groups</b></p> <p>Figure 2.2-46</p>	<p><b>Legend</b></p> <p>South American Subbasin</p> <p><b>Hydrologic Soil Group</b></p> <ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #4F81BD; border: 1px solid black; margin-right: 5px;"></span> A</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #70AD47; border: 1px solid black; margin-right: 5px;"></span> A/D</li> <li><span style="display: inline-block; width: 15px; height: 10px; background-color: #90C040; border: 1px solid black; margin-right: 5px;"></span> B</li> </ul>

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## Groundwater Quality Data

- Additional water quality monitoring at various depths will help inform the understanding of water quality. This can be achieved through installation of new monitoring wells, the use of other existing well and/or through determination of screened intervals of existing monitoring wells.
- Additional depth-specific water quality data will inform SMCs for degraded water quality.

## Subsurface Conditions

- Improved characterization of near-surface soil conditions as they relate to recharge.

## 2.3 Groundwater Conditions

This section provides a description of current and historical groundwater conditions in the South American Subbasin, organized by sustainability indicators. The current and historical groundwater conditions in the SASb are the result of a long history of changes in land and water use throughout the region, together with periods of wet, dry, and normal precipitation and streamflow conditions. An understanding of this historical context is important when considering the current and projected future groundwater conditions.

Groundwater has played an important role in domestic, agricultural, and urban water supply in the SASb since the early 1900s. Starting around 1890, the demand for irrigation water grew as large land grants were subdivided into 10- and 20-acre parcels for small farms. Coupled with the development of more advanced well drilling, well construction, and pumping techniques, the increasing irrigation demand resulted in increased groundwater pumping. By 1928, 28 percent of the irrigated land in the Subbasin was using groundwater, and the water table was reported to be in decline. The Great Depression of the 1930s slowed the spread of farming until the early 1940s. Shortly thereafter, the Carmichael, Citrus Heights, and Fair Oaks Irrigation Districts and the City of Sacramento began utilizing groundwater to meet increasing demands. During the rapid urbanization following World War II, several small water districts were formed. (DWR, 1974)

Since the mid-20<sup>th</sup> century, population has steadily increased in the area. Although including areas beyond the SASb, the Sacramento metropolitan statistical area population trends show a steady increase from around 276,000 in 1950 to a little more than 2,300,000 in 2020, highlighting the urban growth in the Subbasin (US Census Bureau, 1950, 2020). Much of this urban growth displaced irrigated agriculture (notably in the western and southern areas of the Subbasin) or undeveloped rangeland (notably in the northern and eastern areas of the Subbasin). The conversion from irrigated agriculture to urban development typically replaced shallow agricultural groundwater use with deeper municipal groundwater use or municipal surface water use. With some exceptions, urban growth occurred primarily with dependence on surface water in the City of Sacramento, City of Folsom, and Rancho Murieta, with groundwater primarily supplying water to the remaining growth areas.

In the mid-1980s, many urban land use agencies recognized that continued urban growth solely on groundwater would not be sustainable. As a result, Zone 40 of the Sacramento County Water Agency was formed to plan for and construct a regional water distribution system capable

of optimizing the use of available surface water in the wet years with the ability to turn to groundwater in the dry and critical years. This concept of conjunctive water management took advantage of the available sources of natural “in-lieu” recharge in the wet years to off-set higher than average groundwater pumping volumes in the dry years. Further, in order to enforce and maximize the conjunctive use potential within the SASb, Sacramento County General Plan land use policies established that new growth within unincorporated areas be conditioned upon perfecting supplemental water supplies. As a result, much of the impetus to begin importing surface water to the area south of the City of Sacramento between Interstate 5 and Highway 99 occurred in the mid-1990s. SCWA has made significant investments in water infrastructure, including the wheeling of treated surface water from the City of Sacramento’s Sacramento River Water Treatment Plant, the recycled water program by the Sacramento Regional Sanitation District, the joint East Bay Municipal Utility District/SCWA Freeport Intake and Pipeline to the Folsom South Canal, and the SCWA Vineyard Surface Water Treatment Plant to deliver potable water to the Zone 40 area including portions of the cities of Elk Grove and Rancho Cordova.

Urban growth in the Subbasin since the 1950s was substantially supported by military and industrial expansion in the area, including Mather Field and Aerojet facilities. These facilities served critical wartime and post-war functions but left a legacy of significant groundwater contamination currently being remediated to protect the water supply. Recent efforts have allowed for capture and re-use of some of this remediated groundwater.

Groundwater conditions reflect these growth patterns and shifts in water supplies, as well as the variable hydrology in the Subbasin and associated watersheds. The Subbasin has experienced many droughts and wet periods that are reflected in the groundwater conditions due to associated changes in recharge and groundwater use. The drought of 2012-2016 also caused significant urban conservation activities to occur, which lowered urban water demands across the Subbasin. Much of this water conservation behavior has persisted beyond the drought.

Drought and drought-planning has been driven by voluntary and state-mandated demand management in the region, which has steadily increased since the 1990s. State-mandated conservation, both through the Urban Water Management Plan process and during drought conditions, has contributed significantly to hardened demand in the region. While the hardened demand is lower due to conservation, it means that there is less ability to cut demand during periods of drought.

This section presents details on current and historical groundwater conditions to allow for a better understanding of the groundwater system. This understanding is necessary to help distinguish long-term trends associated with land and water uses and short-term trends associated with hydrologic conditions. In addition to providing details on conditions related to each of the sustainability indicators, a section is included to list data gaps that, if filled, would improve the understanding of groundwater conditions.

### 2.3.1 Groundwater Levels

Groundwater levels within the SASb have fluctuated within each year due to seasonal recharge and use variations; over a year or series of years due to short-term droughts and wet periods; and over decades due to changes in land and water use or longer-term hydrologic conditions.

Like most of California, groundwater levels in the SASb typically decline in summer and fall and increase in winter and spring. The summer and fall are periods of reduced natural recharge from precipitation and streamflow and also are periods of higher groundwater production to meet higher urban and agricultural demands during that period. Conversely, the winter and spring have higher recharge and lower groundwater production. The magnitude of seasonal fluctuation in groundwater levels depends on the connectivity of the aquifer with surface recharge sources; the volume and depth of groundwater production in the area; and aquifer characteristics.

The following subsections describe in greater detail how groundwater conditions have changed in the Subbasin in recent decades, including discussions of groundwater hydrographs, vertical gradients, and elevation contours, all of which were based on available groundwater level monitoring data.

### Groundwater Elevation Data Processing

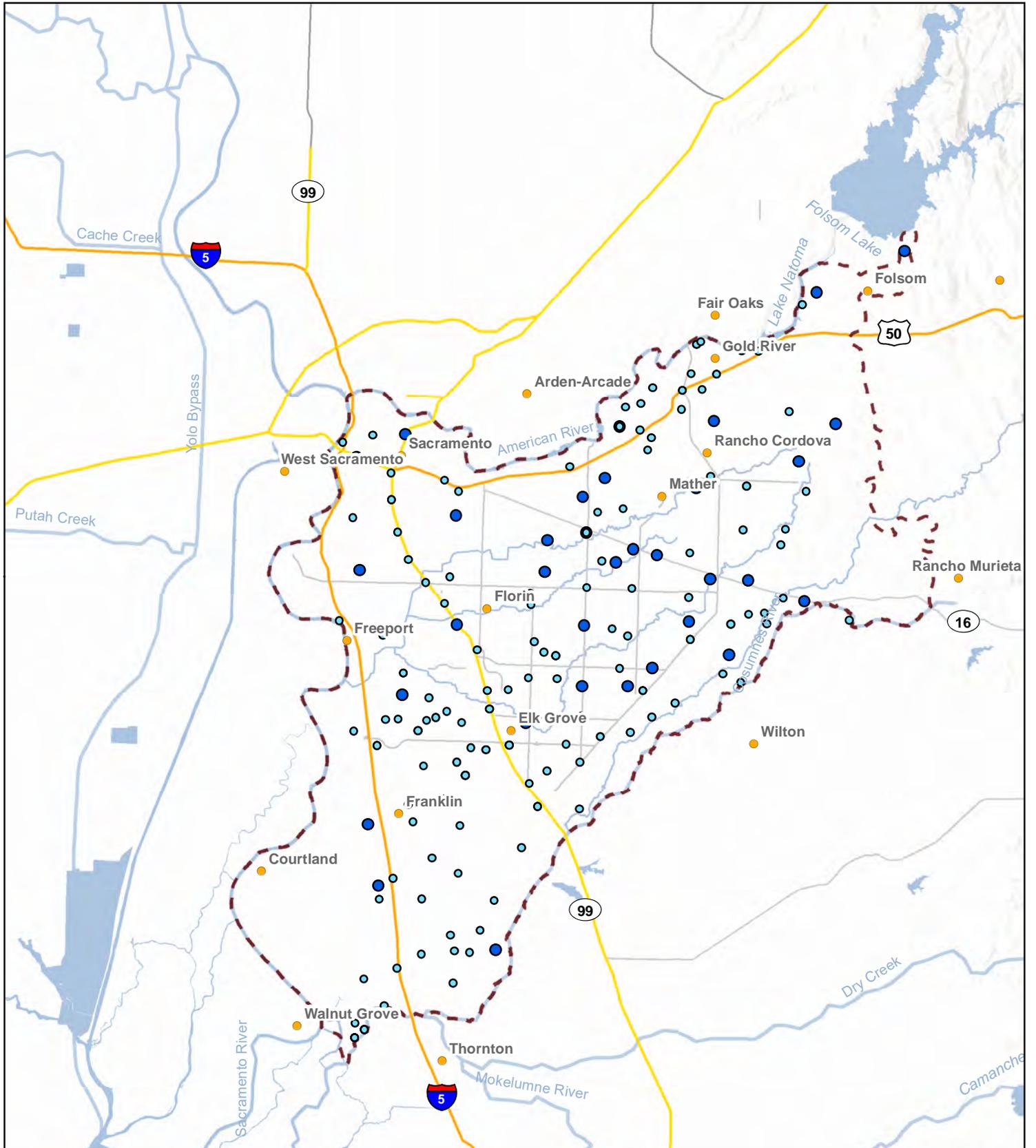
Groundwater well information and groundwater level monitoring data were compiled from six sources, including :

- USGS
- DWR
- University of California at Davis (UCD)
- The Nature Conservancy (TNC)
- Aerojet Rocketdyne
- Elk Grove Water District

Data provided by these sources included well information such as location, construction, owner, and elevation, and groundwater elevation data such as date measured, depth to water, groundwater elevation, data quality codes, and comments. At the time of this analysis, groundwater elevation data were available from 1929 to September 2020<sup>2</sup>. Within this timeframe, many wells provide historical monitoring data but no recent measurements, and a smaller number of wells with monitoring data recorded for periods of greater than 50 years. **Figure 2.3-1** through **Figure 2.3-2** show well locations with available monitoring data and the entity that maintains monitoring records at each well. These figures also show if the monitoring well is currently being monitored (classified as having measurements between January 2018 and September 2020).

**Figure 2.3-1** shows the locations of well data received from the DWR database. Wells with data within the last three years, from January 2018 to 2020, are considered “active” monitoring wells for this analysis. Roughly one third of the wells from DWR’s database contain monitoring data from 2018 to 2020. Wells in DWR’s database are generally concentrated within the topographically flat western two-thirds of the Subbasin. Fewer wells are located in the hills of the eastern third of the Subbasin. Many wells in DWR’s database have been typically measured twice a year, with one measurement in the spring and one measurement in the fall. Some of these wells have been measured on a monthly or quarterly basis.

<sup>2</sup> The analysis shown in this section was performed in the fall of 2020 and does not reflect data that may have been collected after September 2020. In addition, the analysis reflects the available data as provided by each entity.



# South American Subbasin GSP

Wells with Monitoring Data Provided by the DWR

Figure 2.3-1

Legend

- South American Subbasin
- DWR Wells Last Measured in 2018 to 2020
- DWR Wells Last Measured in 2017 or Earlier

0 1.25 2.5 5 Miles



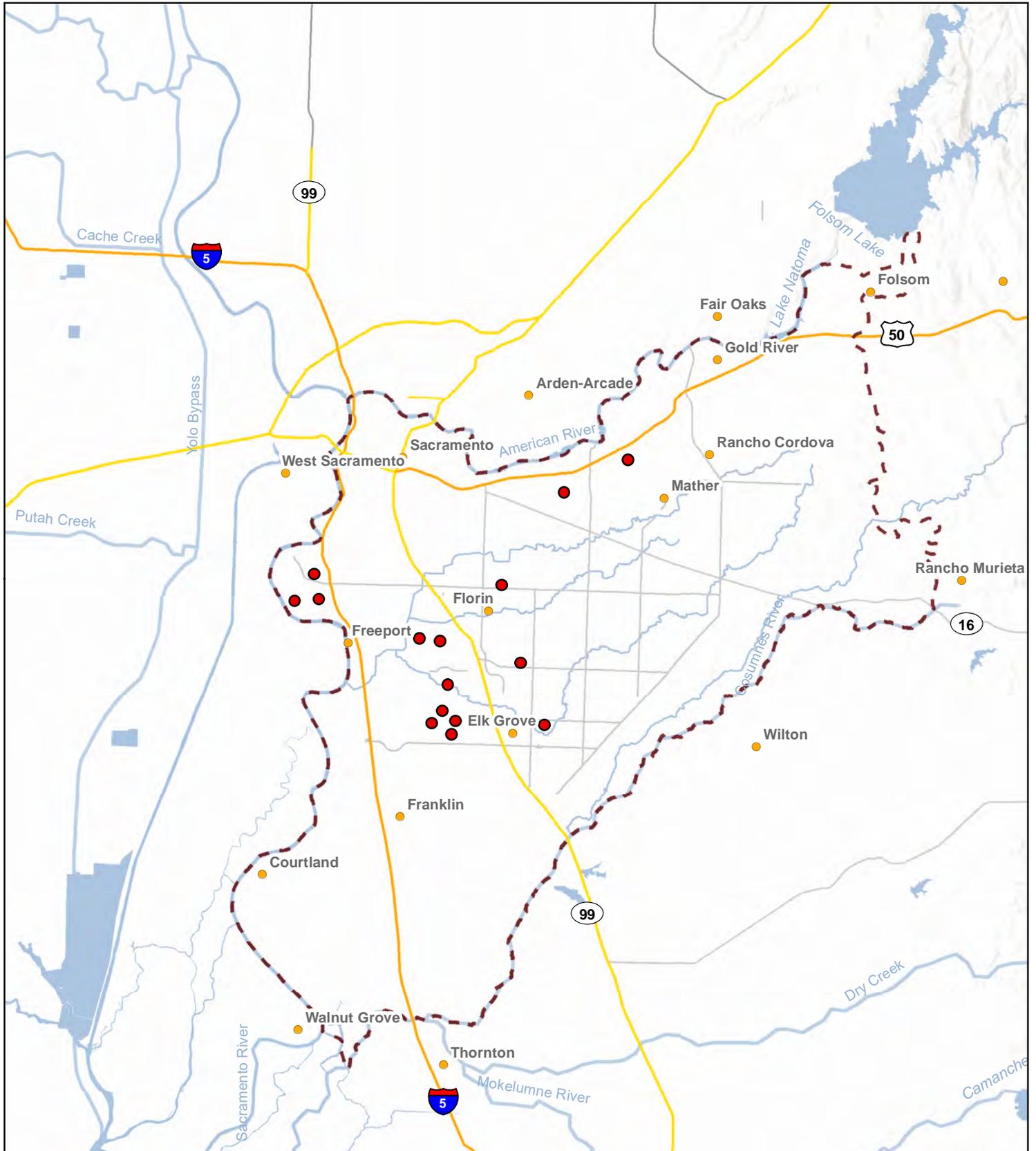
South American SUBBASIN

Map Created: December 2020

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Figure Exported: 1/4/2021, By: velsanda - Using: \\woodardandcurran.net\share\Projects\RMC\SAC0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G- GIS2\_MXD\DWRF\_Wells.mxd

Figure Exported: 1/4/2021, By: velsanda Using: \\woodardcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G- GIS2.MXD\USGS Wells.mxd

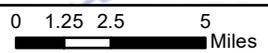


**South American Subbasin GSP**  
**Wells with Monitoring Data Provided by the USGS**

Figure 2.3-2

*Legend*

- South American Subbasin
- USGS Database Active Monitoring Well



**South American SUBBASIN**

Map Created: December 2020

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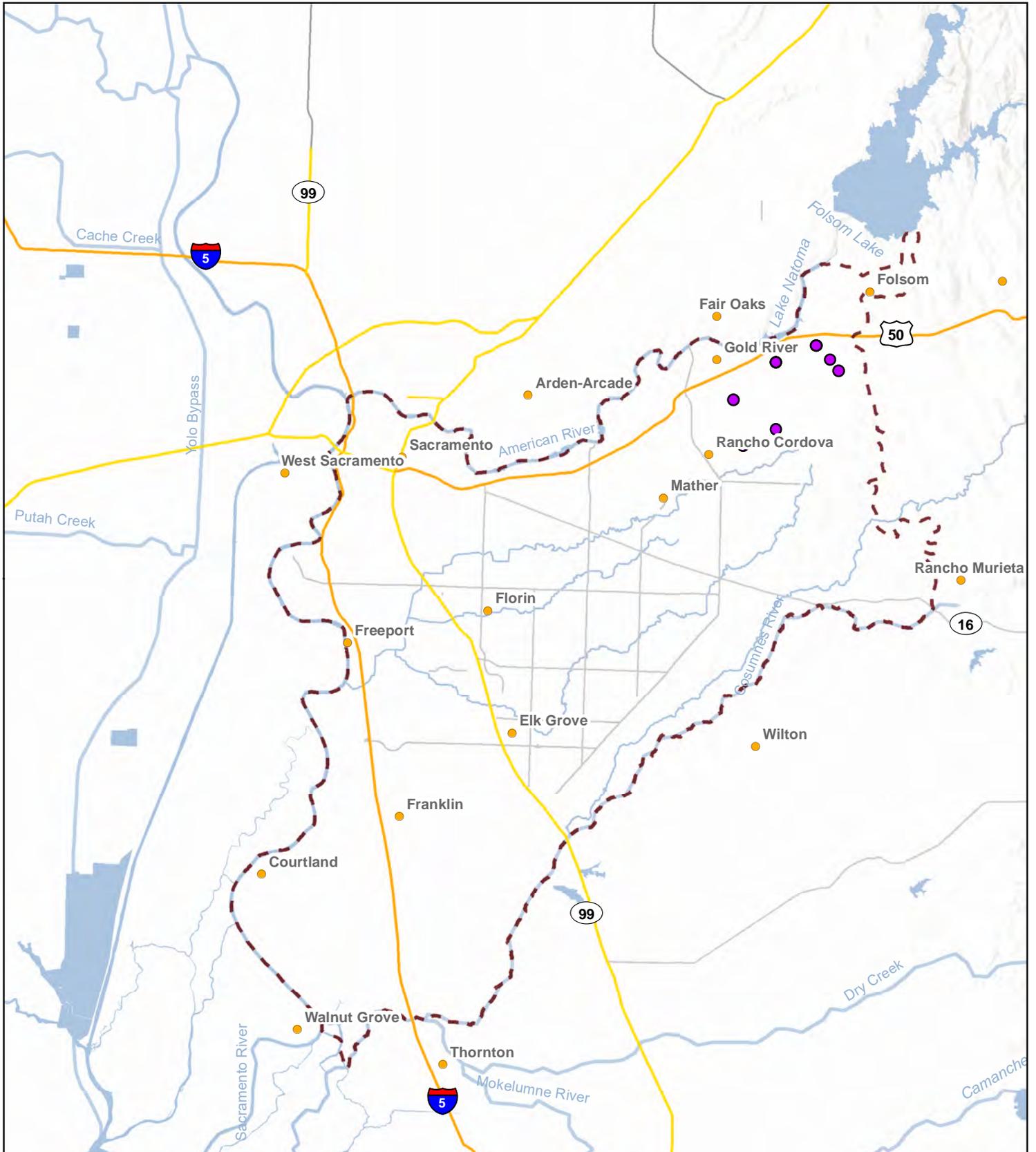


Figure Exported: 1/4/2021, By: velsanda - Using: \\woodardcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G- GIS2\_MXD\Aerojet\_Wells.mxd

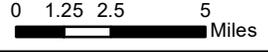
### South American Subbasin GSP

Wells with Monitoring Data Provided by Aerojet Rocketdyne

Figure 2.3-4

Legend

- South American Subbasin
- Aerojet Rocketdyne Provided Monitoring Well



**South American SUBBASIN**

Map Created: December 2020

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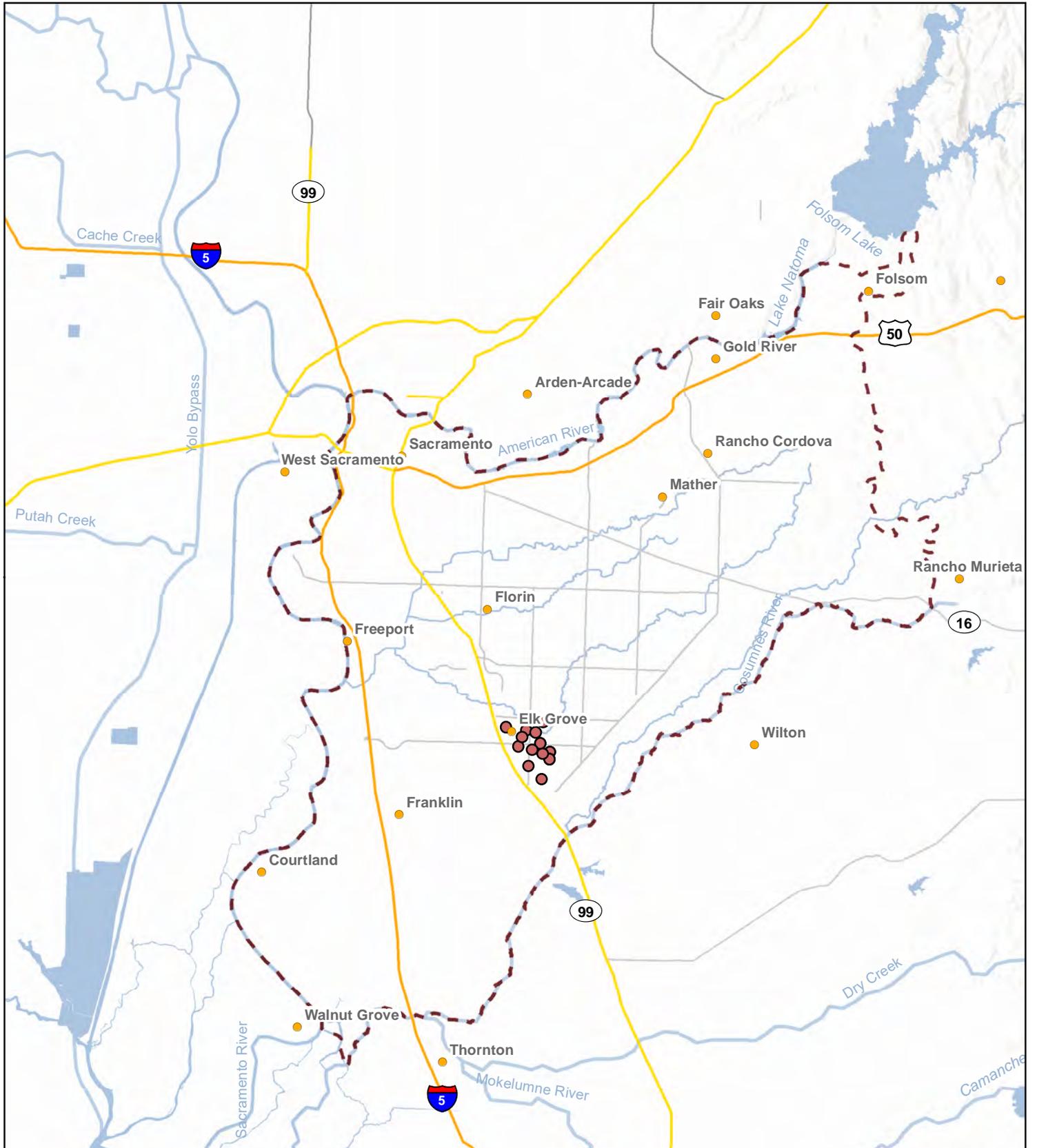


Figure Exported: 1/4/2021, By: vdeanda - Using: \\woodardcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G- GIS2\_MXD\EGWD\_Wells.mxd

**South American Subbasin GSP**  
**Wells with Monitoring Data Provided by EGWD**

Figure 2.3-5

*Legend*

- South American Subbasin
- EGWD Monitoring Wells

0 1.25 2.5 5 Miles



South American  
**SUBBASIN**

Map Created: December 2020

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 2.3-2** shows the locations of active monitoring well data received from the USGS database. Some of these wells are duplicative of wells contained in the DWR database. All active monitoring wells from the USGS were monitored at least once since 2018. The majority of the USGS wells are located on the western portion of the Subbasin, west of Highway 99. A small number of monitoring wells are located in the central portion of the Subbasin between Florin and Mather. Many of the wells in the USGS database have been typically measured twice a year, with one measurement in the spring and one measurement in the fall.

**Figure 2.3-3** shows the locations of well data received from UCD and TNC. All of the wells provided by UCD and TNC were monitored in 2018 - 2020. The wells monitored by UCD and TNC include those that are located along the Cosumnes River in the southern and central portions of the Subbasin where measurement data are collected and recorded continuously by pressure transducers and data loggers.

**Figure 2.3-4** shows the locations of well data received from Aerojet Rocketdyne. All of the wells from Aerojet Rocketdyne were monitored in 2018-2020 and are located in the northeastern portion of the Subbasin between Rancho Cordova and Folsom. Data collected in many of these wells are typically measured twice a year with one measurement in the spring and one measurement in the fall. However, some wells are measured (or have historically been measured) on a quarterly basis.

**Figure 2.3-5** shows the locations of well data received from Elk Grove Water District (EGWD), which are monitored on a quarterly basis, and most have data from 2012 to 2020. These wells are located in the south-central part of the Subbasin. The wells are generally screened at one of two different depth intervals, which provides useful data in understanding variability of groundwater levels with depth.

### **Groundwater Hydrographs**

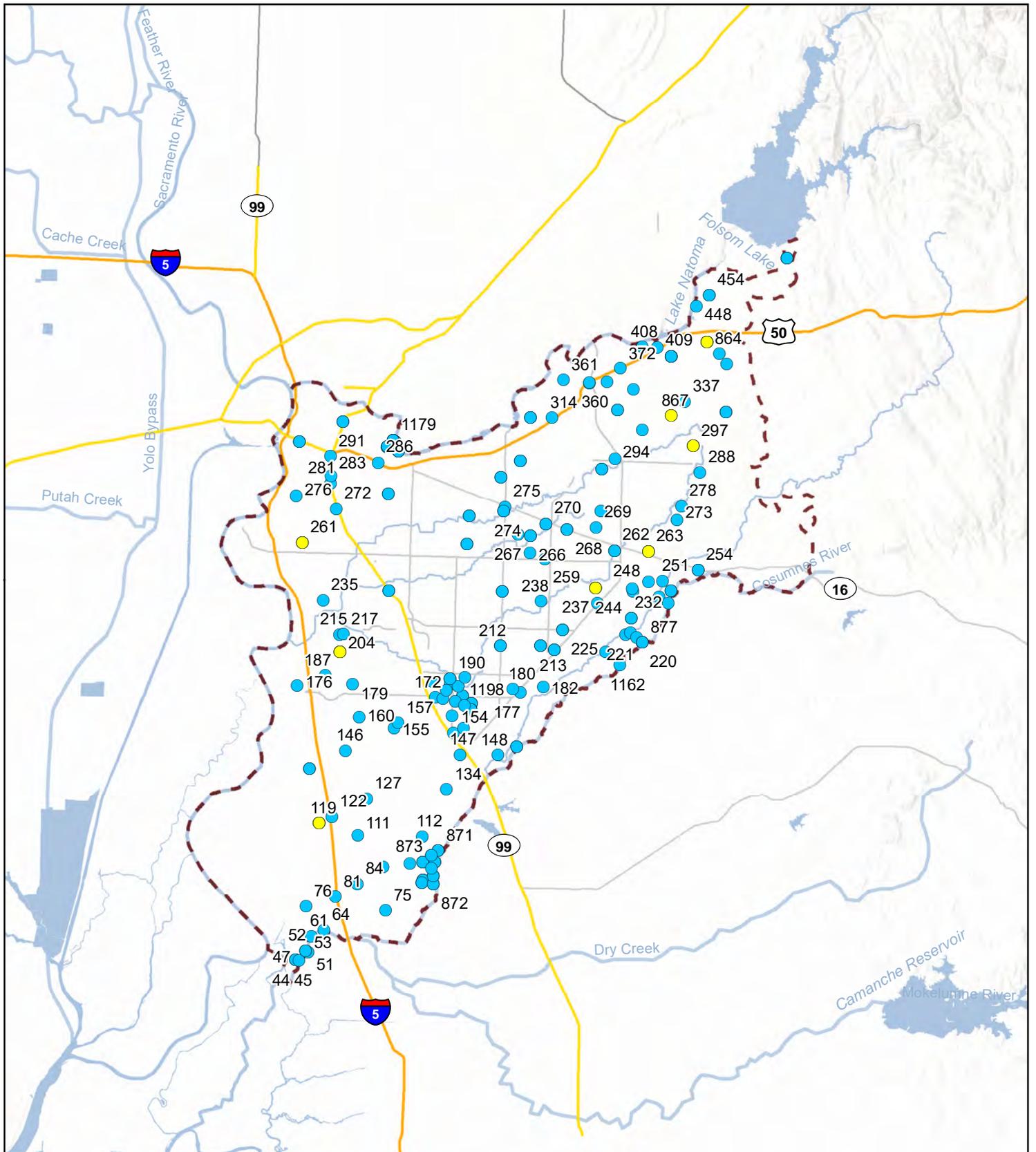
Groundwater hydrographs, i.e., charts of groundwater levels over time at a particular well or set of wells, were developed to identify groundwater trends throughout the Subbasin. Measurements from each well with historical monitoring data were compiled into one hydrograph for each well. Hydrographs for all wells, showing data from 1970 to 2020, are presented in **Appendix 2-C**. Hydrographs for selected wells are provided below.

**Figure 2.3-6** shows the location of wells with measured groundwater levels since 2018 within the Subbasin. **Figure 2.3-7** to **Figure 2.3-14** show hydrographs of groundwater levels from 1970 to 2020 in selected wells. These wells were selected because they broadly represent Subbasin conditions in their areas. **Table 2.3-1** provides details of the general location of the wells, depth of the wells, and the associated aquifer zone.

**Table 2.3-1: Selected Wells Providing Representative Data Across the Basin**

General Area	Well Number	Well Depth (feet)	Zone of the Principal Aquifer
Western Basin	119	125	Upper
	204	170	Upper
	261	172	Upper
Eastern Basin	297	675	Lower
	244	340	Lower
	263	130	Upper
	864	Unknown	Unknown
	867	Unknown	Unknown

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## South American Subbasin GSP

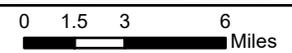
Wells with GWs Since 2018

Figure 2.3-6

Legend

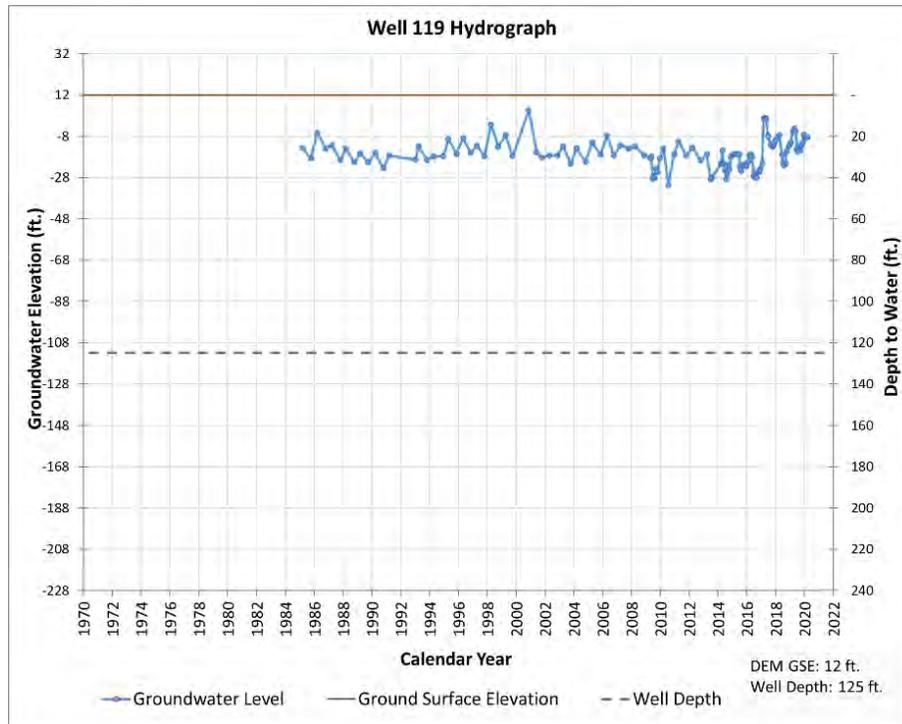
-  South American Subbasin
-  Wells with GWs since 2018
-  Example Wells

Note: Numbers next to each well correspond to the Well ID used in this GSP.

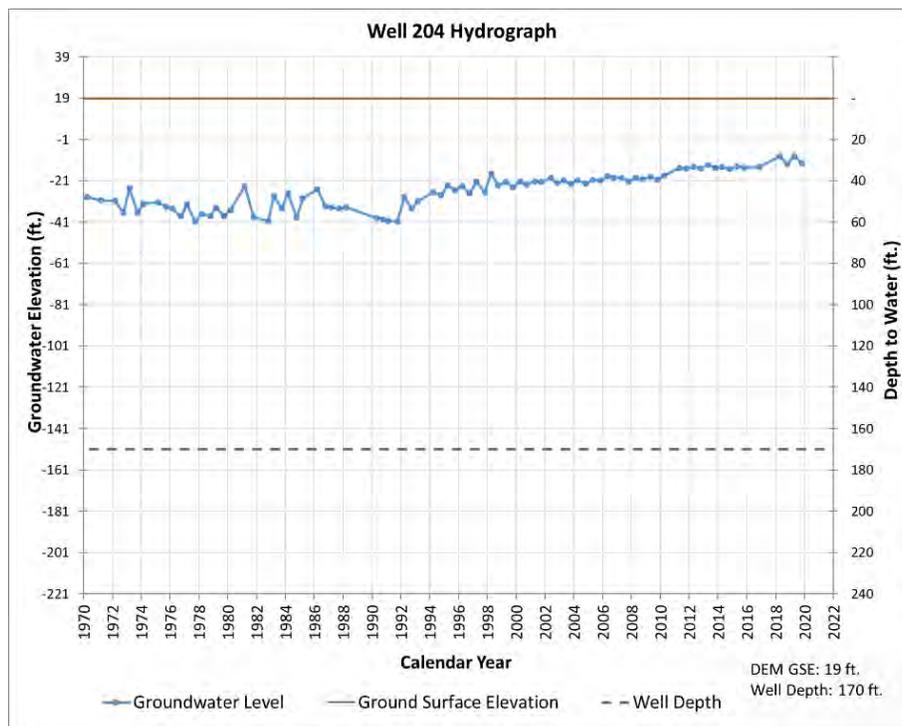


South American SUBBASIN

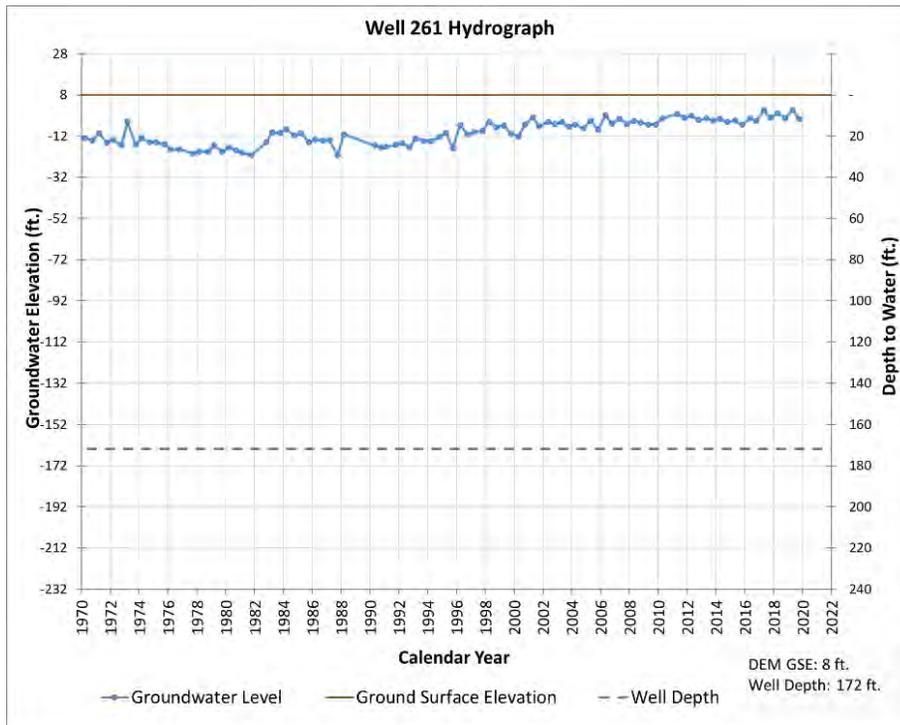
Map Created: Sept 2020



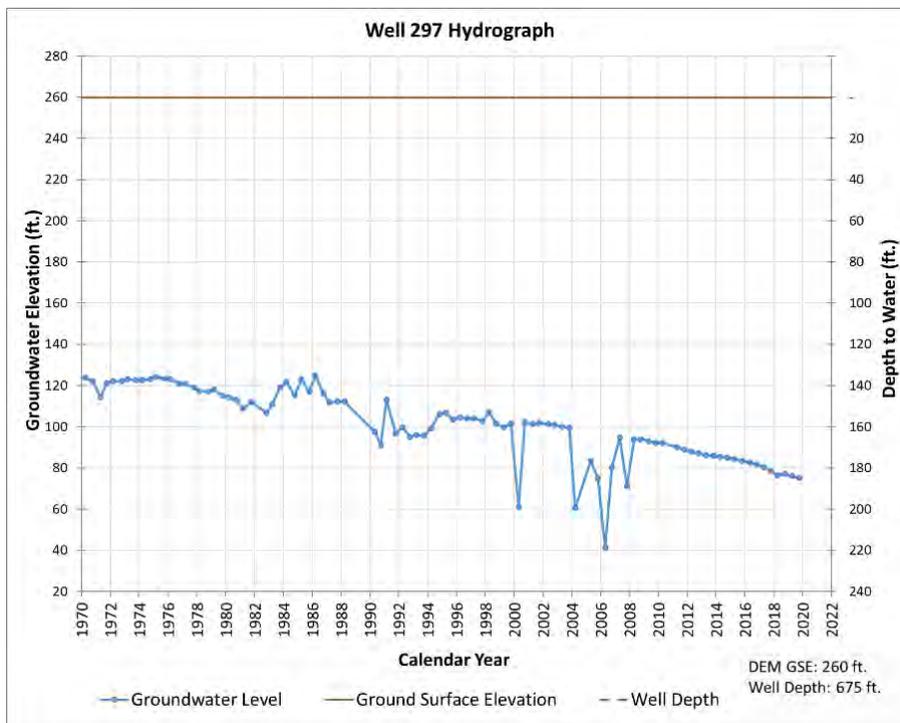
**Figure 2.3-7: Well 119 Hydrograph**



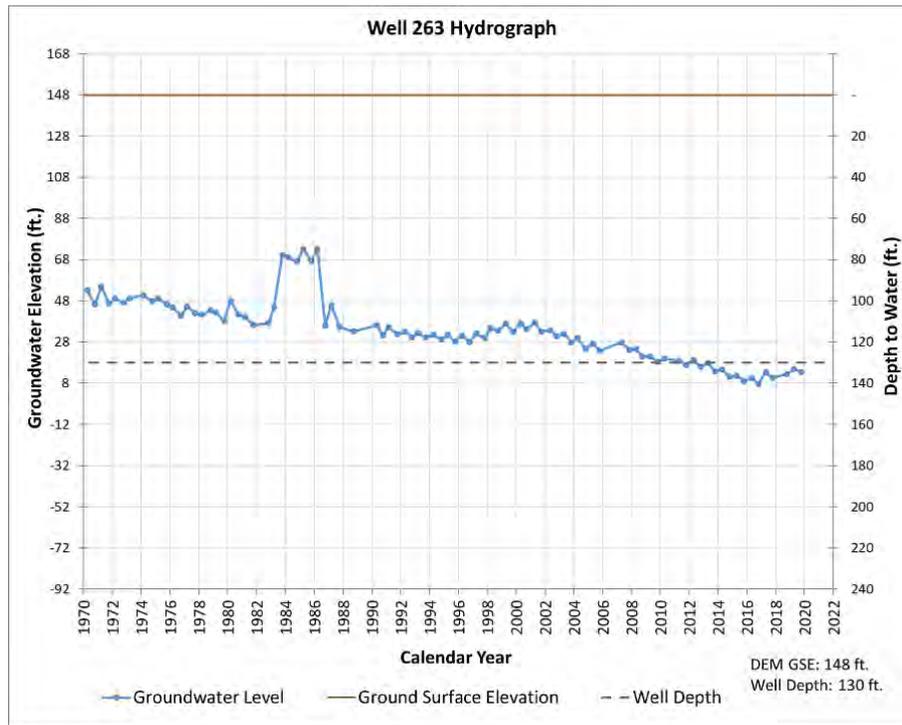
**Figure 2.3-8: Well 204 Hydrograph**



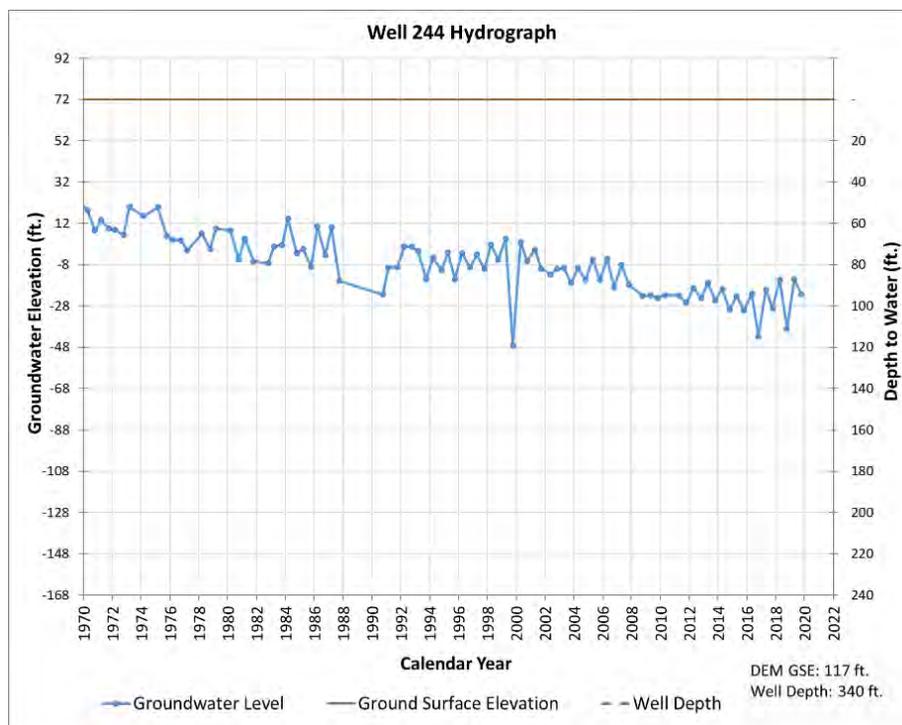
**Figure 2.3-9: Well 261 Hydrograph**



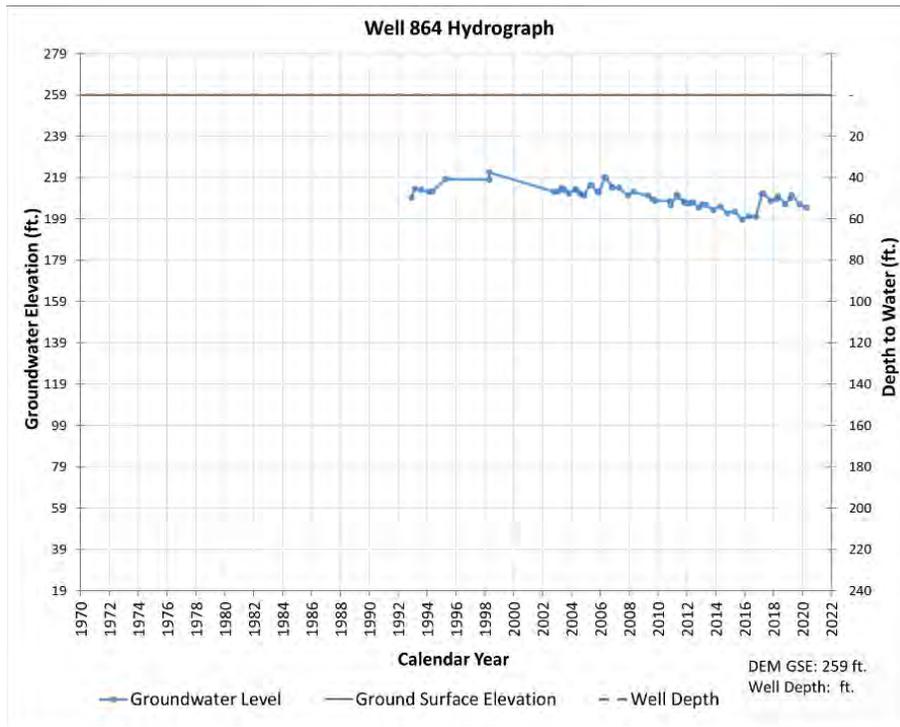
**Figure 2.3-10: Well 297 Hydrograph**



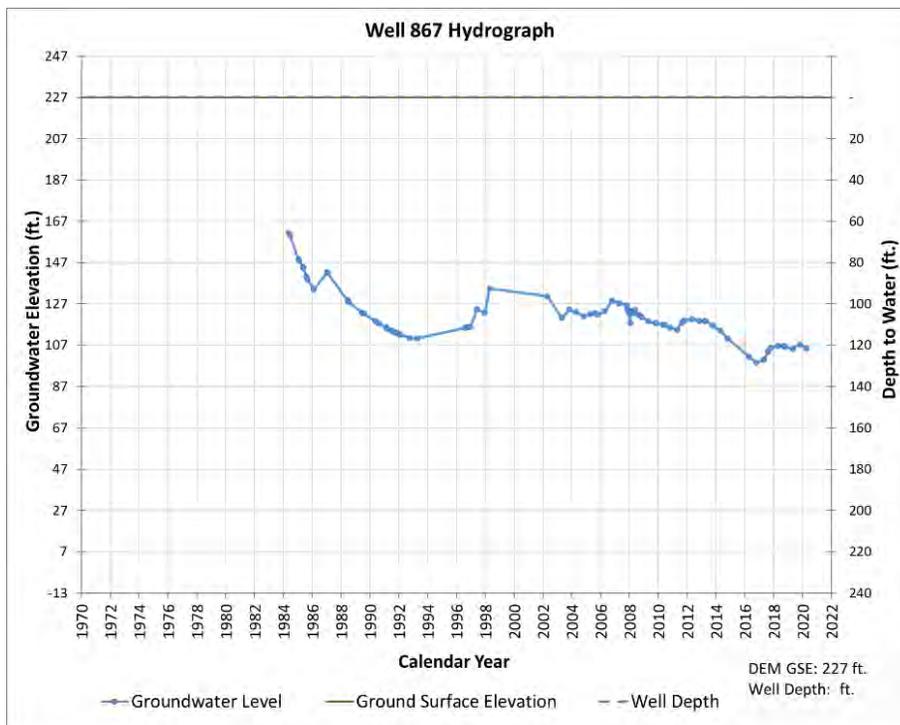
**Figure 2.3-11: Well 263 Hydrograph**



**Figure 2.3-12: Well 244 Hydrograph**



**Figure 2.3-13: Well 864 Hydrograph**



**Figure 2.3-14: Well 867 Hydrograph**

As previously described, changes in historical groundwater conditions have been influenced by climactic patterns in the Subbasin. Historical precipitation has been highly variable, with several relatively wet years and some multi-year droughts. In addition, groundwater pumping has varied significantly over the historical period as water demands and the availability of surface water have changed from year to year. These variations in water supply and water use over time have resulted in increasing and decreasing groundwater levels in the Subbasin at different points during the historical period between 1970 and 2020.

In general, across the Subbasin, groundwater levels decreased during the 1970s, which included the severe drought of 1977-1978, but then recovered during the wet period in the early 1980s, only to decrease again during the 1987-1992 drought. Overall, in the 1980s, groundwater levels were generally stable. Groundwater levels increased in the wet late 1990s, with the trend continuing into the variable 2000s and a wet start to the 2010s. Much of this recovery can be attributed to the increased use of surface water and implementation of urban demand management measures (i.e., conversion from flat rate to metered billing, education, and enforcement) in the SASb, and the fallowing of previously irrigated agricultural lands that transitioned into new urban development areas.

Note that historical monitoring in the Subbasin was more focused at shallower depths normally accessed by agricultural and private domestic users, with less monitoring at deeper depths often accessed for urban uses. Thus, improvements noted at shallower depths attributed to agricultural-to-urban conversion may be missing changes in less monitored deeper semi-confined zones of the aquifer. More information on this issue is presented in the data gap section.

Groundwater conditions also vary across different parts of the Subbasin. For example, many of the rivers and streams that flow along the boundaries or within the Subbasin are sources of groundwater recharge. Other zones are utilized for pumping for both domestic and agricultural uses, while some areas of the Subbasin have contamination plumes that require constant remediation pumping.

Wells in the western portion of the Subbasin show an overall increase in groundwater levels since 1970 to present. **Figure 2.3-7 to Figure 2.3-9** shows hydrographs of Wells 119, 204 and 261 in the western portion of the Subbasin near Interstate 5. Groundwater levels in these wells generally declined from 1970 to 1982 by approximately 10 feet, recovered approximately 10 feet during the wet period from 1982 to 1986, and then declined during the drought period from 1987 to 1992 by approximately 5 – 10 feet. All three wells have shown an increase in groundwater levels since then, with levels increasing by 20 – 25 feet in Wells 261 and 204 during this period.

Declining trends are seen in the eastern portions of the Subbasin. Wells 297, 263, and 244 (**Figure 2.3-10 to Figure 2.3-12**) are located generally along Laguna Creek from near Douglas Road to just south of Jackson Highway and show a relatively steady decline in groundwater levels of 40 feet over the 1970-2020 period. Wells 864 and 867 (**Figure 2.3-13 and Figure 2.3-14**), located generally south of Folsom, also show recent declines in groundwater levels, with a 10 -foot decline since the 1990s at Well 864 and a 40-foot decline since the 1980s at Well 867, with the bulk of the decline between 1984 and 1993. The causes of these declines are not well understood but could be attributed to remediation activities at Mather Field, the

Aerojet Superfund Site, and the Inactive Rancho Cordova Test Site together with an aquifer that becomes thin and low-yielding in this area.

## Vertical Gradients

As discussed in **Section 2.2**, the SASb has one principal aquifer composed primarily of post-Eocene sedimentary deposits. However, the principal aquifer is divided into upper and lower zones. The upper zone is contained in Pleistocene to Quaternary-age sediments including the Modesto, Riverbank, and Laguna Formations, South Fork Gravels and Arroyo Seco Gravels. The lower zone is contained in Miocene to Pliocene-age volcanic sediments including the Mehrten Formation and portions of the underlying Valley Springs and Lone Formations (DWR, 1974). These zones are partially separated by a discontinuous clay layer in the upper portion of the Mehrten Formation that can act as a semi-confining layer for the lower zone (SCGA, 2012). These two zones of the principal aquifer are important for determining vertical gradients.

A vertical gradient describes the vertical flow direction of groundwater perpendicular to the ground surface and is typically measured by comparing the elevations of groundwater in a well with multiple completions that are of different depths. If groundwater elevations in the shallower completions are higher than in the deeper completions, the gradient is identified as downward. If groundwater elevations in the shallower completions are lower than in the deeper completions, the gradient is identified as upward. If groundwater elevations are equal in both completions, a vertical gradient is not present. Note that a vertical gradient only indicates a potential for vertical groundwater flow. If a confining layer is present, flow will not occur between the zones.

Two types of wells can provide data to assess vertical gradients: multi-completion wells (also known as nested wells), and clustered wells. Multi-completion wells are constructed in the same borehole and contain multiple casings (typically two to four) with perforations at different depths that are isolated from each other by cement grout or by a bentonite layer. Clustered wells are typically two or more individual wells with perforations at different depths that are located close to one another.

In addition, the potentiometric map of two zones (shallow and deep) can be used to evaluate vertical gradients even if different wells (minimum 3 well per zone) were used to define the contours of the groundwater elevation.

Data on multiple completion monitoring wells are typically not readily available as they have generally been installed to support groundwater remediation efforts or to support operations of municipal water agencies. In both these cases, groundwater level data are generally not available on DWR's Water Data Library or other readily available datasets, although data may be available through various reports. Within the northeastern portion of the SASb, hundreds of multiple completion wells are thought to be present at the Aerojet, IRCTS, and Mather remediation sites. Further, SCWA is thought to maintain several multiple completion wells near its facilities. As the contaminated areas are of less interest to the regional potable water supply and as the SCWA data was not available at the time of writing, two multiple completion wells

with recent available measurement data, shown in **Figure 2.3-15**, were analyzed for vertical gradients. These wells are located in the central or eastern portion of the Subbasin.

**Figure 2.3-16** shows the combined hydrograph for the multi-completion wells designated as Wells 858 through 861, which were installed by Aerojet. Well 858 through 861 are four completions in a single borehole, each at different depths as follows:

- Well 858 is the shallowest completion with a screened interval from 67 to 72 feet bgs.
- Well 859 is the second deepest completion with a screened interval from 88 to 98 feet bgs.
- Well 860 is the third deepest completion with a screened interval from 124 to 134 feet bgs.
- Well 861 is the deepest completion with a screened interval from 155 to 165 feet bgs.

The hydrographs of the four completions show that groundwater elevations in the deepest completion are higher than those in the three shallower completions in the winter and spring, indicating a consistent, slight upward gradient from a depth of at least 155 to 165 feet bgs at this location.

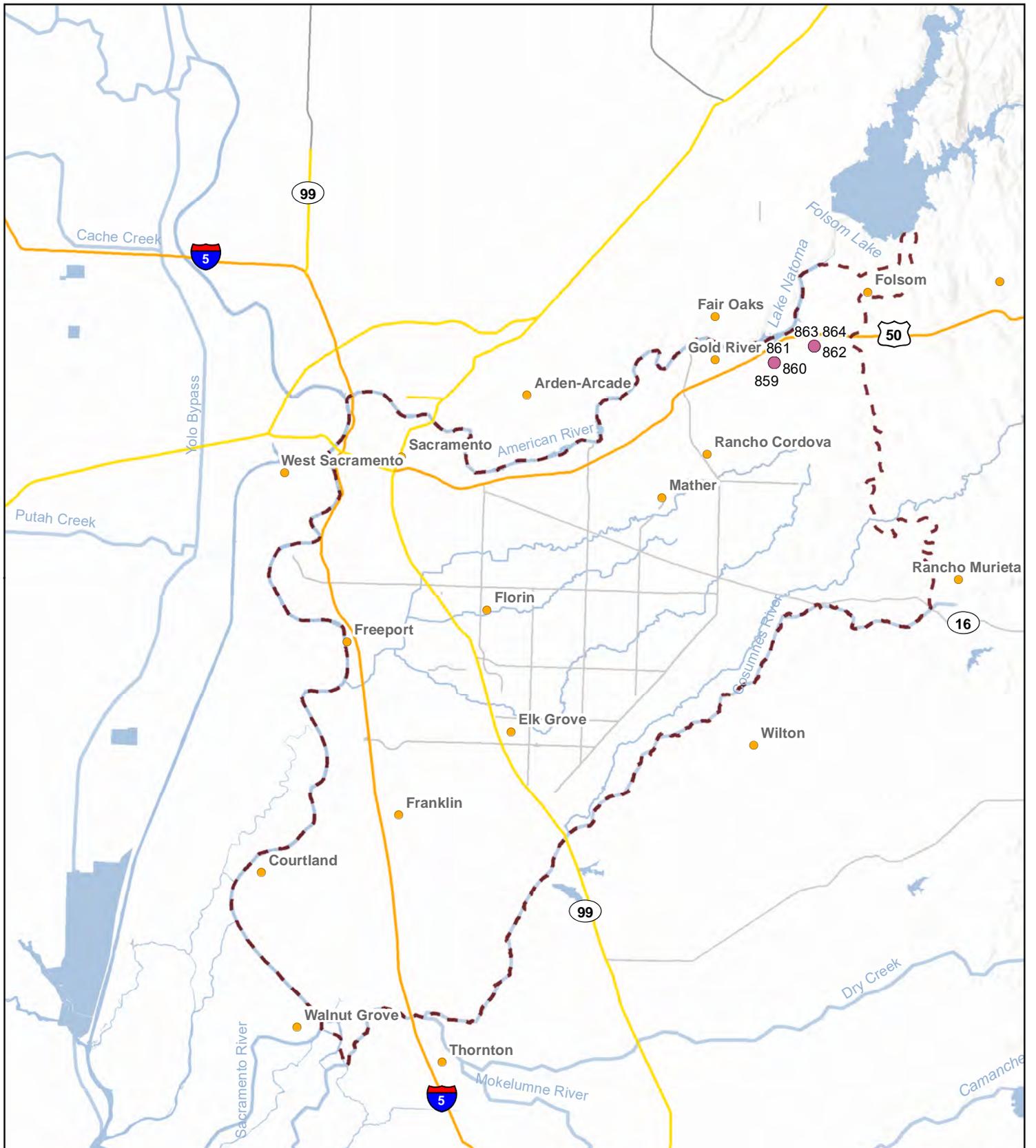
**Figure 2.3-17** shows the combined hydrograph for the multiple completion designated as Well 862 through 864, which were also installed by Aerojet. Wells 862 through 864 are three completions in a single borehole, each at different depths as follows:

- Well 862 is the shallowest completion with a screened interval from 43 to 64 feet bgs.
- Well 863 is the second deepest completion with a screened interval from 94 to 104 feet bgs.
- Well 864 is the deepest completion with a screened interval from 128 to 138 feet bgs.

The hydrographs of the three completions shows that groundwater elevations are nearly the same at each completion, thus not showing any significant vertical gradient at depths above 138 feet bgs at this location.

**Figure 2.3-19** shows the combined hydrograph for all the wells for which data was provided by EGWD. As shown in **Figure 2.3-5**, these wells are located close to each other in the vicinity of Elk Grove. Four wells (1185, 1191, 1192 and 1197) have depths between 400 and 600 feet and three wells (1187, 1195 and 1198) have depths between 1,000 and 1,200 feet. The groundwater elevations in the four shallower wells range from -20 feet to -40 feet, while the groundwater elevations in the deeper wells range from about -60 feet to -80 feet. An additional deeper well (1184) has perforations in both the upper and lower aquifer zones and therefore shows groundwater level depths in between the other groups of wells. These data suggest a downward gradient in the Elk Grove area, likely driven by newer urban production wells screened in the deeper aquifer. The preference for deeper screening is partially due to a desire to avoid conflicts with private domestic and agricultural wells, which are typically screened at shallower depths.

Figure Exported: 12/8/2020 By: kalmestad Using: \\woodardcurran\net\shared\Projects\RMCSAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA GSP\G- GIS2- MXD\SASb- Multiple Completion Wells.mxd



**South American Subbasin GSP**  
**Multiple Completion Wells**

Figure 2.3-15

*Legend*

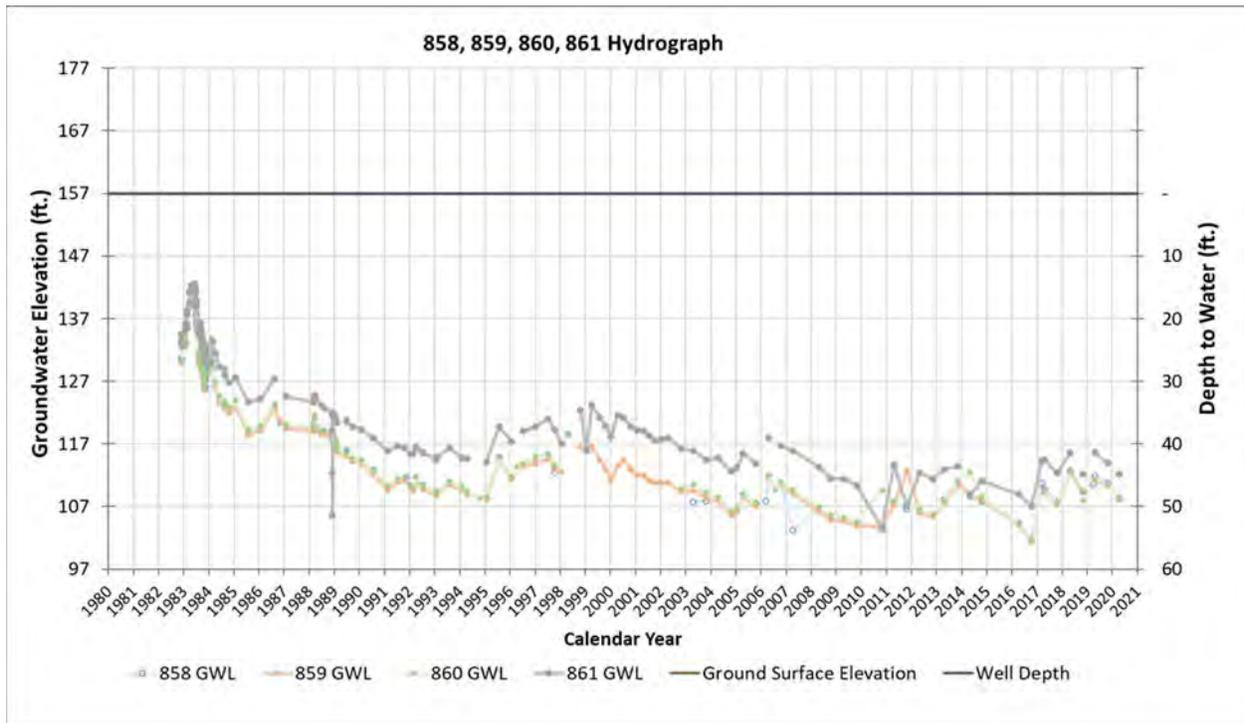
-  South American Subbasin
-  Multiple Completion Well

0 1.25 2.5 5 Miles

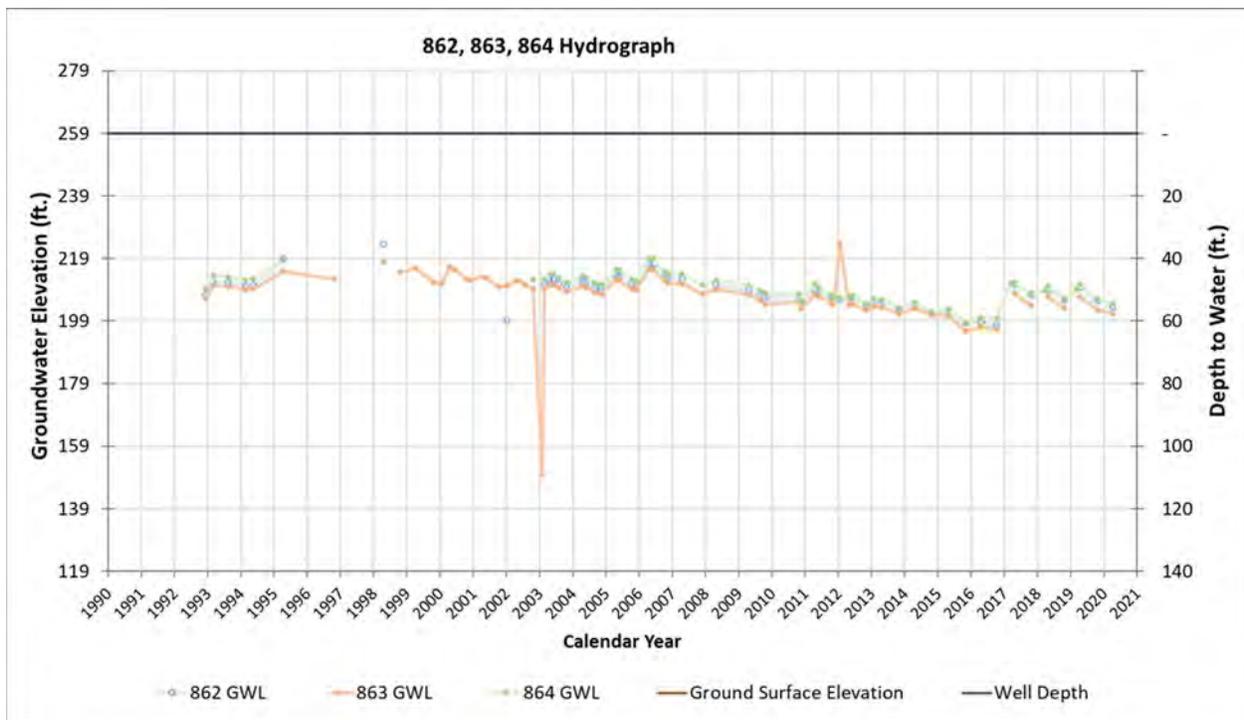
N



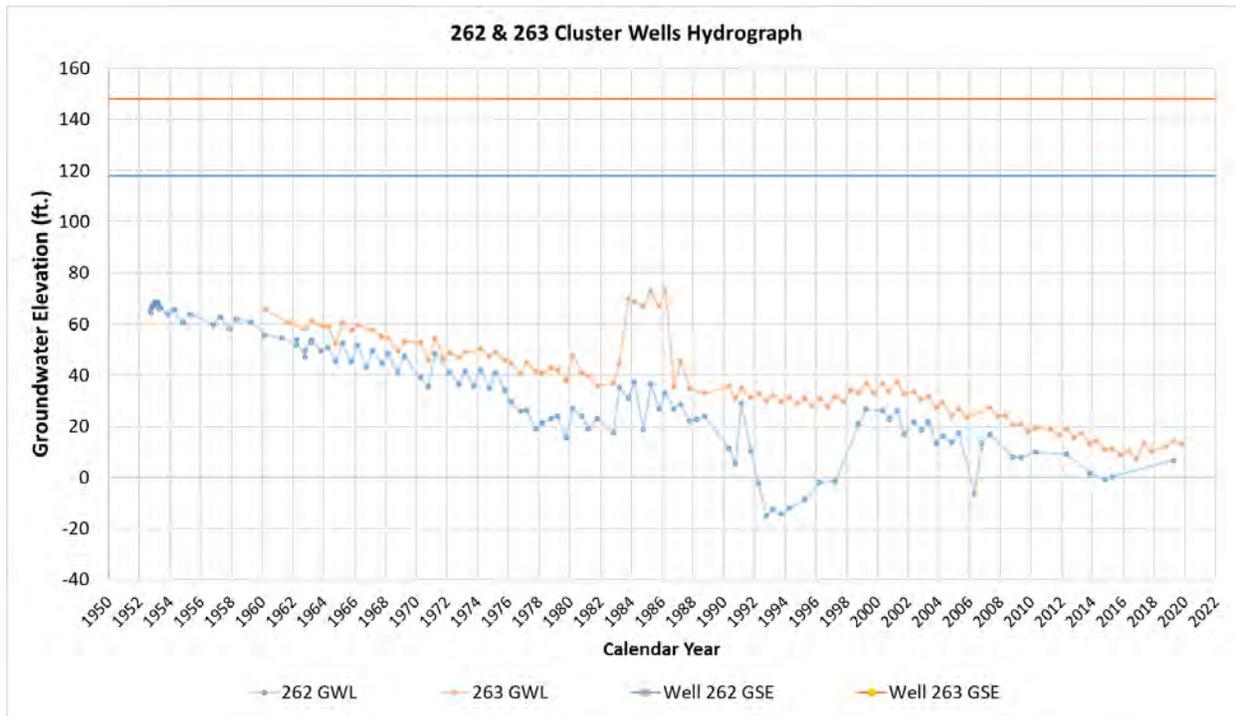
Project #: 0011575.00  
 Map Created: October 2021



**Figure 2.3-16: Wells 858, 859, 860 and 861 Hydrograph**



**Figure 2.3-17: Wells 862, 863 and 864 Hydrograph**



**Figure 2.3-18: EGWD Cluster Wells Hydrograph**

### Groundwater Contour Maps

Groundwater contour maps are presented to provide information on groundwater elevations across the Subbasin. A contour map shows this information by interpolating groundwater data between monitoring sites and plotting a contour line at locations of equal elevation. These elevation contours are then used to identify groundwater flow directions and to calculate the gradient of horizontal flow.

Groundwater elevation contour maps are shown for the following time periods:

- Fall 1977                      Critically dry water year (WY)
- Fall 1986                      Wet WY
- Fall 2005                      Wet WY
- Fall 2015                      Critically dry WY
- Spring 2019                  Wet WY
- Fall 2019                      Wet WY

These periods were selected for contours because they are representative of recent and historical conditions, and because they identify conditions near January 1, 2015, when SGMA came into effect.

In addition, seasonal fluctuations can be seen in the spring and fall maps for 2019, and depth to water contours are also provided for 2019.

These contours follow the same general format: 20-foot interval contour elevations shown with white numeric labels, and measurements at individual monitoring points shown with black numeric labels. The groundwater contours were also developed with a limited amount of available data so wells with various completions and depths within the principal aquifer were used to accumulate enough data points.

Note that available data differs between the contour maps and some variability between the maps can be attributed to these differences, while other components are due to actual changes in the groundwater system. Each map shows the wells with data used in the contouring for each map.

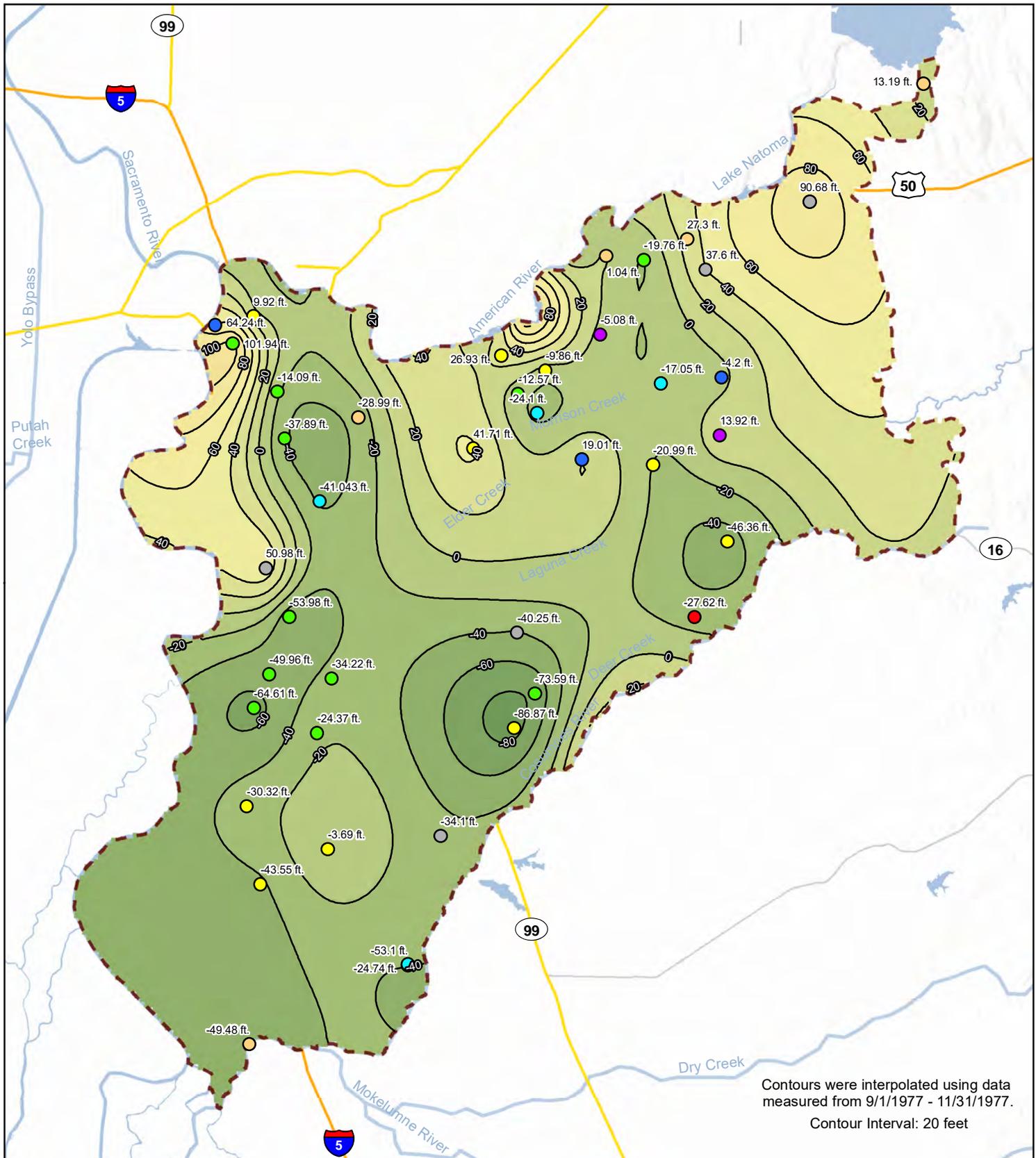
**Figure 2.3-19** shows groundwater elevation contours for Fall 1977, which represents conditions at the end of one of the worst droughts recorded in California's history. The index (0.84) for WY 1977 is the second lowest in the 120-year WY record. The groundwater flow direction in the Subbasin was generally westward from the eastern edge of the SASb toward the center of the SASb and from the west towards the center of the Subbasin. Several groundwater depressions were present in the central portion of the Subbasin. The deepest depression is located near Elk Grove, east of Highway 99, with groundwater levels as low as 87 feet below sea level. Groundwater generally flowed radially toward this groundwater depression.

**Figure 2.3-20** shows groundwater elevation contours for Fall 1986, which occurred at the end of an extended wet period which provided recharge to the Subbasin. While the flow directions are similar, the Elk Grove groundwater depression shifted location to the west side of Highway 99 and the elevation rose 17 feet to about 70 feet below sea level. Groundwater continued to flow radially toward the groundwater depression.

**Figure 2.3-21** shows groundwater elevation contours for Fall 2005. Similar to 1977 and 1986, groundwater flow in the Subbasin was generally westward from the eastern margin of the subbasin and from the western margin toward the groundwater depression at Elk Grove. The location of the depression shifted eastward to straddle Highway 99 and the lowest elevation rose to 55 feet below sea level. The groundwater depression is defined by the -40-foot contour which is located within a trough of low groundwater elevations (less than -20 feet) that traverses the subbasin north to south. As is consistent with a depression, groundwater generally flowed radially toward the depression.

**Figure 2.3-22** shows groundwater elevation contours for Fall 2015 at the peak of the recent drought. The WY index (0.81) for 2015 is the lowest on record. Again, the groundwater flow directions were generally from the eastern and western margins toward the Elk Grove groundwater depression. Horizontal gradients were steepest along the eastern margin and shallowest in the western portion of the Subbasin on the Sacramento Valley floor. The Elk Grove groundwater depression (-40-foot contour) has migrated to the west side of Highway 50 and is somewhat smaller with the lowest elevation at 43 feet below sea level. However, the -20-foot contour encompasses a much larger area that encroaches into the adjacent Cosumnes Subbasin to the south. Groundwater generally flowed radially toward the center of the depression, albeit with a lower gradient due to the smaller depression.

Note that the indicated reduction in this pumping depression may be impacted by a monitoring network that has more shallow wells than deep wells, and observed benefits accruing in the shallow zone may not necessarily be accruing in the deeper zone. The focused monitoring in the shallow zone is due to its importance for many users in the Subbasin, which led to a high



Contours were interpolated using data measured from 9/1/1977 - 11/31/1977.  
 Contour Interval: 20 feet

**South American Subbasin GSP**  
**Fall 1977 Groundwater Level Contours**  
 Figure 2.3-19

<b>Legend</b>	South American Subbasin	300 - 400
	Groundwater Elevation Contours	400 - 500
<b>Well Depth (feet)</b>	Unknown	500 - 600
	0 - 100	600 - 700
	100 - 200	
	200 - 300	
<p>NOTE: Numbers next to each well indicate the groundwater elevation during the measurement period. The color of each well point corresponds to the depth of the well completion.</p>		

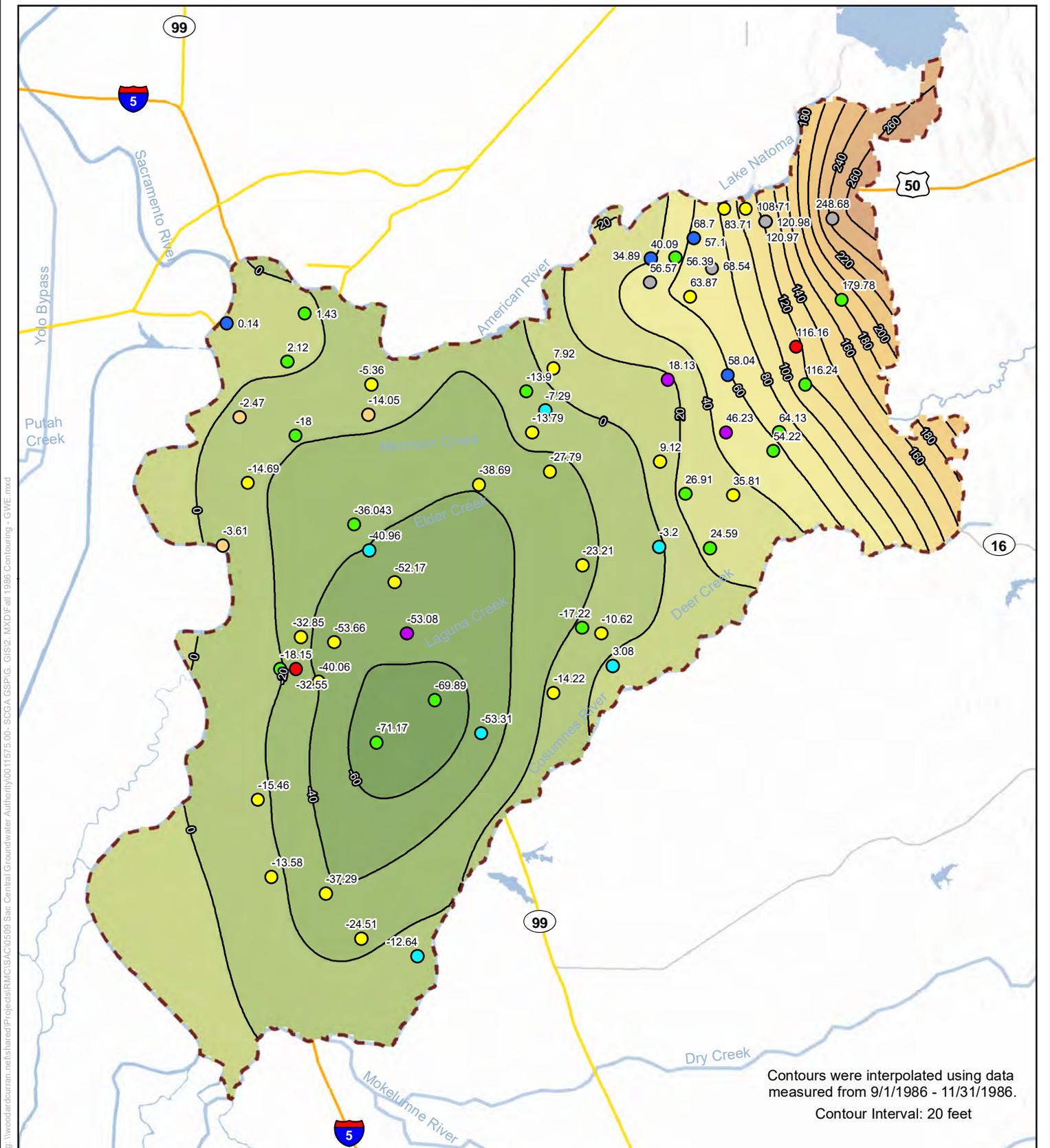
0 1 2 4 Miles

**South American SUBBASIN**

Map Created: Dec. 2020

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 Exported: 1/4/2021, By: veldandis Using: \\woodandcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G. GIS2.MXD\F all 1977 Contouring - GWE.mxd



Contours were interpolated using data measured from 9/1/1986 - 11/31/1986.  
 Contour Interval: 20 feet

**South American Subbasin GSP**  
**Fall 1986 Groundwater Level Contours**

Figure 2.3-20

<b>Legend</b>	South American Subbasin	300 - 400
	Groundwater Elevation Contours	400 - 500
	<b>Well Depth (feet)</b>	500 - 600
	Unknown	600 - 700
	0 - 100	
100 - 200		
200 - 300		

NOTE: Numbers next to each well indicate the groundwater elevation during the measurement period. The color of each well point corresponds to the depth of the well completion.

0 1 2 4 Miles

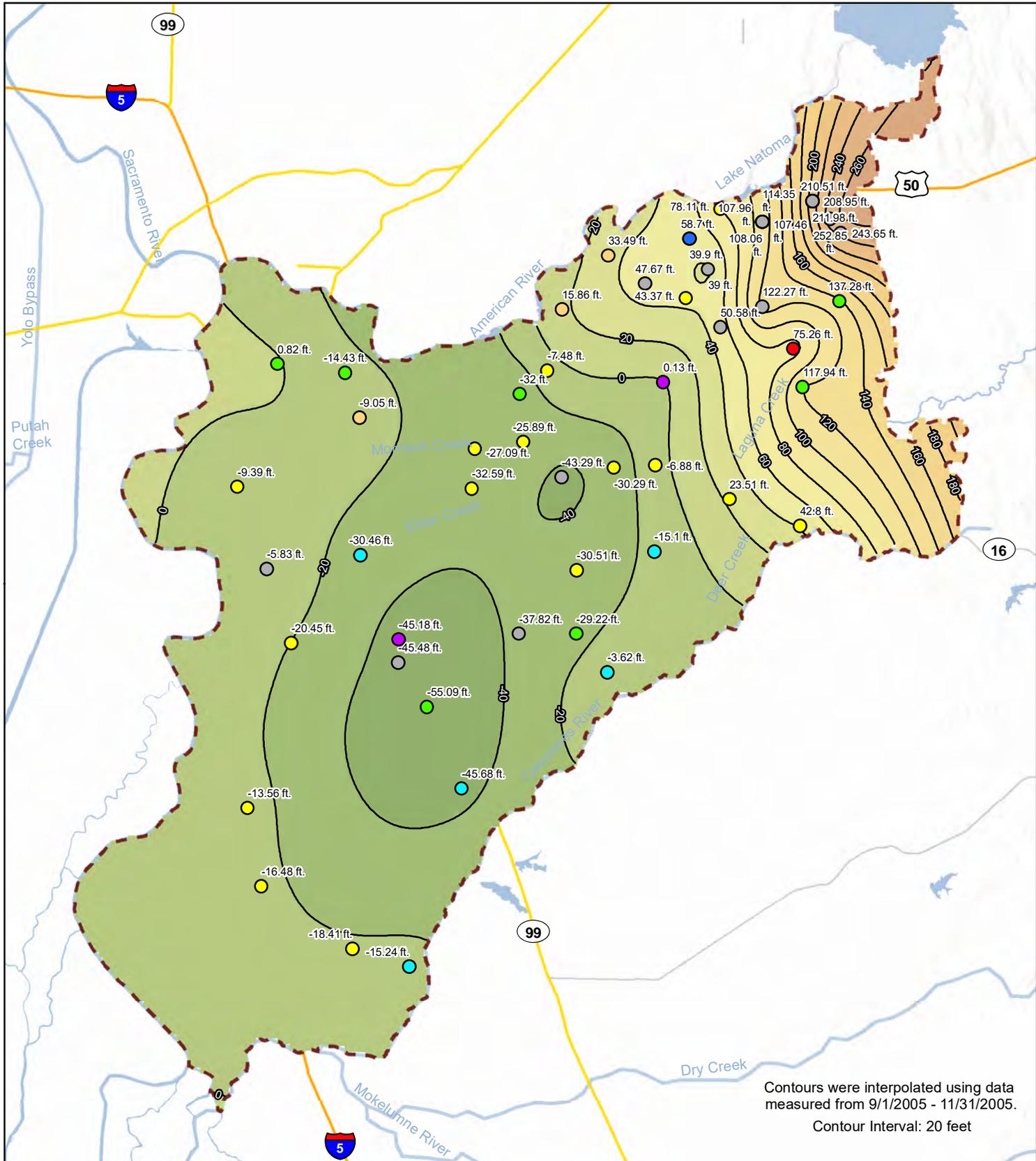
N

**South American SUBBASIN**

Map Created: Dec. 2020

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Figure Exported: 1/4/2021, By: veldandis Using: \\woodandcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G. GIS2.MXD\F all 1986 Contouring - GWE.mxd



Contours were interpolated using data measured from 9/1/2005 - 11/31/2005.  
 Contour Interval: 20 feet

**South American Subbasin GSP**  
**Fall 2005 Groundwater Level Contours**

Figure 2.3-21

<b>Legend</b>	South American Subbasin	300 - 400
	Groundwater Elevation Contours	400 - 500
	<b>Well Depth (feet)</b>	500 - 600
	Unknown	600 - 700
	0 - 100	
100 - 200		
200 - 300		

NOTE: Numbers next to each well indicate the depth to water during the measurement period. The color of each well point corresponds to the depth of the well completion.

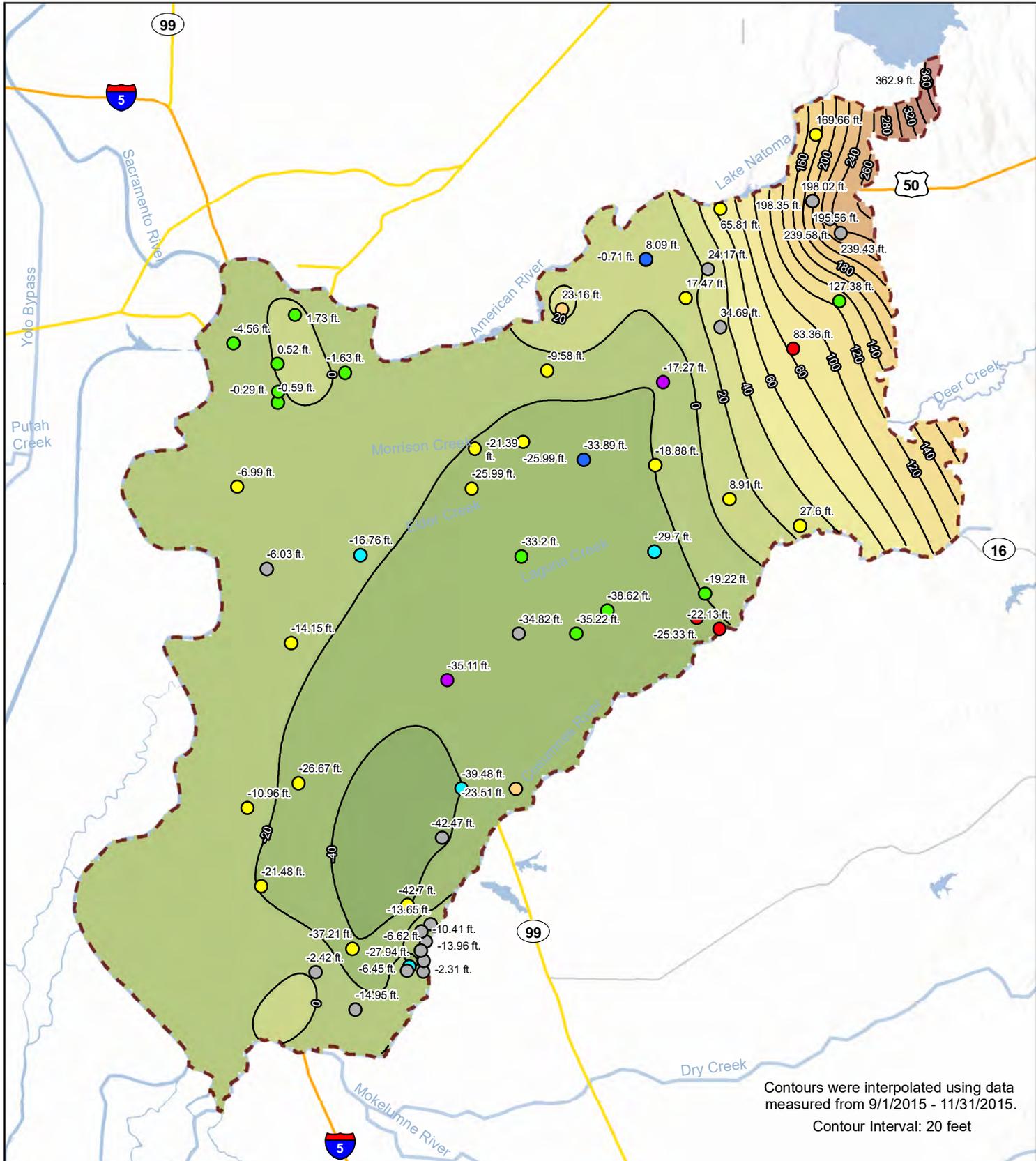
0 1 2 4 Miles

**South American SUBBASIN**

Map Created: Dec. 2020

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Figure Exported: 1/4/2021, By: veldandis Using: \\woodandcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G- GIS2\_MXD\F all 2005 Contouring - GWE.mxd



Contours were interpolated using data measured from 9/1/2015 - 11/31/2015.  
 Contour Interval: 20 feet

### South American Subbasin GSP

#### Fall 2015 Groundwater Level Contours

Figure 2.3-22

<b>Legend</b>	South American Subbasin	300 - 400
	Groundwater Elevation Contours	400 - 500
<b>Well Depth (feet)</b>	Unknown	500 - 600
	0 - 100	600 - 700
	100 - 200	
	200 - 300	
<p>NOTE: Numbers next to each well indicate the depth to water during the measurement period. The color of each well point corresponds to the depth of the well completion.</p>		

Map Created: Dec. 2020

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 Exported: 1/4/2021, By: veldandri, Using: \\woodandri\arcgis\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G- GIS2.MXD\F all 2015 Contouring - GWE.mxd

priority for monitoring and management. Beginning in the early 1990s, municipal water purveyors started drilling more costly deep wells, requiring treatment of iron and manganese to protect the shallow aquifer and causing a downward vertical gradient that kept these same constituents and salts from upwelling into the shallow aquifer. Consideration of deeper monitoring is discussed in the data gaps section.

Contours were developed for both Fall and Spring 2019 to allow for a comparison of seasonal trends within the SASb over the most recent period for which sufficient data was available. Seasonal groundwater contour maps for both elevation and depth to water for Spring 2019 and Fall 2019 are provided in **Figure 2.3-23** through **Figure 2.3-26**.

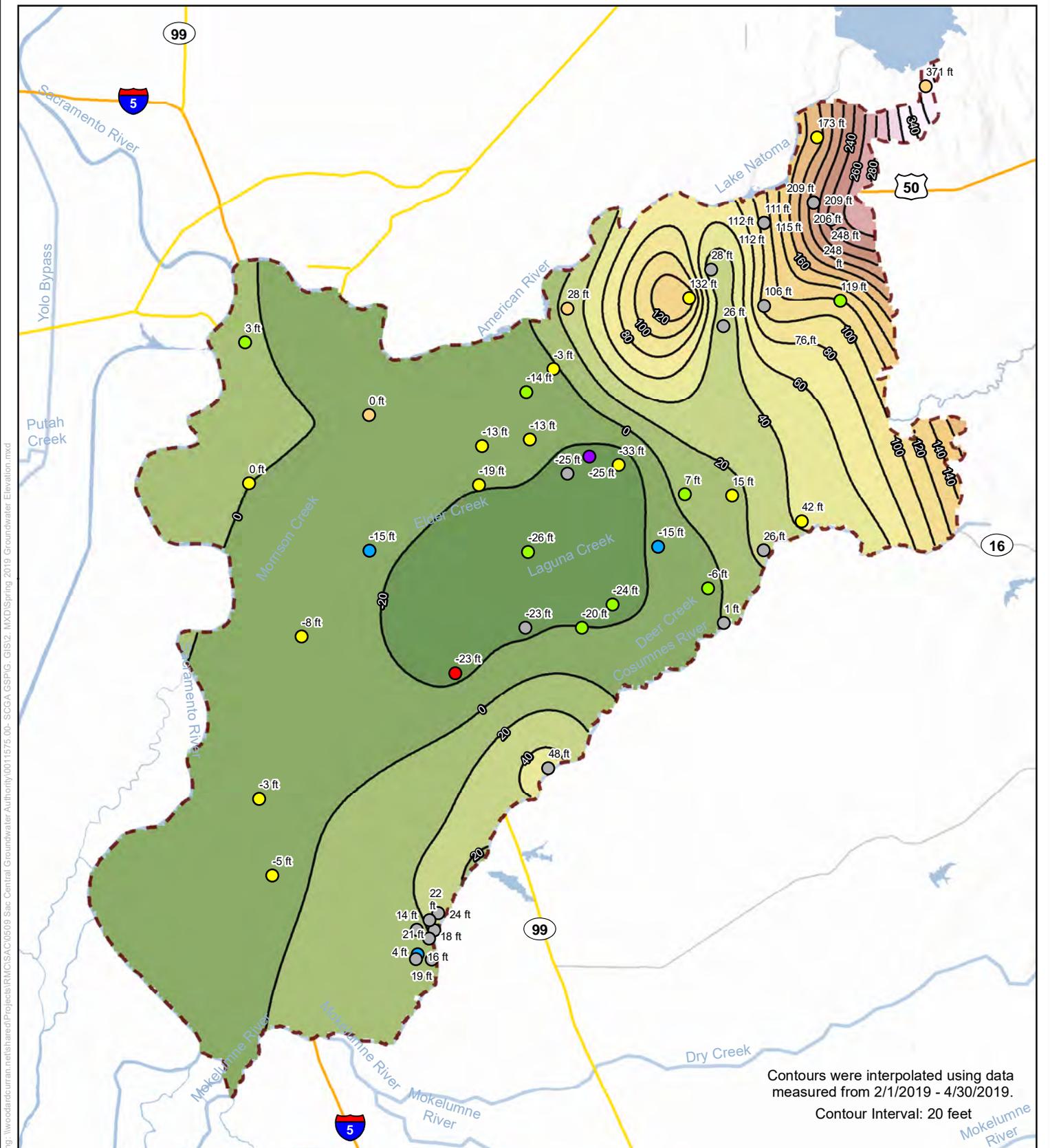
Data included to develop these contours were from April through May for Spring 2019, and September through November for Fall 2019. If multiple measurements for a well were available during this time, the measurement closest to the middle of the season (mid-April for Spring and mid-October for Fall) were used.

**Figure 2.3-23** shows groundwater elevation contours for Spring 2019. Similar to previous periods, groundwater flow in the Subbasin was generally westward from the eastern margin of the subbasin and eastward from the western margin toward the groundwater depression northeast of Elk Grove. Horizontal gradients were steepest in the eastern portion of the Subbasin and shallowest in the western portion on the Sacramento Valley floor. Groundwater in the northwest corner appeared to flow toward the adjacent North American Subbasin. A groundwater high was present along the Cosumnes River and creates a shallow gradient in the western portion of the SASb toward the Sacramento River.

**Figure 2.3-24** shows depth to water contours for spring 2019. In the western portion of the Subbasin, from the western boundary to California State University – Sacramento (CSUS), Florin, and Elk Grove, depth to water was between approximately 20 to 60 feet bgs. In the central part of the Subbasin, between Florin and Mather depth to water was between approximately 60 and 80 to 100 feet bgs. For the northeastern portion of the Subbasin near Folsom, depth to water was between approximately 20 to 60 feet bgs. Depth to water was greatest along the eastern and southeastern Subbasin boundary where groundwater could be as deep as 200 feet bgs, although data are limited in this area and the topography is more variable. In the southeastern portion of the Subbasin, depth to water near the Cosumnes River varied between 80 and 100 feet, somewhat deeper than near the American River.

**Figure 2.3-25** shows groundwater elevation contours for fall 2019. As in spring, groundwater flow was generally from the eastern margin and from the western area toward the groundwater depression in the south-central area of the subbasin, northeast of Elk Grove and south of Mather. The groundwater elevation was as low as 28 feet below sea level. Horizontal gradients were steepest on the eastern side and shallowest on the western side.

**Figure 2.3-26** shows depth to water contours for Fall 2019. In the western portion of the Subbasin, from the western boundary to CSUS, Florin, and Elk Grove, depth to water was between approximately 20 to 60 feet bgs. In the central part of the Subbasin between Florin and Mather, depth to water was between approximately 60 to 120 feet bgs. For the northeastern portion of the Subbasin near Folsom, depth to water was between approximately 20 to 60 feet bgs. Depth to water was greatest along the eastern and southeastern Subbasin boundary where groundwater is deeper than 180 feet bgs. Depth to water along the Cosumnes River in the eastern half of the subbasin was somewhat deeper than near the American River.



Contours were interpolated using data measured from 2/1/2019 - 4/30/2019.  
 Contour Interval: 20 feet

**South American Subbasin GSP**  
**Spring 2019 Groundwater Elevation**  
 Figure 2.3-23

**Legend**

- South American Subbasin
- Groundwater Elevation (feet)

**Well Depth below GSE**

- Unknown
- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600

NOTE: Numbers next to each well indicate the groundwater elevation during the measurement period. The color of each well point corresponds to the depth of the well completion.

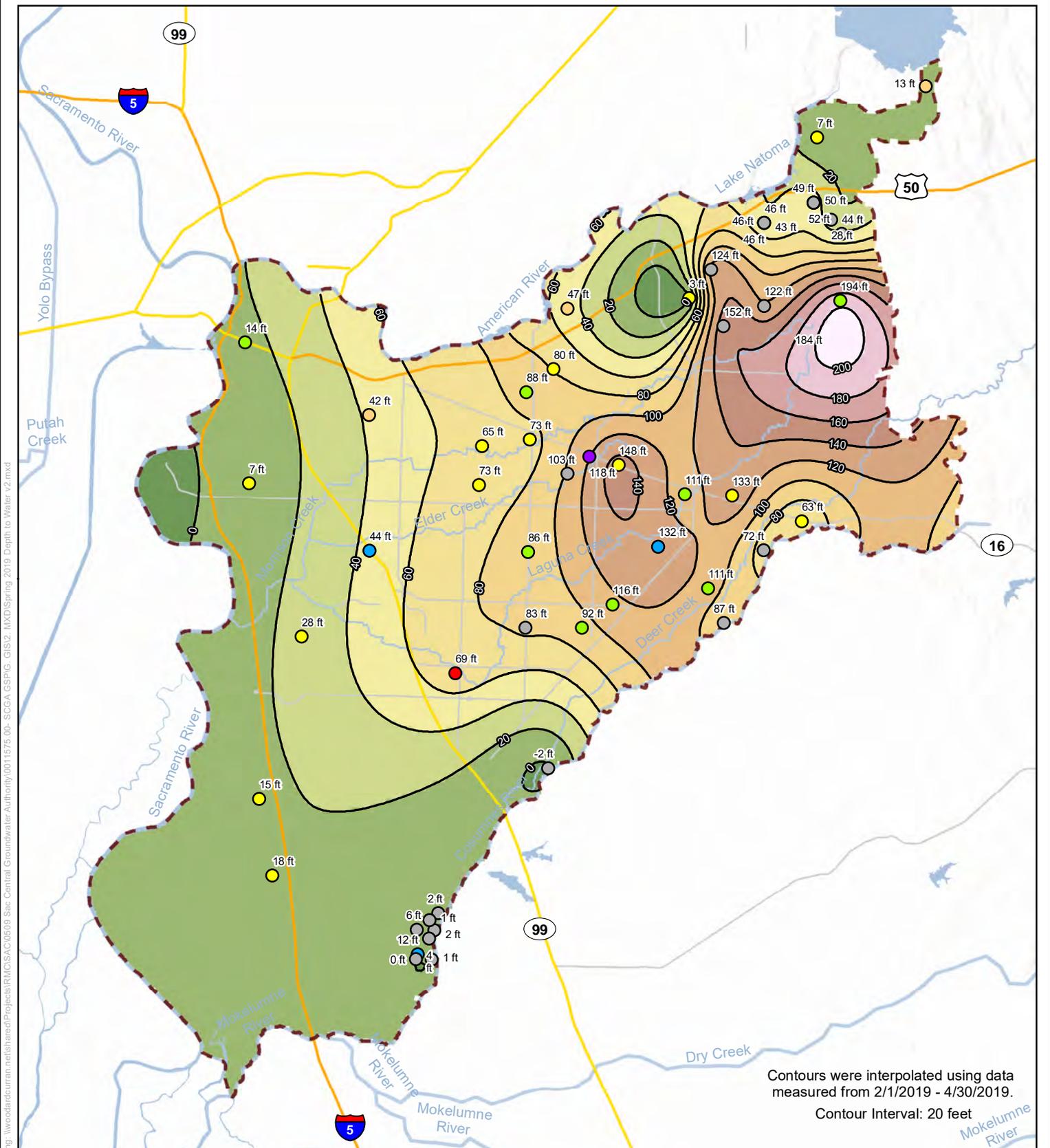
0 1 2 4 Miles

**South American SUBBASIN**

Map Created: Dec. 2020

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 Exported: 2/5/2021, By: ceggleton Using: \\woodardcurran.net\shared\Projects\RWC\SAC\0509 Sac Central Groundwater Authority\0011575 00- SCGA GSP.GIS\2. MXD\Spring 2019 Groundwater Elevation.mxd

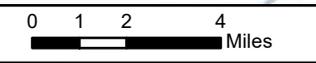


Contours were interpolated using data measured from 2/1/2019 - 4/30/2019.  
 Contour Interval: 20 feet

**South American Subbasin GSP**  
**Spring 2019 Depth to Groundwater**  
 Figure 2.3-24

<b>Legend</b>	South American Subbasin	300 - 400
	Depth to Groundwater (feet)	400 - 500
<b>Well Depth below GSE</b>	Unknown	500 - 600
	0 - 100	
	100 - 200	
	200 - 300	

**NOTE:** Numbers next to each well indicate the depth to water during the measurement period. The color of each well point corresponds to the depth of the well completion.

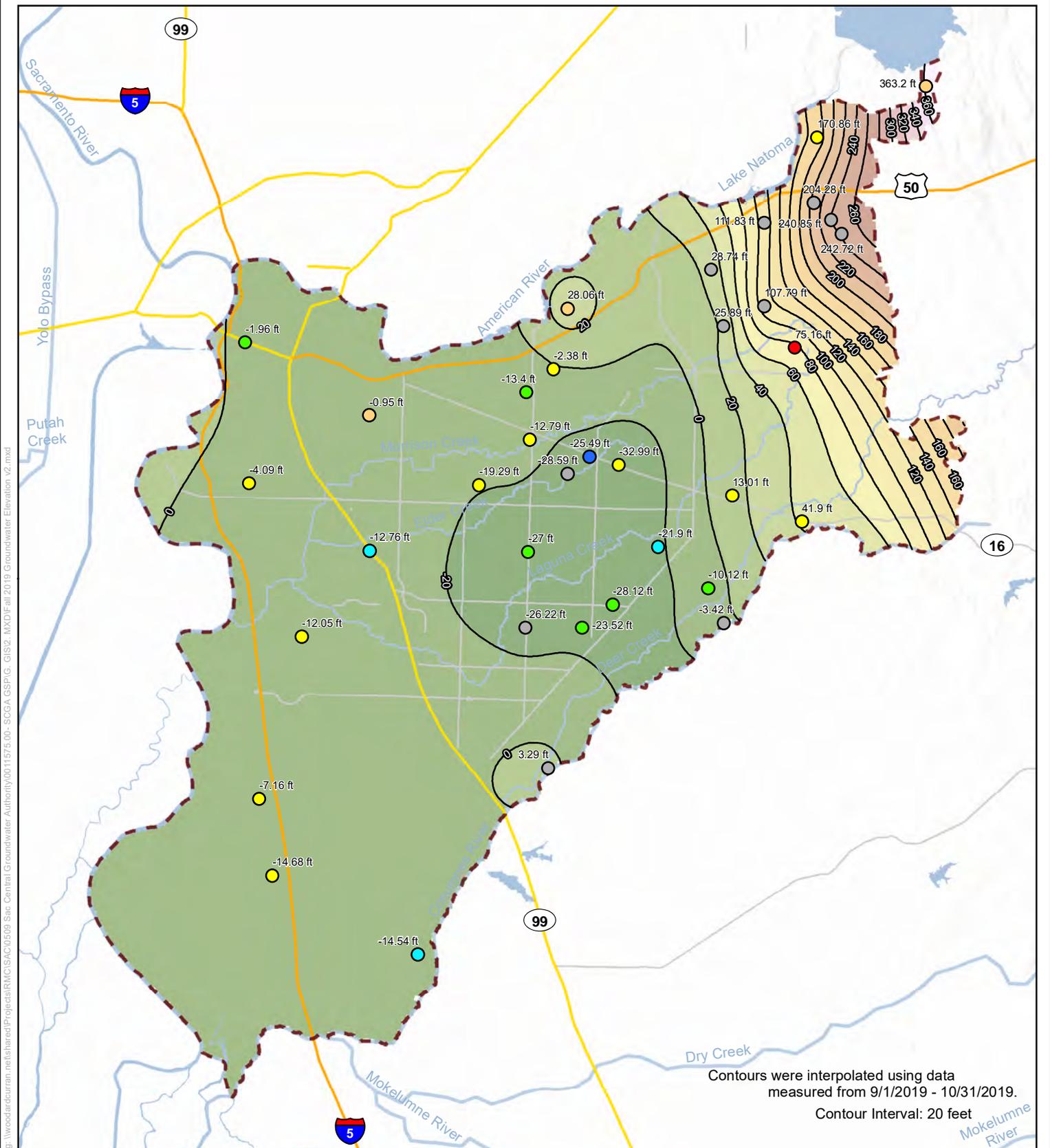


South American SUBBASIN

Map Created: Dec. 2020

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Figure Exported: 2/5/2021, By: cegglelsm, Using: \\woodardcurran.net\shared\Projects\RWC\SAC\0509 Sac Central Groundwater Authority\0011575 00- SCGA GSP.GIS\2- MXD\Spring 2019 Depth to Water.v2.mxd



Contours were interpolated using data measured from 9/1/2019 - 10/31/2019.  
 Contour Interval: 20 feet

**South American Subbasin GSP**  
**Fall 2019 Groundwater Elevation**  
 Figure 2.3-25

<b>Legend</b>	South American Subbasin	300 - 400
	Groundwater Elevation (feet)	400 - 500
	<b>Well Depth from GSE</b>	500 - 600
	Unknown	600 - 700
	0 - 100	
	100 - 200	
	200 - 300	

NOTE: Numbers next to each well indicate the groundwater elevation during the measurement period. The color of each well point corresponds to the depth of the well completion.

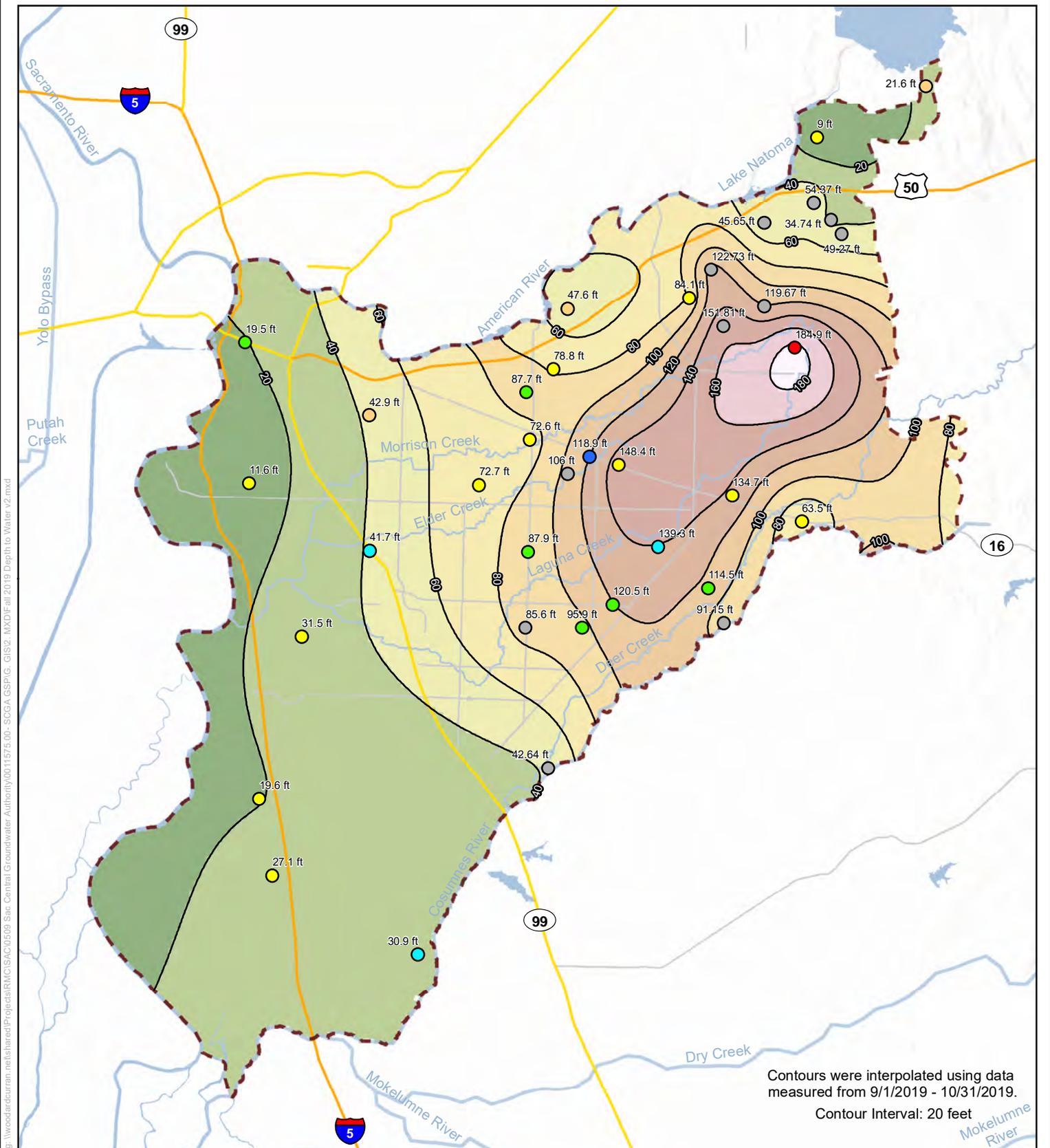
0 1 2 4 Miles

**South American SUBBASIN**

Map Created: Dec. 2020

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 Exported: 1/4/2021, By: veldandc, Using: \\woodardcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G- GIS2.MXD\F all 2019 Groundwater Elevation v2.mxd



Contours were interpolated using data measured from 9/1/2019 - 10/31/2019.  
 Contour Interval: 20 feet

### South American Subbasin GSP

#### Fall 2019 Depth to Groundwater

Figure 2.3-26

<b>Legend</b>	South American Subbasin	300 - 400
	Depth to Groundwater (feet)	400 - 500
<b>Well Depth (feet)</b>	Unknown	500 - 600
	0 - 100	600 - 700
	100 - 200	
	200 - 300	

**NOTE:** Numbers next to each well indicate the depth to water during the measurement period. The color of each well point corresponds to the depth of the well completion.



**South American SUBBASIN**

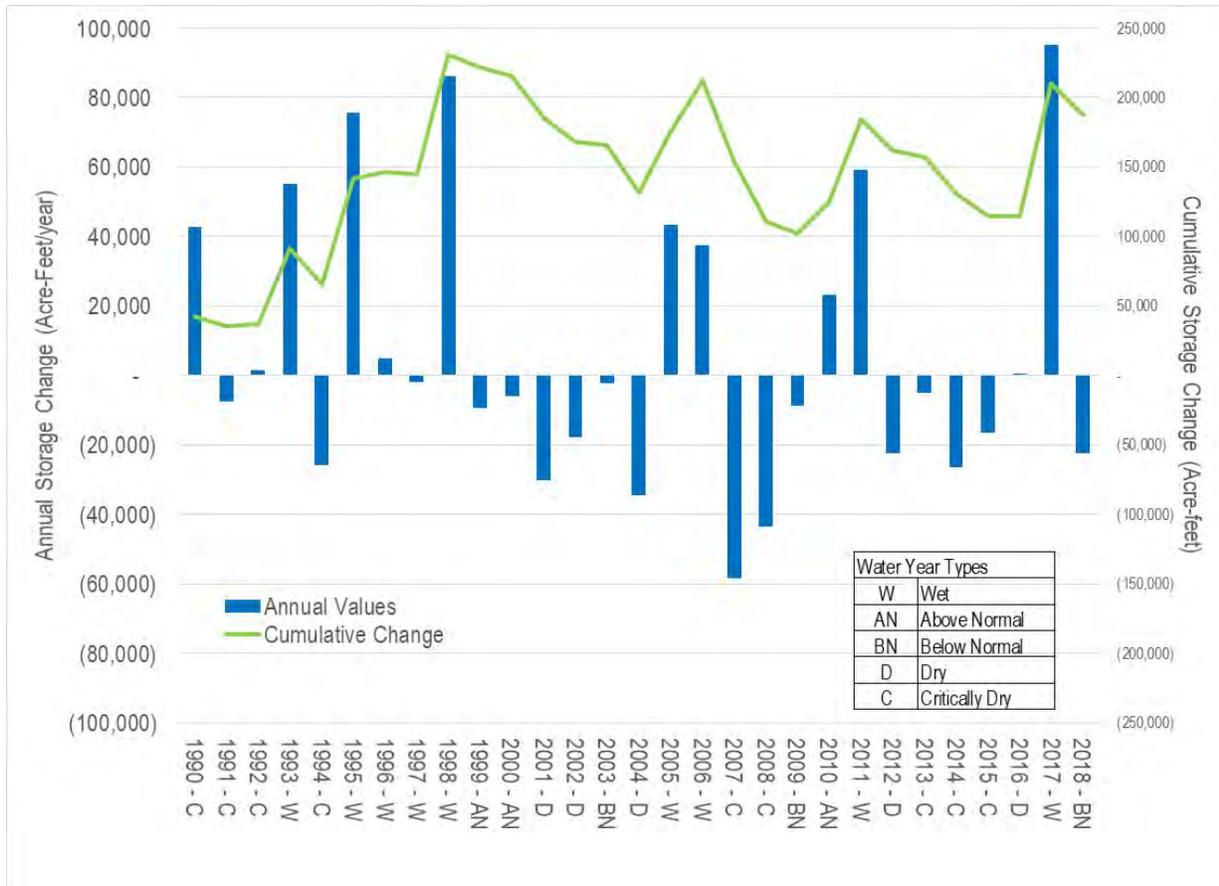
Map Created: Dec. 2020

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 Excerpted: 1/4/2021, By: veldanda Using: \\woodardcurran.net\share\Projects\RMC\SAC\0509 Sac Central Groundwater Authority\0011575.00-SCGA.GSP\G- GIS2.MXD\F all 2019 Depth to Water v2.mxd

### 2.3.2 Change in Groundwater Storage

The CoSANA model was used to estimate historical changes in storage of SASb from 1990-2018. **Figure 2.3-27** shows annual total storage for the SASb as well as the cumulative change in storage, and water year type. Between 1990 and 2018, the cumulative storage in the subbasin is estimated to have increased by 188,000 acre-feet. For the most recent 10-year period (2009-2018), the cumulative storage increase is estimated to be about 77,000 acre-feet.



**Figure 2.3-27: Groundwater Storage by Year, Water Year Type, and Cumulative Volume**

### 2.3.3 Seawater Intrusion

Seawater intrusion is not an issue in the SASb due to the distance between the Subbasin and the Pacific Ocean, which at its closest is approximately 30 miles west at San Francisco Bay. Part of the Sacramento-San Joaquin Delta overlies the western margin of the Subbasin. Salinity in the Delta is regulated by a series of natural and manmade conditions and is managed using the “X2”, or the distance in kilometers from the Golden Gate Bridge where salinity is 2 ppt (seawater is usually 35 ppt). The location of X2 is influenced seasonally by precipitation and outflows from rivers and dams such as the Sacramento and American Rivers and Folsom and Oroville Dams. X2 also fluctuates daily with normal tides. The Delta also hosts an array of hydraulic barriers, gates, and channels that are utilized to control flows and manage salinity. The Delta Atlas (DWR, 1995) documents salinity intrusion (1000 ppm chloride) into the Delta.

Between 1921 and 1943, the maximum salinity intrusion occurred in 1931, a critical WY, and was midway between Courtland and Hood on the Sacramento River when salinity control was minimal compared now. Between 1944 and 1990, the maximum salinity intrusion occurred at Rio Vista in 1977, another critical WY.

### 2.3.4 Groundwater Quality

This section presents Subbasin groundwater quality information, including a discussion of numeric thresholds set by federal and state agencies, the processing of available water quality data, and the findings of the water quality data evaluation performed for the GSP.

To determine what groundwater quality constituents in the Subbasin may be of current or near-future concern, a reference standard was defined to which groundwater quality data were compared. The regulatory standards are named maximum contaminant levels (MCLs) and they dictate the maximum concentration at which a specific constituent may be present in potable water sources. There are two categories of MCLs: Primary MCLs are established based on human health effects from constituents and are enforceable standards for public water supply wells and state small water supply wells; and Secondary MCLs (SMCLs), which are unenforceable standards established for constituents that may negatively affect the aesthetics of drinking water quality, such as taste, odor, or appearance.

Groundwater in the Subbasin is generally of good quality and meets local needs for municipal, domestic, and agricultural uses. Exceedances of constituents may be caused by localized conditions and generally are not reflective of regionally poor groundwater quality.

#### **Groundwater Quality Data Processing**

Groundwater quality data were downloaded from the Groundwater Ambient Monitoring and Assessment Program (GAMA) Groundwater Information System<sup>3</sup> on May 22, 2020, and included groundwater quality data from the following sources:

- Department of Pesticide Regulation (DPR)
- Department of Water Resources (DWR)
- Lawrence Livermore National Laboratory
- State and Regional Water Board Regulatory Programs (Electronic Deliverable Format (EDF) and Irrigated Agricultural Land Waiver (AGLAND))
- State Water Board, GAMA Program water quality data (GAMA, USGS)
- State Water Board, Division of Drinking Water public supply well water quality (DDW)
- U.S. Geological Survey (USGS)

Additional data for nitrate, total dissolved solids (TDS), chloride, arsenic, iron, and manganese were obtained directly from GEI Consultants, Inc., which developed the SASb 2016 Alternative. All data were then compiled into a database for analysis.

<sup>3</sup> <http://geotracker.waterboards.ca.gov/gama/datadownload>

## Groundwater Quality Trends According to Available Historical Data

The combined database from GAMA and GEI Consultants was evaluated for nitrate, TDS, and arsenic. Data solely from the GAMA database was evaluated for hexavalent chromium, and the larger family of per- and poly-fluoroalkyl substances (PFAS), which are an emerging contaminant of concern. These constituents were included in the evaluation because they were cited in previous studies of the Subbasin, or they were discussed during public meetings as being of concern to stakeholders in the Subbasin. Groundwater quality samples collected from less than 300 feet bgs were assigned to the shallow zone, while samples collected from greater than 300 feet were assigned to the deep zone. With the exception of PFAS, only measurements from wells located entirely in either the shallow zone or the deep zone are included in this evaluation. Wells of all depths are analyzed for PFAS, as monitoring data are sparse and less temporally extensive than the other constituents. GAMA data from State and Regional Water Board Regulatory Programs (EDF) are omitted from the analysis presented in this Chapter because they are representative of site-specific conditions and are not indicative of regional groundwater conditions (evaluation of PFAS includes EDF data as the data is sparse). Data evaluation was conducted for chloride, iron, and manganese; evaluation of these constituents, as well as evaluation of nitrate, TDS, arsenic, hexavalent chromium, and PFAS, including the EDF data, are presented in **Appendix 2-D**.

The following subsections present the evaluation of nitrate, TDS, arsenic, hexavalent chromium, and PFAS. Variations of nitrate and TDS over time were plotted as “box and whisker” plots, where the box represents the concentration range for the middle 50 percent of the data (first quartile middle to third quartile middle, or interquartile range), the mean is represented as an ‘x’, and the median is shown as the line in the center of the box. The top whisker extends to the highest concentration that is less than or equal to the sum of the third quartile and 1.5 times the interquartile range; and the bottom whisker extends to the lowest concentration that is greater than or equal to the difference of the first quartile and 1.5 times the interquartile range. Regulatory limits are displayed as a dashed red line, and the concentration is displayed on the left side of each plot. Box and whisker plots of arsenic, hexavalent chromium, and PFAS are included in **Appendix 2-D**.

GAMA data include numerous estimated values (where the value was detected at a concentration below the reporting limit, but above the method detection limit). These estimated values are included in the box and whisker plots as their reported result in the GAMA database. A small number of ND results are included in the GAMA data, these data are not included in this evaluation.

Figures of spatial groundwater quality data plot the location of wells where groundwater quality samples were collected and indicate the maximum sampled concentration at each well for the entirety of the dataset. With the exception of PFAS, individual maps are provided for samples collected from the shallow zone and deep zone of the aquifer. Due to the scarcity of PFAS data, wells of all depths are included in one map.

## Nitrate

Nitrate data in the SASb were extensive and spanned from 1951 to present. **Figure 2.3-28** illustrates variation in nitrate for seven time intervals. The primary MCL is displayed as a dashed red line (10 mg/L for Nitrate as N). As shown, nitrate concentrations in both the shallow and deep zones were relatively consistent throughout the period of evaluation. Concentrations in the shallow zone increased slightly between the period 1991-95 and 1996-00; however, this increase was minor and not representative of an increasing trend. Nitrate concentrations in the deep zone have remained relatively stable throughout the period of analysis. It is noted that the elevated average and statistical distribution shown for the deep zone during the period 1986-90 is the result of one high estimated value (10 mg/L).

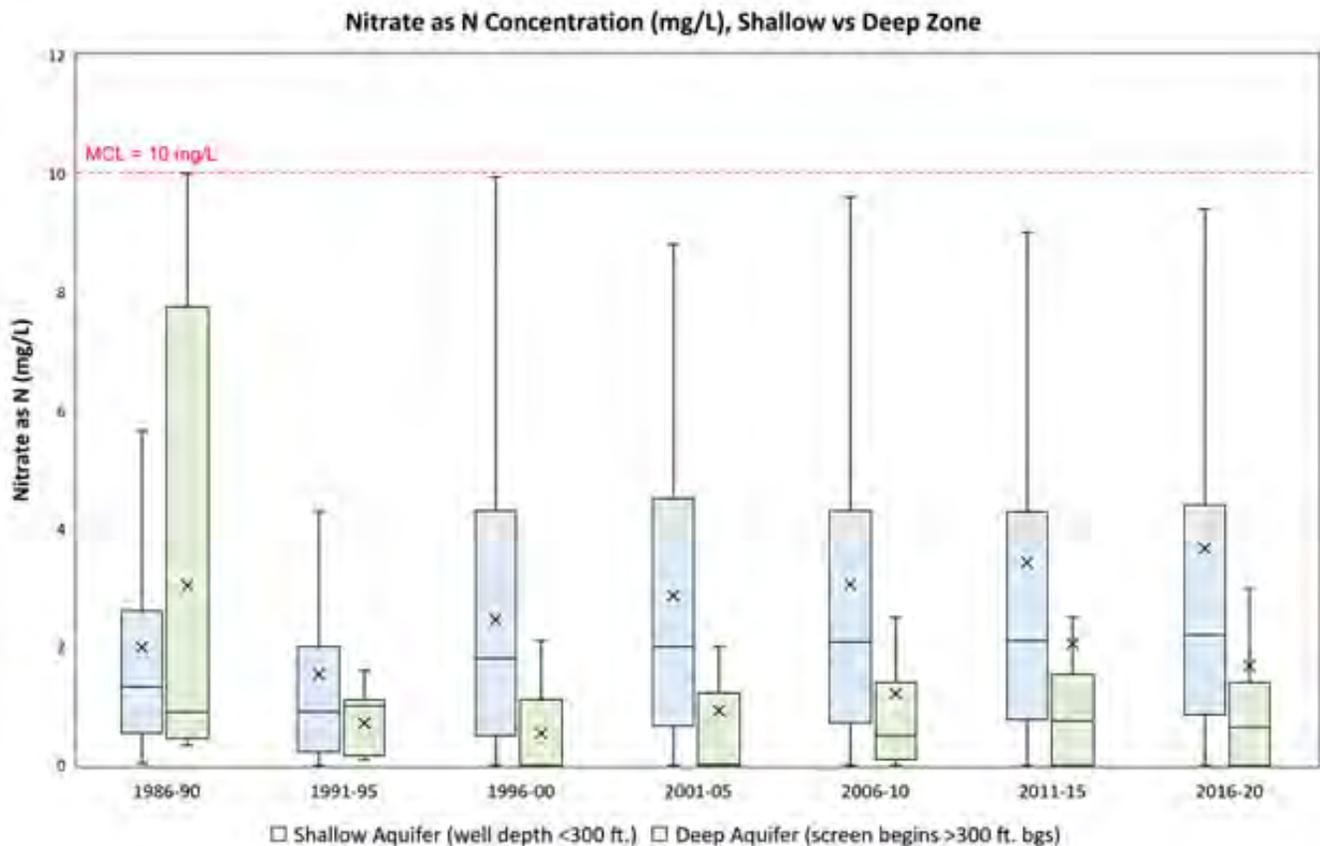
Nitrate data are plotted spatially for the shallow zone in **Figure 2.3-30** and the deep zone in **Figure 2.3-31**. The maps divide the wells into three categories: wells where all samples were below 50 percent of the MCL (indicated as a green point), wells where at least one sample was above 50 percent of the MCL (indicated as a yellow point), and wells where at least one sample was above the MCL (indicated as a red point). It is noted that not all wells analyzed are drinking water supply wells; therefore, a single exceedance of the MCL may not be a violation of the limits as the State Water Board has set nitrate MCL compliance to be determined by a running annual average.

**Figure 2.3-30** shows that nitrate is less than 50 percent of the MCL in the majority of shallow wells. Evaluation of wells where the maximum nitrate concentration was greater than 50 percent of the MCL, or greater than the MCL, indicated that municipal community water systems deliver domestic water supply to these areas, and that domestic well density is low. **Figure 2.3-31** shows that one deep well contained nitrate at a concentration greater than the MCL, while nitrate is less than 50 percent of the MCL in all other wells.

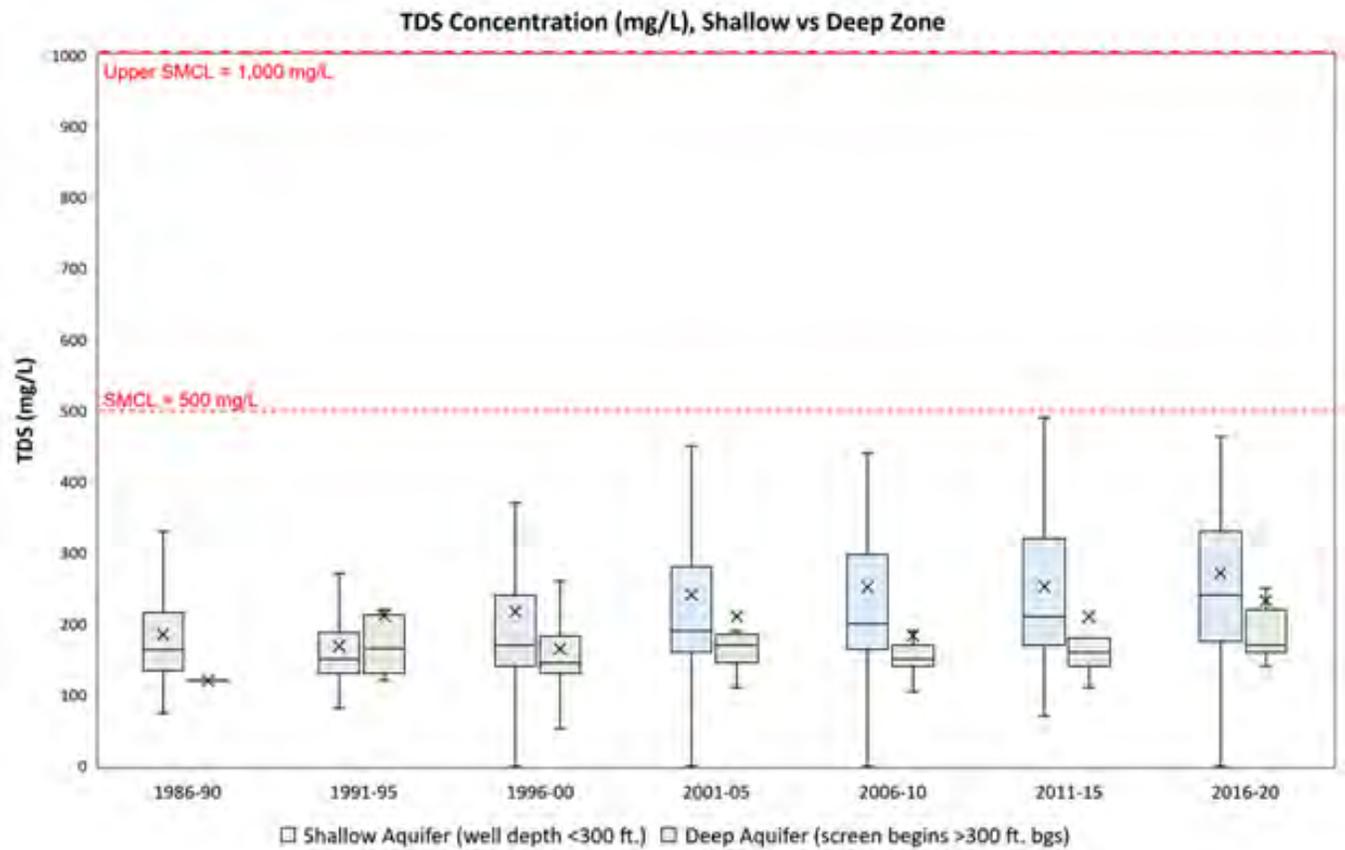
## Total Dissolved Solids (TDS)

TDS data were extensive and spanned from 1955 to present. TDS concentrations below the Recommended SMCL of 500 mg/L are desirable for a higher degree of consumer acceptance, while concentrations up to the Upper SMCL of 1,000 mg/L are also deemed to be acceptable. **Figure 2.3-29** illustrates variation in TDS for seven time intervals; the SMCL and Upper SMCL are displayed as dashed red lines. As illustrated, TDS concentrations measured in the deep zone were consistently below the SMCL value of 500 mg/L and remained relatively stable throughout the period of evaluation. Concentrations in the shallow aquifer remained relatively stable from 1986 to 2005 and exhibit higher concentrations during the years 2006 to 2020; however, these elevated concentrations are still deemed acceptable.

TDS data are plotted spatially for the shallow zone in **Figure 2.3-32** and the deep zone in **Figure 2.3-33**. The maps divide the wells into four categories: wells where all samples were below 250 mg/L (indicated as a green point), wells where at least one sample was greater than 250 mg/L (indicated as a yellow point), wells where at least one sample was greater than 500 mg/L (indicated as an orange point), and wells where at least one sample was greater than 1,000 mg/L (indicated as a red point). **Figure 2.3-32** shows an overall increasing trend in shallow TDS values from the east to the west; however, the majority of shallow wells produced a maximum TDS concentration below the SMCL of 500 mg/L. **Figure 2.3-33** shows that all TDS data for deep wells were less than the upper SMCL value of 1000 mg/L.

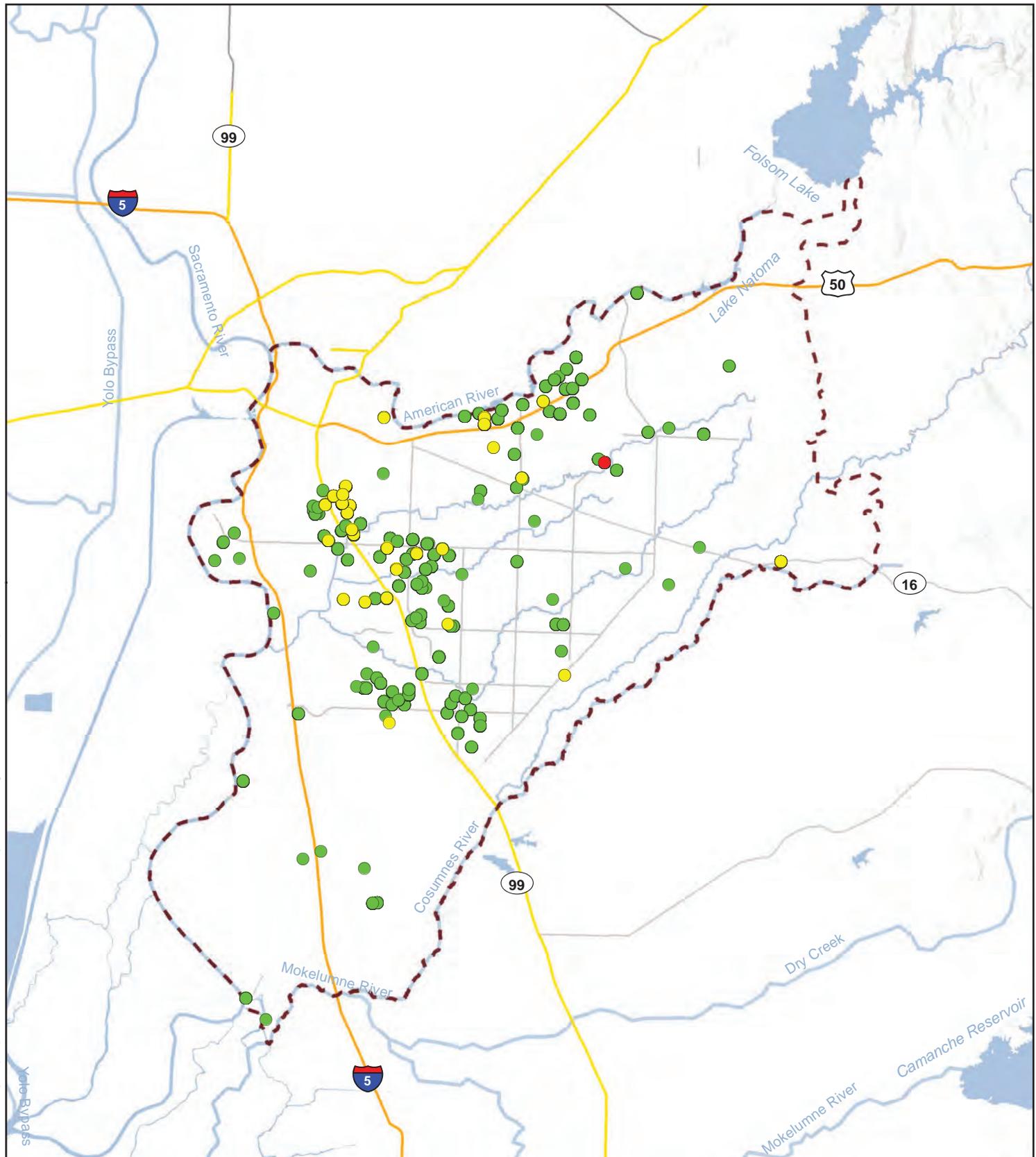


**Figure 2.3-28: Historical Range of Nitrate Concentrations**



**Figure 2.3-29: Historical Range of TDS Concentrations**

Figure Exported: 3/4/2021 By: OlinA Using: C:\Users\olinal\Dropbox (LVA)\olm a601.0.3 - GSP 2020\_LFSAS GIS - Template and Final Figures\Sec 2.3 - Nitrate\_Shallow\_Aquifer\_2.25\_2021\_v2\_NoMWS.mxd



**South American Subbasin GSP**  
Nitrate Concentrations in the Shallow Zone (<300 Ft. Depth), GAMA  
Figure 2.3-30

**Legend**

- South American Subbasin
- Maximum Nitrate as N (1955 - 2020), Shallow Zone**
  - Below 50% MCL (0 - 5 mg/L)
  - Above 50% MCL (> 5 - 10 mg/L)
  - Above MCL (> 10 mg/L)

0 1.25 2.5 5 Miles

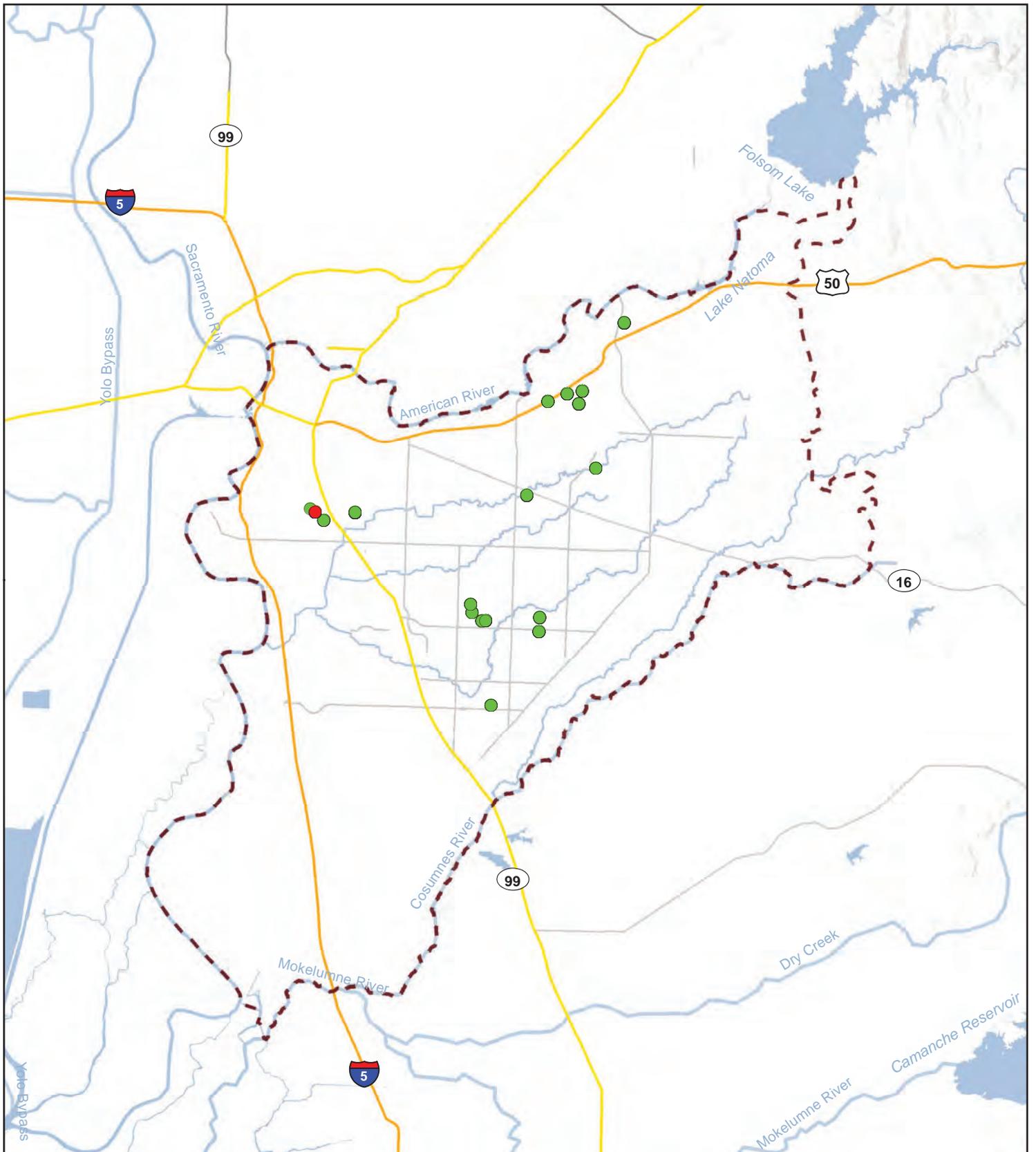
N

**South American SUBBASIN**

Map Created: 02 2021

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### South American Subbasin GSP

Nitrate Concentrations in the Deep Zone (Screen Begins >300 Ft. bgs)  
GAMA

Figure 2.3-31

Legend

South American Subbasin  
Maximum Nitrate as N (1986 - 2020), Deep Zone

- Below 50% MCL (0 - 5 mg/L)
- Above 50% MCL (> 5 - 10 mg/L)
- Above MCL (> 10 mg/L)

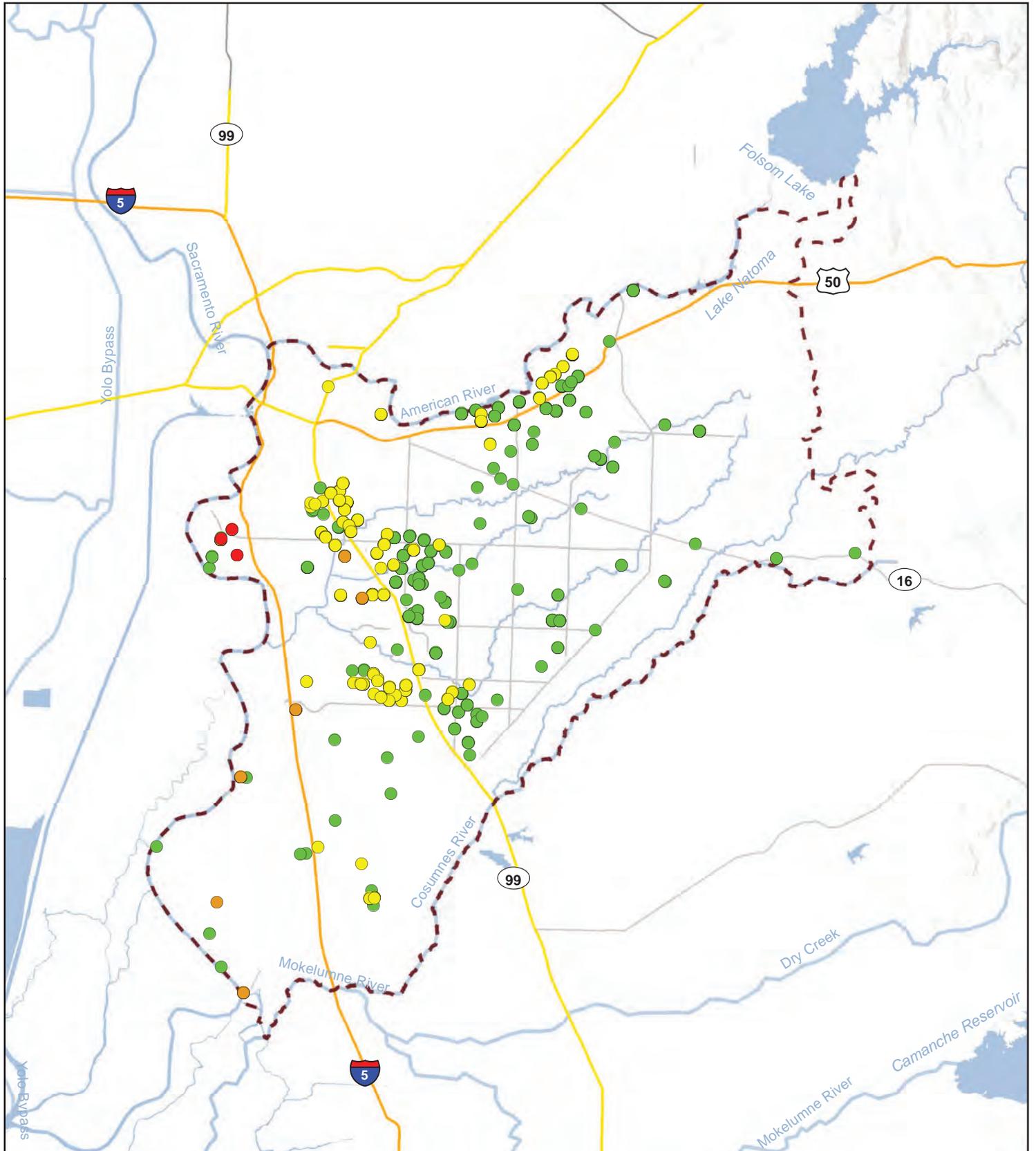
0 1.25 2.5 5 Miles



South American SUBBASIN

Map Created: 02 2021

Figure Exported: 3/4/2021 By: OlinA Using: C:\Users\olinal\Dropbox (LVA)\olm a601.0.3 - GSP 2020\_LFSAS GIS - Template and Final Figures\Sec 2.3 - TDS\_Shallow\_Aquifer\_2\_25\_2021\_v2\_NoMWS.mxd

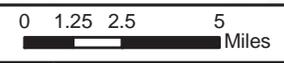


**South American Subbasin GSP**  
 TDS Concentrations in the Shallow Zone (<300 Ft. Depth), GAMA

Figure 2.3-32

*Legend*

- South American Subbasin
- Maximum TDS (1955 - 2020), Shallow Zone**
- 0 - 250 mg/L
- > 250 - 500 mg/L
- > 500 - 1,000 mg/L
- > 1,000 mg/L

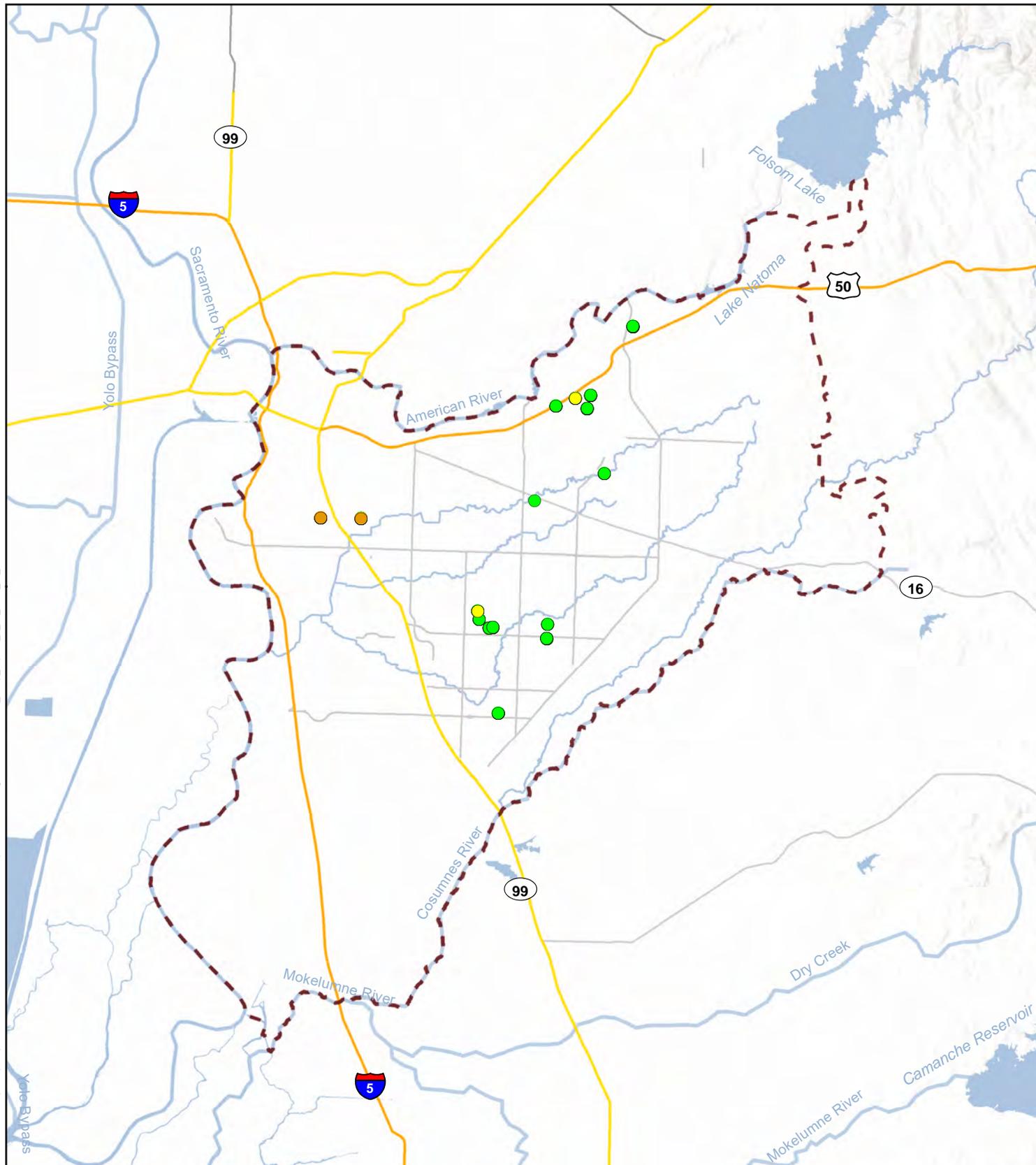


South American  
**SUBBASIN**

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**South American Subbasin GSP**  
**TDS Concentrations in the Deep Zone (Screen Begins >300 Ft. bgs) GAMA**  
Figure 2.3-33

**Legend**

--- South American Subbasin

**Maximum TDS (1986 - 2020), Deep Zone**

- 0 - 250 mg/L
- > 250 - 500 mg/L
- > 500 - 1,000 mg/L
- > 1,000 mg/L

0 1.25 2.5 5 Miles

N

**South American SUBBASIN**

Map Created: 02 2021

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## Arsenic

Arsenic data were extensive and spanned from 1982 to present. Arsenic data from 2005 – 2020 are plotted spatially for the shallow zone in **Figure 2.3-34** and the deep zone in **Figure 2.3-35**. The maps divide the wells into three categories: wells where all samples were below 50 percent of the MCL of 10 µg/L (indicated as a green point), wells where at least one sample was above 50 percent of the MCL (indicated as a yellow point), and wells where at least one sample was above the MCL (indicated as a red point).

**Figure 2.3-34** shows that exceedances of arsenic occur in the shallow zone of the aquifer, with 25 of the 131 sampled wells experiencing one or more exceedances. Evaluation of wells where the maximum arsenic sampled concentration was greater than 50 percent of the MCL, or greater than the MCL, indicates that municipal community water systems deliver domestic water supply to these areas, and that domestic well density is low. Within water system boundaries, monitoring and treatment should be available to protect beneficial users of groundwater. The boundary of municipal community water systems is shown in the figure. **Figure 2.3-35** shows that high arsenic values are less prevalent in the deep zone, with no wells exceeding the MCL.

Because arsenic is known to occur naturally in the aquifer sediments, some trace is expected to occur in shallow wells. Whether the arsenic is released from a geologic source into groundwater depends on the chemical form of the arsenic, the geochemical conditions in the aquifer, and the biogeochemical processes that occur. It is noted that recent groundwater pumping, observed through land subsidence, may result in increased arsenic aquifer concentrations (Smith et al., 2018). It is unclear if this is the cause of elevated arsenic in the Basin; regardless, increased land subsidence is not predicted, and therefore is not expected to result in increased arsenic concentrations in the shallow zone.

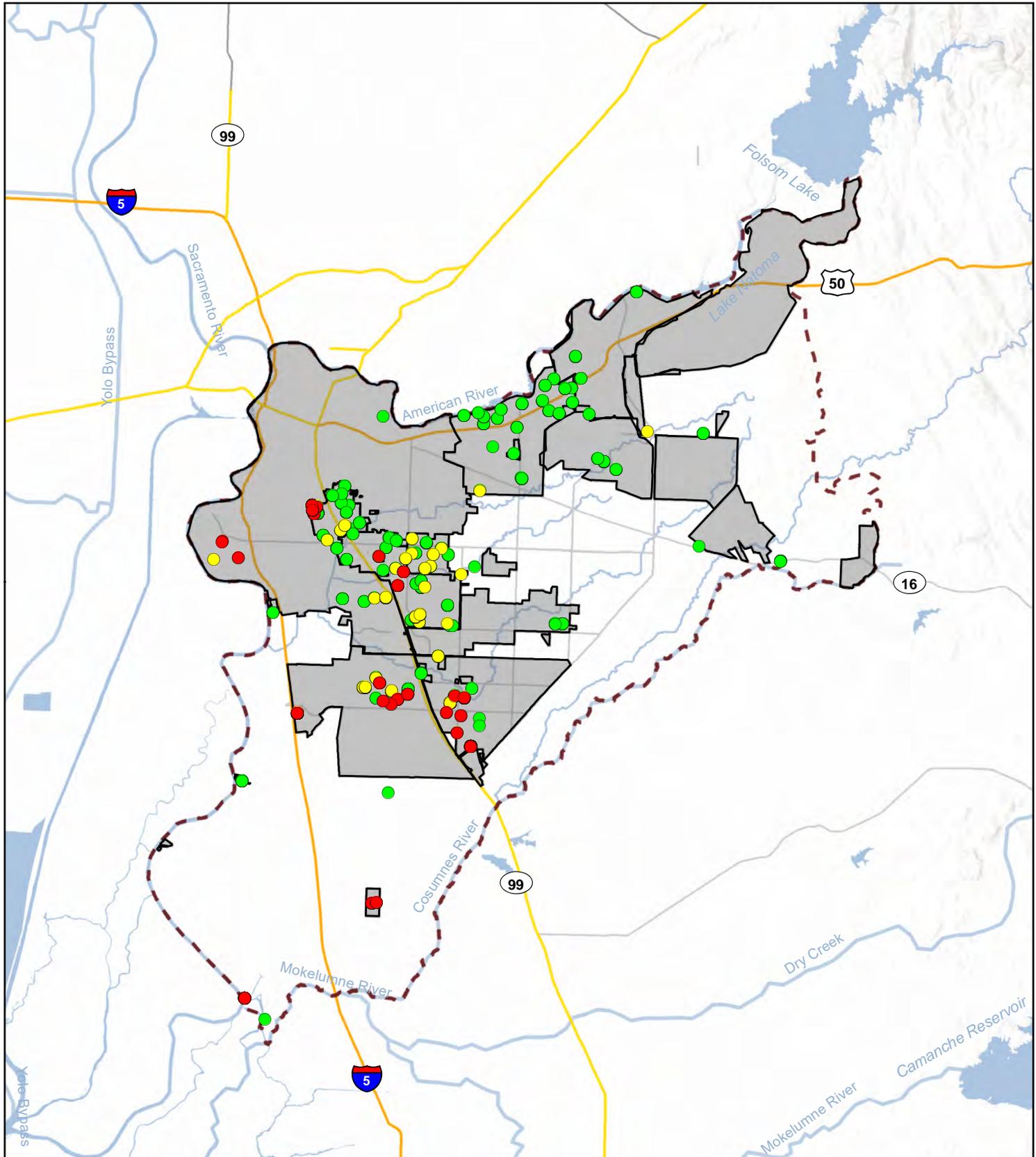
## Hexavalent Chromium

Hexavalent chromium data span from 2001 to present and are plotted spatially for the shallow zone in **Figure 2.3-36**, and the deep zone in **Figure 2.3-37**. The maps divide the wells into three categories: wells where all samples were below 50 percent of the proposed MCL of 10 µg/L (indicated as a green point), wells where at least one sample was above 50 percent of the proposed MCL (indicated as a yellow point), and wells where at least one sample was above the proposed MCL (indicated as a red point). As shown, hexavalent chromium was not present in shallow wells above the proposed MCL, and was not present in deep wells above 5 µg/L.

## Polyfluoroalkyl Substances (PFAS)

Monitoring of PFAS began more recently, with data beginning in 2017. MCLs have not been established for PFAS substances; alternatively, the DDW has instituted guidelines for local water agencies to report the presence of perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) in drinking water at 5.1 and 6.5 nanograms per liter (ng/L) or parts per trillion, respectively. PFOA and PFAS data are plotted spatially in **Figure 2.3-38**, and indicate that 31 of 55 samples have PFOS concentrations greater than 6.5 ng/L, and 22 of 43 samples have PFOA concentrations greater than 5.1 ng/L.

Figure Exported: 10/12/2021 10:12:21 AM By: C:\Users\olm\OneDrive\Documents\Dropbox (LWA)\Olin\A601\0.3 - GSP 2020\_LFISAS GIS - Template and Final Figures\Sec 2.3 - As\_Shallow\_Aquifer\_Max\_noMWS\_wWatersystem\_05-20\_10\_7\_2021.mxd



**South American Subbasin GSP**  
**Arsenic Concentrations in the Shallow Zone (<300 Ft. Depth), GAMA**  
Figure 2.3-34

**Legend**

- South American Subbasin
- Maximum Arsenic (2005-2020), Shallow Zone**
  - Below 50% MCL (0 - 5 µg/L)
  - Above 50% MCL (>5 - 10 µg/L)
  - Above MCL (> 10 µg/L)
- Municipal Community Water System

0 1.25 2.5 5 Miles

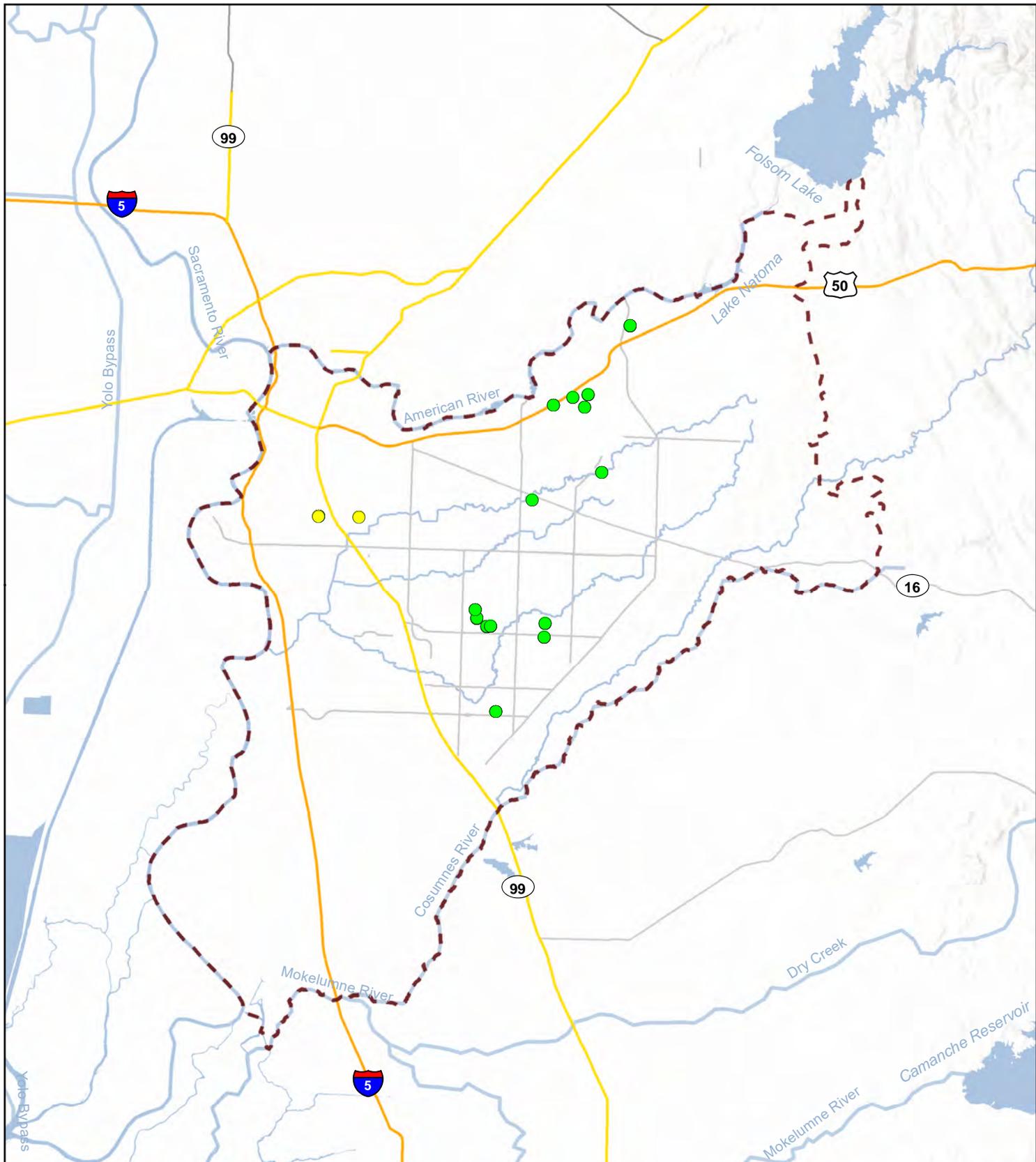
N

**South American SUBBASIN**

Map Created: 10 2021

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**South American Subbasin GSP**  
**Arsenic Concentrations in the Deep Zone (Screen Begins >300 Ft. bgs) GAMA**  
Figure 2.3-35

**Legend**

- South American Subbasin
- Maximum Arsenic (2005-2018), Deep Zone**
- Below 50% MCL (0 - 5 µg/L)
- Above 50% MCL (>5 - 10 µg/L)
- Above MCL (> 10 µg/L)

0 1.25 2.5 5 Miles

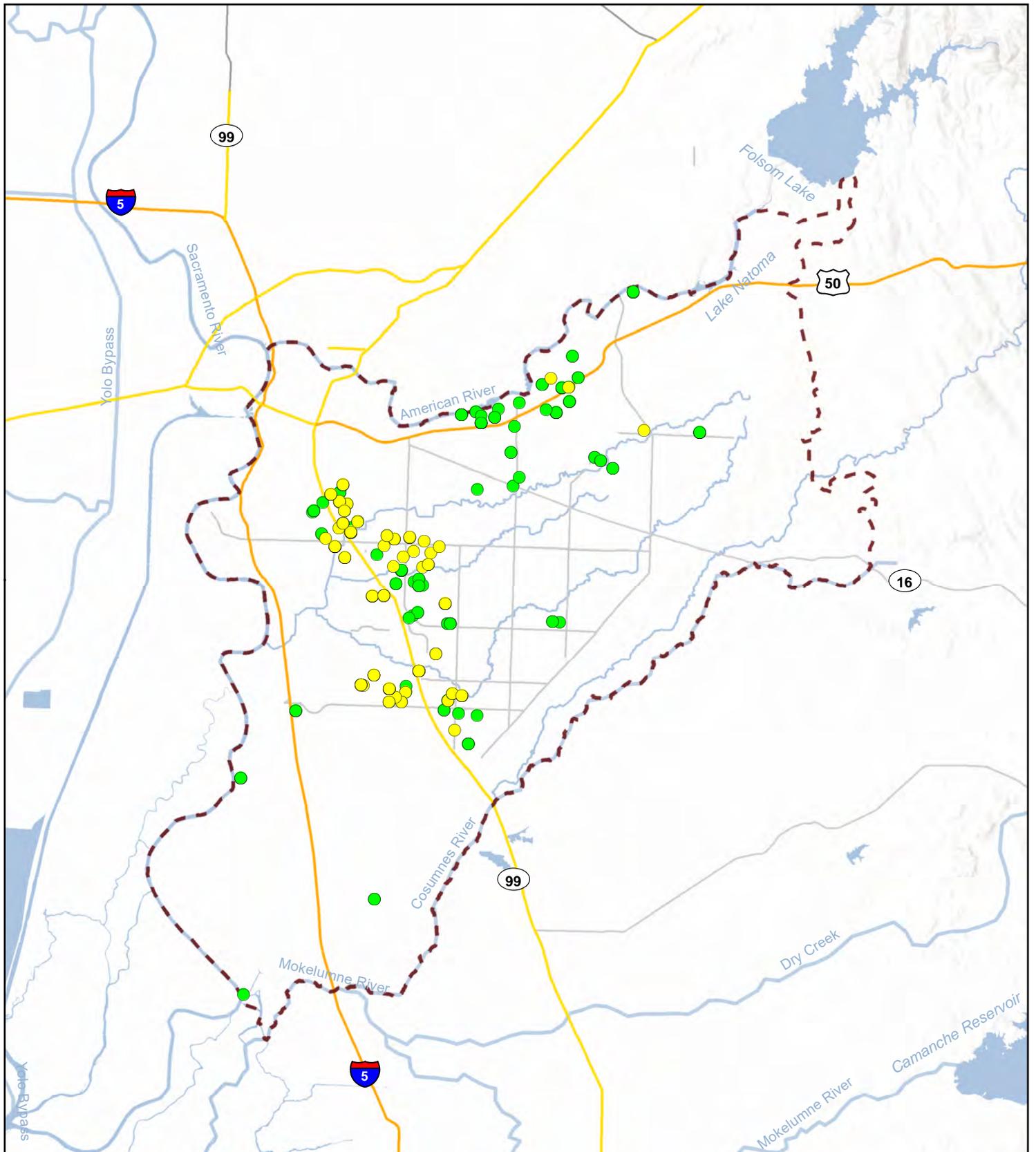


South American SUBBASIN

Map Created: 10 2021

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**South American Subbasin GSP**  
**Hexavalent Chromium Concentrations in the Shallow Zone (<300 Ft. Depth), GAMA**  
Figure 2.3-36

*Legend*

- South American Subbasin
- Max. Hexavalent Chromium (2001-20), Shallow Zone**
- Below 50% Proposed MCL (0 - 5 µg/L)
- Above 50% Proposed MCL (> 5 - 10 µg/L)

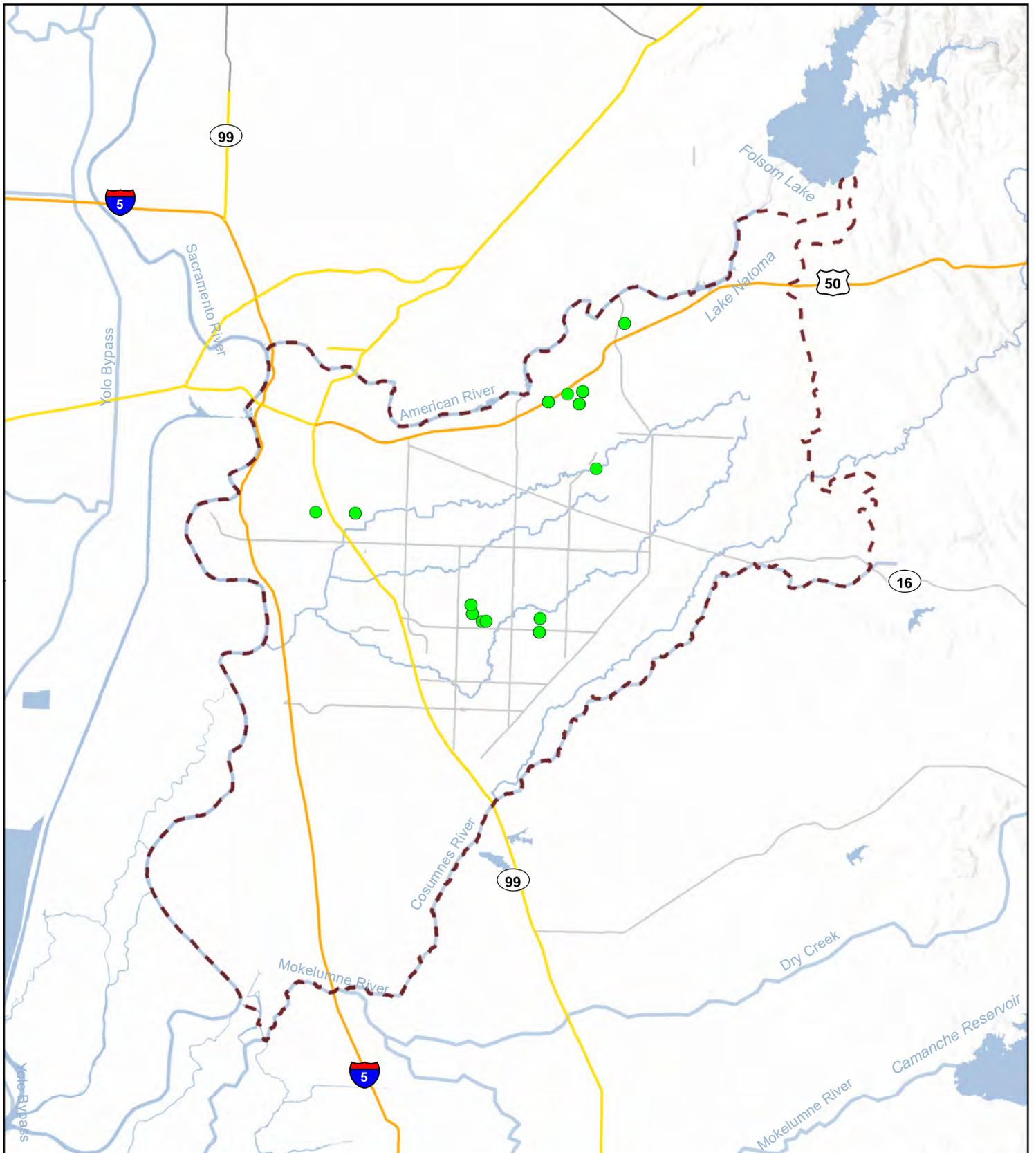
0 1.25 2.5 5 Miles

**South American SUBBASIN**

Map Created: 02 2021

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**South American Subbasin GSP**  
Hexavalent Chromium Concentrations in the Deep Zone (Screen Begins >300 Ft. bgs), GAMA  
Figure 2.3-37

**Legend**

- South American Subbasin
- Max. Hexavalent Chromium (2001-18), Deep Zone**
- Below 50% Proposed MCL (0 - 5 µg/L)

0 1.25 2.5 5 Miles

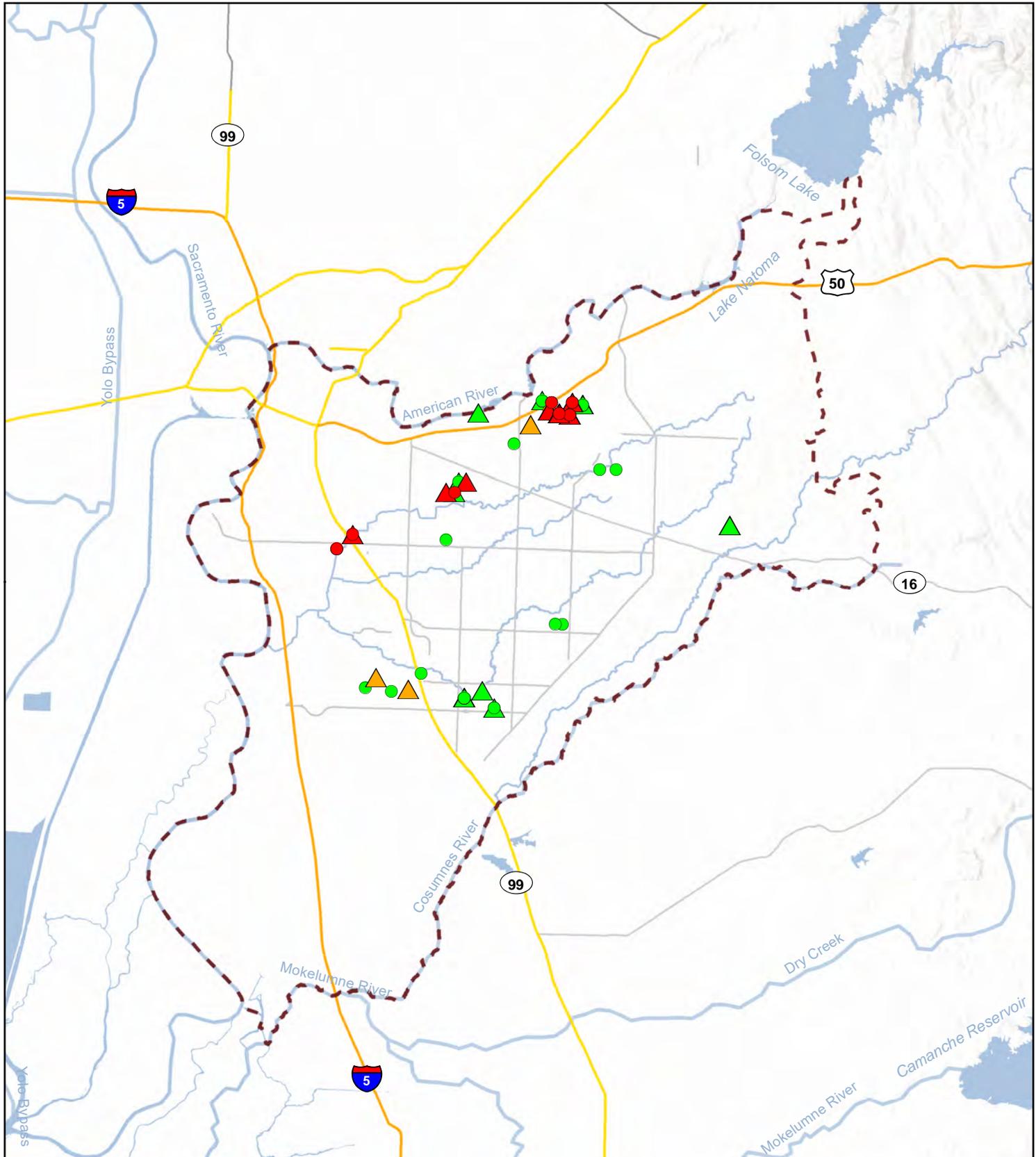


South American  
**SUBBASIN**

Map Created: 02 2021

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Figure Exported: 10/17/2021 By: OlinA Using: C:\Users\olinal\Dropbox (LWA)\OlinA601.03 - GSP 2020\_LFISAS GIS - Template and Final Figures\Sec 2-3 - PFAS\_OS\_All\_Aquifer\_2\_25\_2021\_v4\_wMWS\_lessConstit.mxd



### South American Subbasin GSP

#### PFOA and PFOS Concentrations in Groundwater

Figure 2.3-38

<b>Legend</b>	South American Subbasin		
	<b>Max. PFOA (2017-20)</b>		<b>Max. PFOS (2017-20)</b>
	<50% NL (0-2.55 ng/L)	<50% NL (0-3.25 ng/L)	
	>50% NL (>2.55-5.1 ng/L)	>50% NL (>3.25-6.5 ng/L)	
Above NL (>5.1 ng/L)	Above NL (>6.5 ng/L)		

0 1.25 2.5 5 Miles

**South American SUBBASIN**

Map Created: 10 2021

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### 2.3.5 Land Subsidence

Land subsidence is the lowering of the ground surface elevation and is often caused by groundwater pumping from an aquifer with a substantial number of clay layers. Land subsidence can be elastic and inelastic. Elastic subsidence is small, reversible lowering and rising of the ground surface and can be cyclical with seasonal changes year to year. Inelastic subsidence is irreversible. Land subsidence is not known to be historically or currently significant in the South American Subbasin.

#### Previous Land Subsidence Studies

Previous studies of land subsidence in the SASb have shown small-to-zero amounts of subsidence having occurred. Such efforts have mainly been through leveling profiles studied between 1947 and 1966, the 2006 GMP, a 2008 DWR and the US Bureau of Reclamation subsidence project throughout the Sacramento Valley using GPS technology (Frame Surveying & Mapping, 2008), and DWR's more recent Sacramento Valley 2017 GPS Survey program (specific results are summarized in SCGA [2018]), all of which demonstrated that subsidence has been very minimal, clearly not significant or unreasonable, across the SASb during the time period 2008-2017.

#### Current Data Sources and Analysis

DWR published Interferometric Synthetic Aperture Radar (InSAR) satellite data on their SGMA Data Viewer web map , providing an estimate of land subsidence for the time period from June 13, 2015, to October 1, 2020. **Figure 2.3-39** shows total vertical displacement between June 2015 and September 2019. The maximum total displacement is 0.15 feet or 1.8 inches and is located on the west side of SASb at two locations west of Elk Grove and at one location along the Sacramento River. The figure shows considerably smaller values throughout the remainder of the subbasin. These data are processed by TRE Altamira and are made available by DWR as downloadable raster and point datasets for monthly time steps, updated annually.

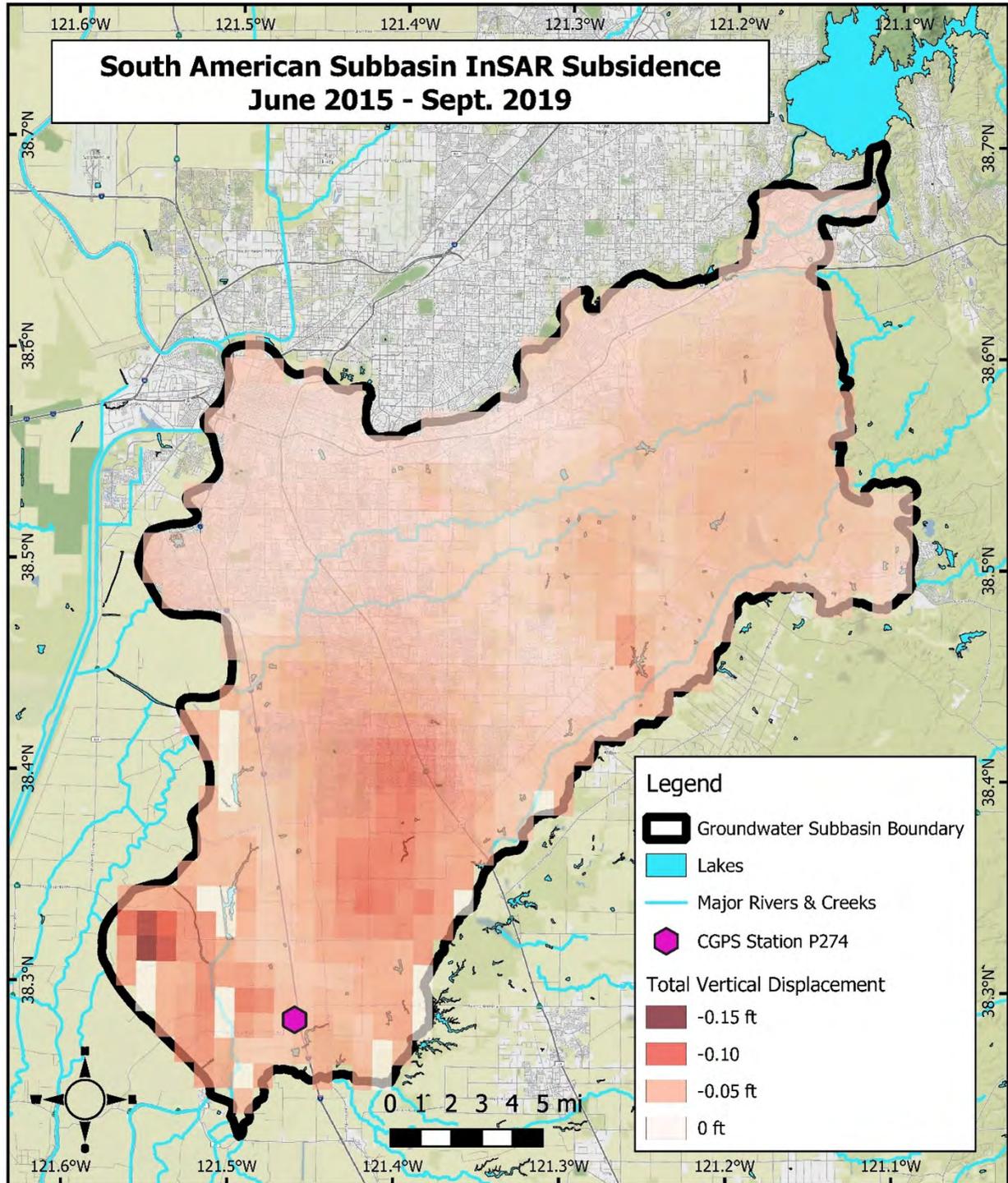
Elevation data are recorded daily at one continuous global positioning satellite (CGPS) station (P274), located in the southwestern corner of SASb. **Figure 2.3-40** is a time series plot of the elevation data, beginning in October 2005 to through October 2020. The trend line suggest minimal land subsidence has occurred at the station since October 2005, equating to -0.14 feet in total, or less than -0.01 feet/year.

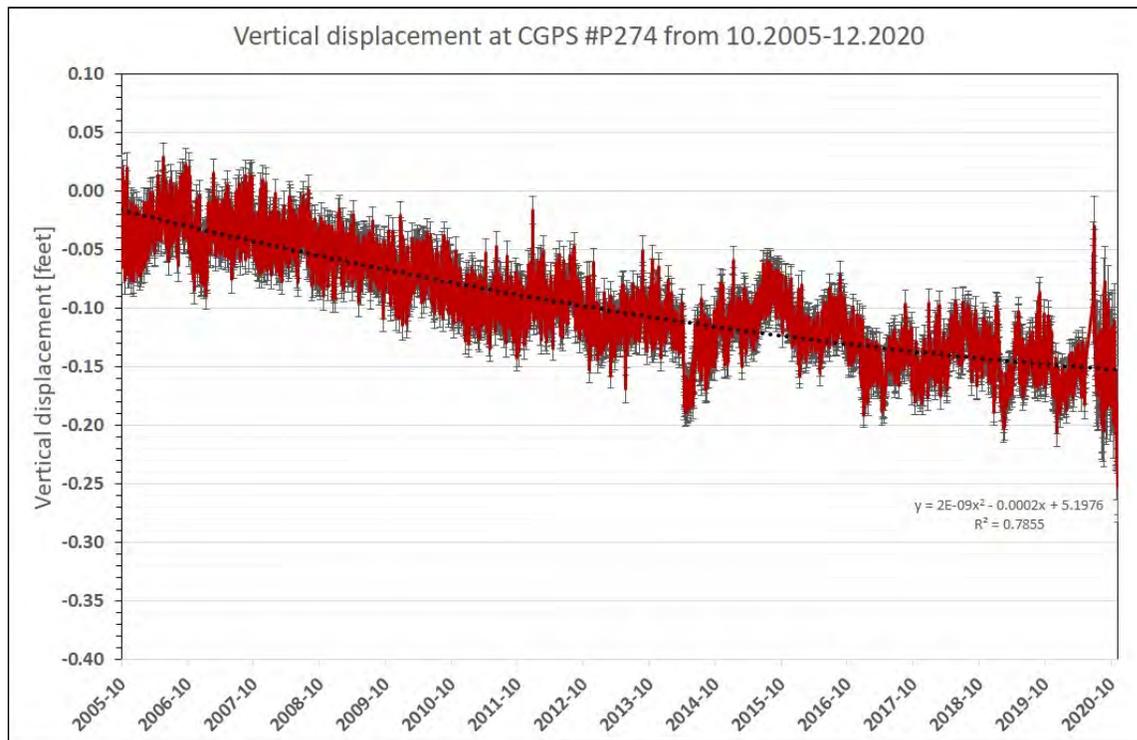
The analysis of CGPS and InSAR data confirm the results of previous studies, i.e., minimal occurrence of subsidence in the SASb. Additional information on InSAR data can be found on the CNRA data access webpage<sup>4</sup>.

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<sup>4</sup> <https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence>

**Figure 2.3-39: South American Subbasin InSAR Subsidence, June 2015 – September 2019**





1. Note: Trend line added solely for the purpose of added assistance with the interpretation of subsidence time series data. Trend line equation included for reference.

**Figure 2.3-40: South American Subbasin CGPS Station (UNAVCO #P274) Subsidence, October 2005 – December 2020<sup>1</sup>**

### 2.3.6 Interconnected Surface Water Systems

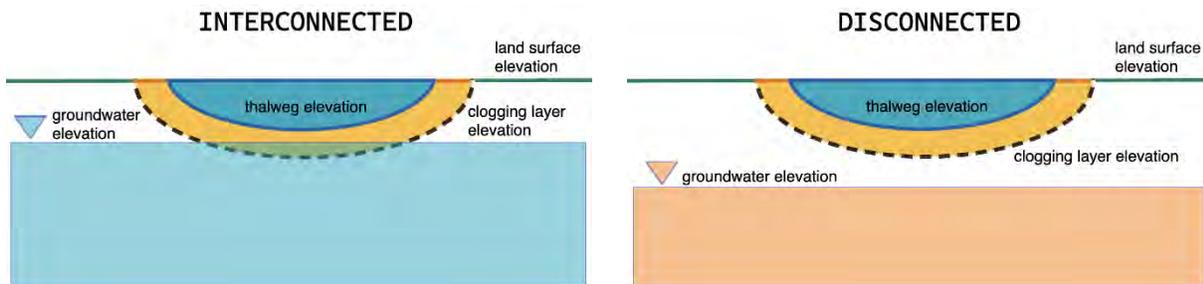
This section presents a characterization of present-day Interconnected Surface Water (ISW) within the Subbasin. ISW are distinguished from disconnected systems in that they are connected by a continuous saturated zone to the regional groundwater system. A detailed description of historical, present day, and future ISW (under projected groundwater conditions and climate change) is discussed in **Appendix 3-A: Interconnected Surface Water (ISW) in the South American Subbasin: Characterization of Historical and Present-day Conditions, and Approaches for Monitoring and Management**, and a summary of historical and present day ISW is presented here.

#### Identification of interconnected surface water systems

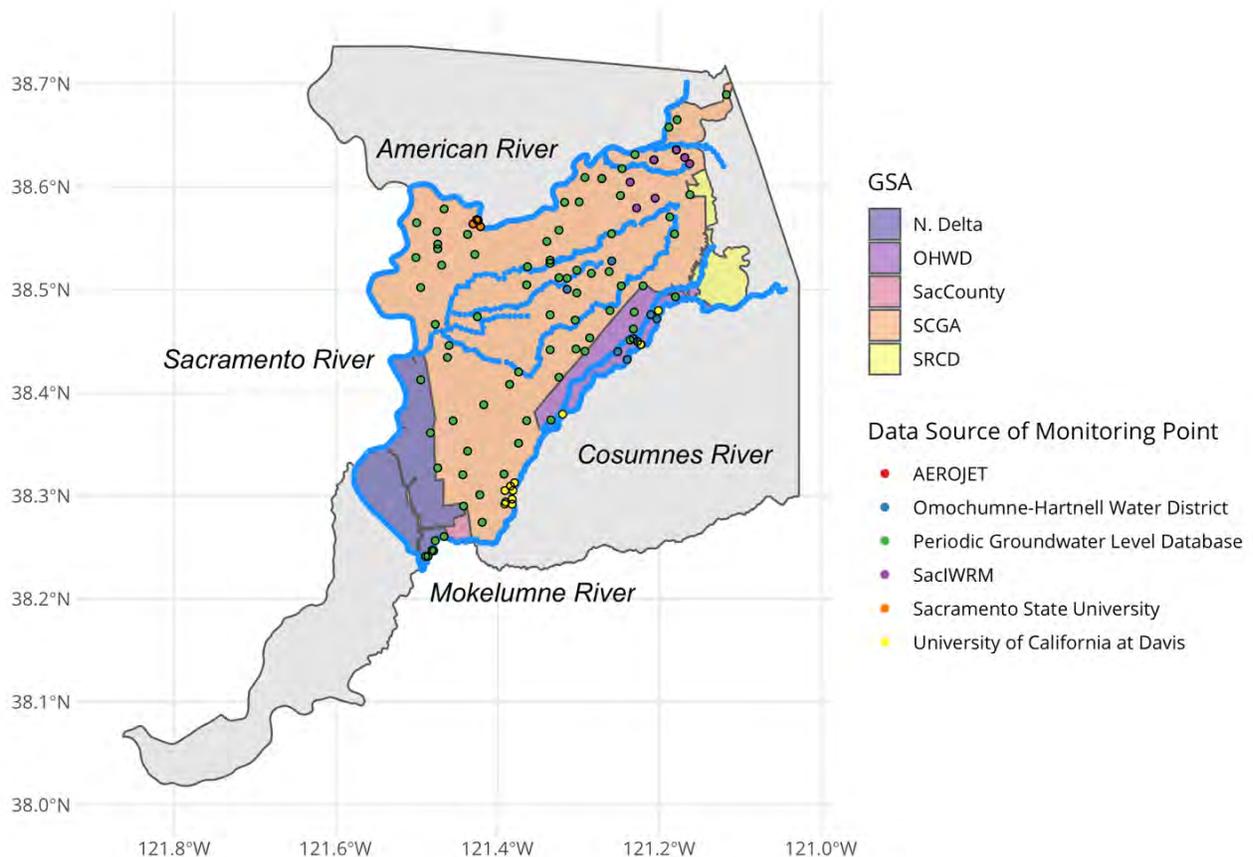
Groundwater levels change over time, and thus ISW locations also change over time. To assess the timing of ISW interconnection and disconnection, all available shallow groundwater elevation data were used to kriged groundwater elevation surfaces at spring and fall seasons between 2005 and 2018. Next, the best available streambed elevation<sup>5</sup> data were combined with local soil maps as an estimate of the clogging layer beneath the thalweg. If the groundwater elevation intersects the clogging layer, a stream node is considered ISW for the time considered,

<sup>5</sup> Streambed locations and elevations used in this analysis are the same as those in the CoSANA groundwater flow model to maintain consistency in data and models.

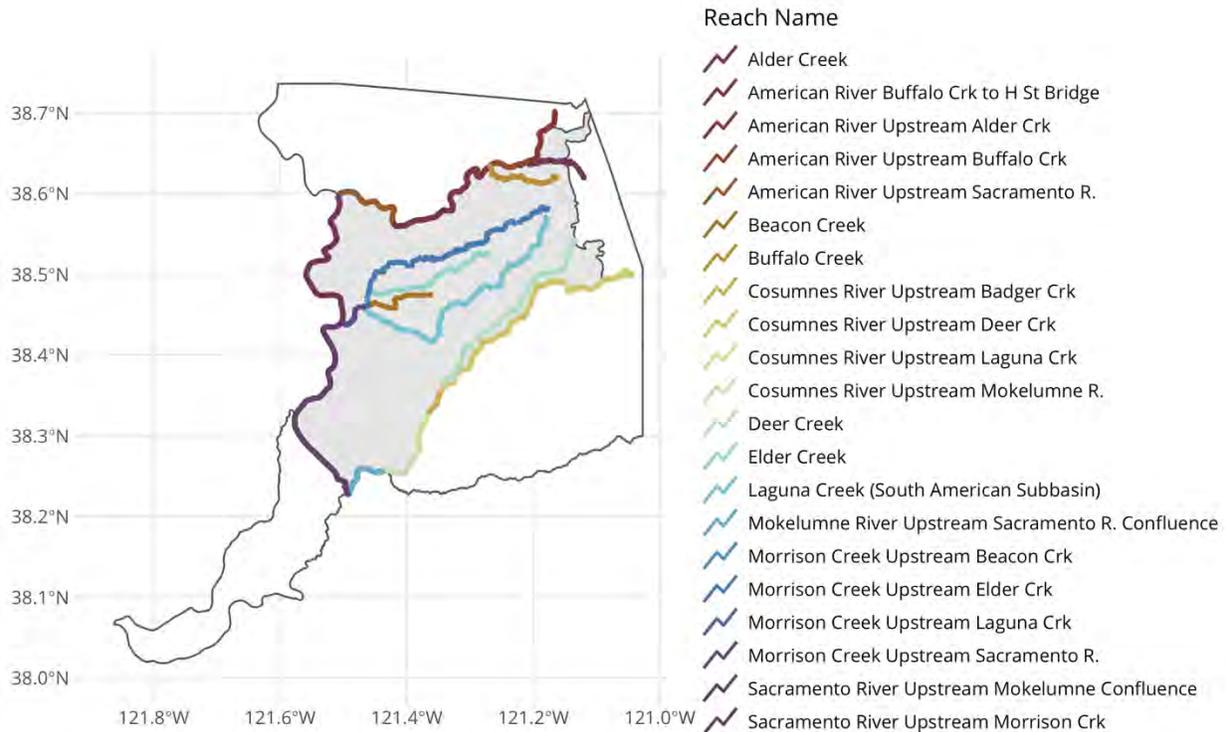
otherwise, it is considered disconnected (**Figure 2.3-41**). The surface waters considered in this analysis included only major surface water systems represented in the CoSANA model (**Figure 2.3-42**), which are subdivided in 21 reaches (**Figure 2.3-43**).



**Figure 2.3-41: Classification of Interconnected Surface Water (ISW) and Disconnected stream nodes depends on a comparison of the clogging layer elevation beneath the streambed and the groundwater elevation.**



**Figure 2.3-42: South American Subbasin surface water nodes in the CoSANA model, GSAs, and locations of groundwater level monitoring locations and sources used for seasonal groundwater level interpolation.**



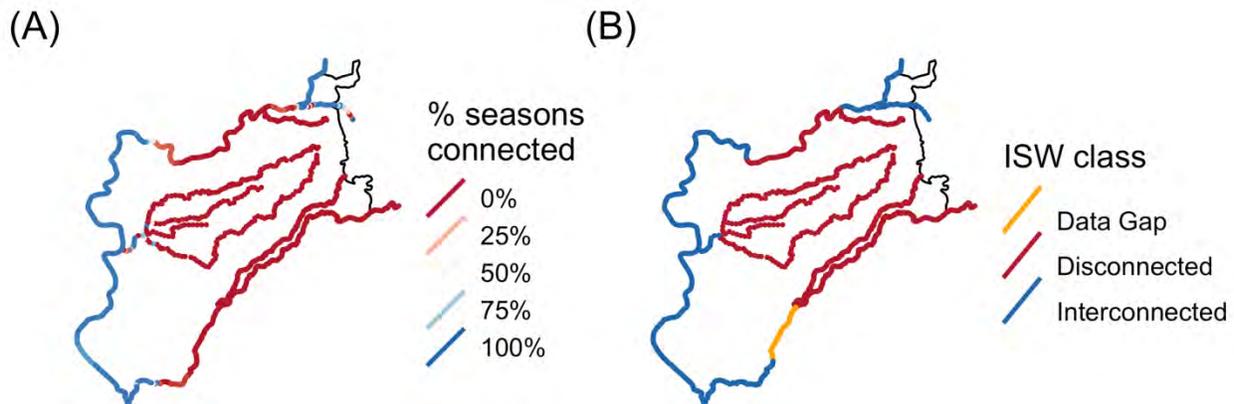
**Figure 2.3-43: Major surface waters in the South American Subbasin divided into 21 reaches, based on CoSANA surface node representation.**

### Location of interconnected surface water systems

After seasonal groundwater elevations were intersected with the elevation of the clogging layer, the percentage of seasons over the historical period were evaluated to determine whether a stream node was interconnected to groundwater. **Figure 2.3-44** shows the percentage of seasons where surface water is historically connected to groundwater (A) for the various stream reaches and final ISW classification (B).

Finally, present day ISW was defined by considering historical variation in ISW. Disconnected stream reaches are persistently disconnected from groundwater at all seasons evaluated, whereas Interconnected reaches (ISW) are conservatively defined as having at least the majority of nodes connected for > 0% of all seasons evaluated. In other words, if the majority of surface water nodes in a reach are connected for at least one season in the historical period considered, the entire reach is considered ISW. Results indicate ISW along the entire Sacramento and Mokelumne rivers that border the South American Subbasin, and along reaches of the American River and Cosumnes River. Alder Creek and Morrison Creek above the Sacramento River are also identified as ISW. This characterization of ISW is consistent with The Nature Conservancy’s ICONS web tool (TNC, 2021), which uses a similar methodology of comparing streambed elevation and groundwater levels.

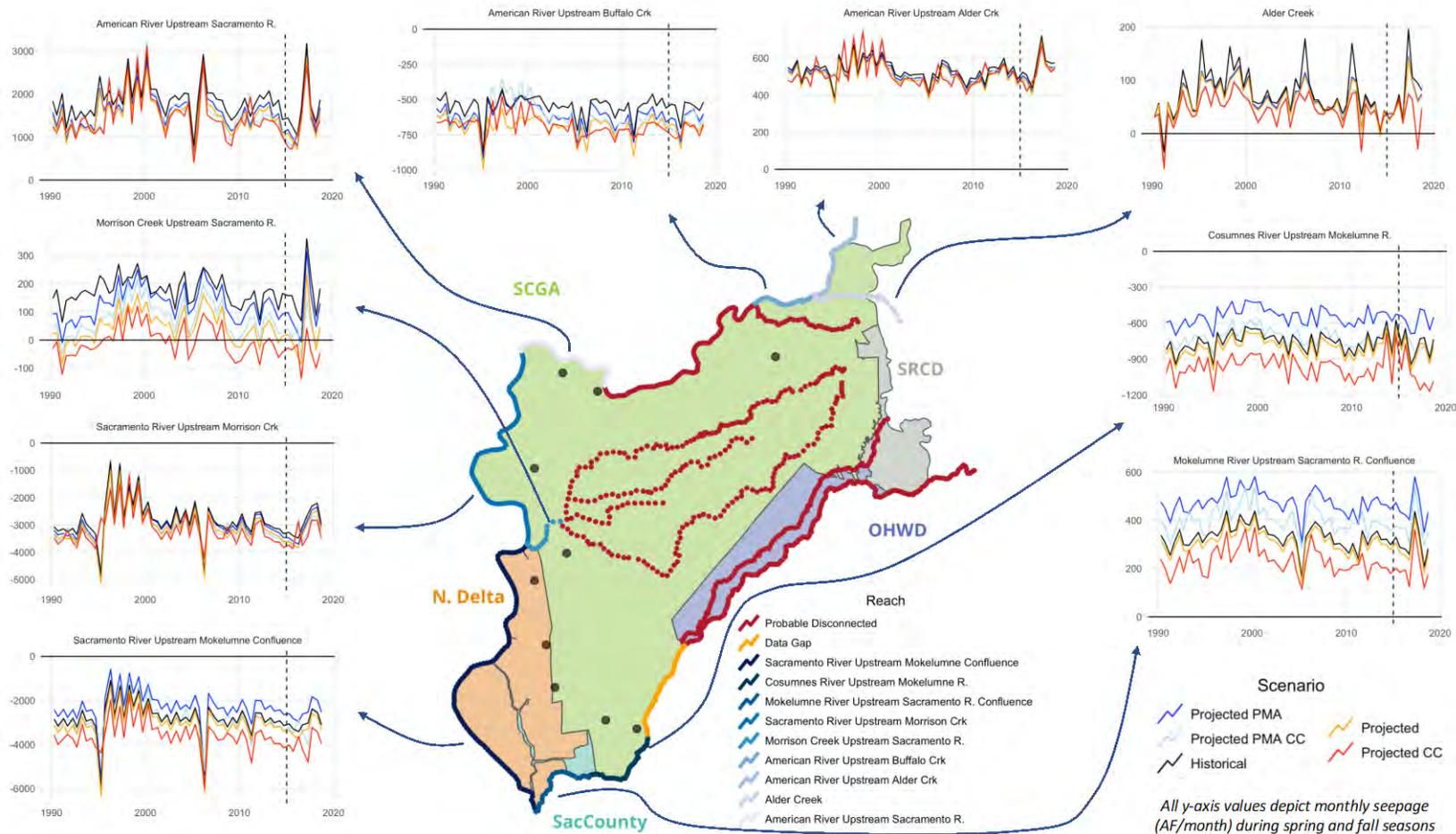
The Cosumnes River, approximately between Deer Creek and Twin Cities Road, is disconnected on a seasonal level, but some evidence of sub-seasonal connection exists, so this reach is considered a data gap for planning purposes and more research is needed to understand stream-aquifer interactions in this region.



**Figure 2.3-44: South American Subbasin Interconnected and Disconnected stream nodes according to (A) historical percentage of seasons between 2005-2018 that the node is connected to groundwater; and (B) final classification of ISW.**

### Estimates of timing and quantity of interconnected surface water depletions

Stream-aquifer interaction is, in practice, very difficult to measure in the field and hence the timing and quantity of ISW depletion (i.e., seepage) is almost always estimated by a model. In this case, stream seepage is estimated by the CoSANA integrated surface and groundwater model and evaluated along ISW reaches. Negative seepage indicates a losing stream system and positive seepage indicates a gaining stream system. All ISW reaches identified are persistently gaining or losing across the CoSANA current conditions baseline (**Figure 2.3-45**). Importantly, analysis to support the development of Sustainable Management Criteria (**Section 3**) rely on comparison of the baseline ISW seepage to ISW seepage under projected groundwater management and climate change scenarios.



**Figure 2.3-45: Seasonally averaged ISW depletion estimated by CoSANA at ISW designated reaches. The black line represents historical to near present-day conditions. See Section 3.3.1.2 for more details on projected scenarios.**