June 2026

DRAFT REPORT

South American Subbasin Groundwater Sustainability Plan
2027 Update

South American
SUBBASIN

SCGA Sacramento Central Groundwater Authority

SACRAMENTO COUNTY

Omochumne - Hartnell Water District
Servicing the Community of the Cosumnes River

NDGSA
NORTHERN DELTA GROUNDWATER SUSTAINABILITY AGENCY

RECLAMATION DISTRICT 551

Contributing GSAs

South American
SUBBASIN

NDGSA
NORTHERN DELTA
GROUNDWATER
SUSTAINABILITY AGENCY

SACRAMENTO
COUNTY

SCGA Sacramento Central
Groundwater Authority

Omochumne - Hartnell Water District
Servicing the Community of the Cosumnes River

RECLAMATION DISTRICT 551

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

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GEI Consultants, Larry Walker Associates, and Woodard & Curran compose the consulting technical team for the South American Subbasin Groundwater Sustainability Plan 2027.

Other consultant contributors include Stantec (DWR-funded facilitators).

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Preface

As Groundwater Sustainability Agencies (GSAs) continue to collect new data and gain experience managing the South American Subbasin (Subbasin), the Groundwater Sustainability Plan (GSP or Plan) is expected to evolve over time. The 2027 GSP for the Subbasin incorporates updated information developed through five years of GSP implementation, as well as responses to recommended corrective actions identified by the Department of Water Resources (DWR) in the Statement of Findings Regarding the Approval of the Sacramento Valley – South American Subbasin Groundwater Sustainability Plan issued July 27, 2023.

This 2027 GSP reflects new data, refined analyses, and additional project and monitoring information developed since adoption of the 2022 GSP. While these updates enhance the Plan, the fundamental components of the GSP remain unchanged. The Sustainable Management Criteria (SMCs), including measurable objectives, minimum thresholds, and interim milestones, remain materially unchanged, and implementation of projects and management actions continues to proceed as planned. The undesirable result definitions for land subsidence and degraded water quality have been refined in response to DWR's recommended corrective actions, but the underlying numeric criteria and the Subbasin's sustainability goal are unchanged. The approach to undesirable results and definition of SMCs for depletions of Interconnected Surface Water (ISW) due to groundwater use have been refined further in response to the DWR's recommended corrective action and information published by the DWR for analysis of depletion of ISWs.

Based on the findings of the 2027 Periodic Evaluation, the GSAs determined that the GSP is being implemented in a manner consistent with achieving the Subbasin's sustainability goal. As a result, a formal Plan Amendment is not required at this time. The 2027 GSP, together with the accompanying 2027 Periodic Evaluation, represents the current and authoritative version of the Plan.

To maintain continuity, figures and information from the 2022 GSP that remain valid are retained in this 2027 GSP. Updated figures are identified with a 2027 title block, while unchanged figures retain the 2022 designation.

Moving forward, GSP implementation will continue, progressing towards achieving the Subbasin's sustainability goal by 2042.

The table below summarizes the 2027 GSP sections that have been modified or added.

Section	Subsection	Title
Section 2	2.1.2.6	Land Use Types
	2.1.2.7	Wells
	2.1.7	Subsidence Monitoring
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Section	Subsection	Title
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	4.5.2	Wilton Road Floodplain Reconnection Project
	4.7.4	Address Data Gaps

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), Reclamation District No. 551 and Sacramento County. The Sloughhouse Resource Conservation District (SRCD) GSA withdrew as a GSA in December 2025, and the other GSAs are working cooperatively with DWR to bring that area under the jurisdiction of one of the other GSAs.

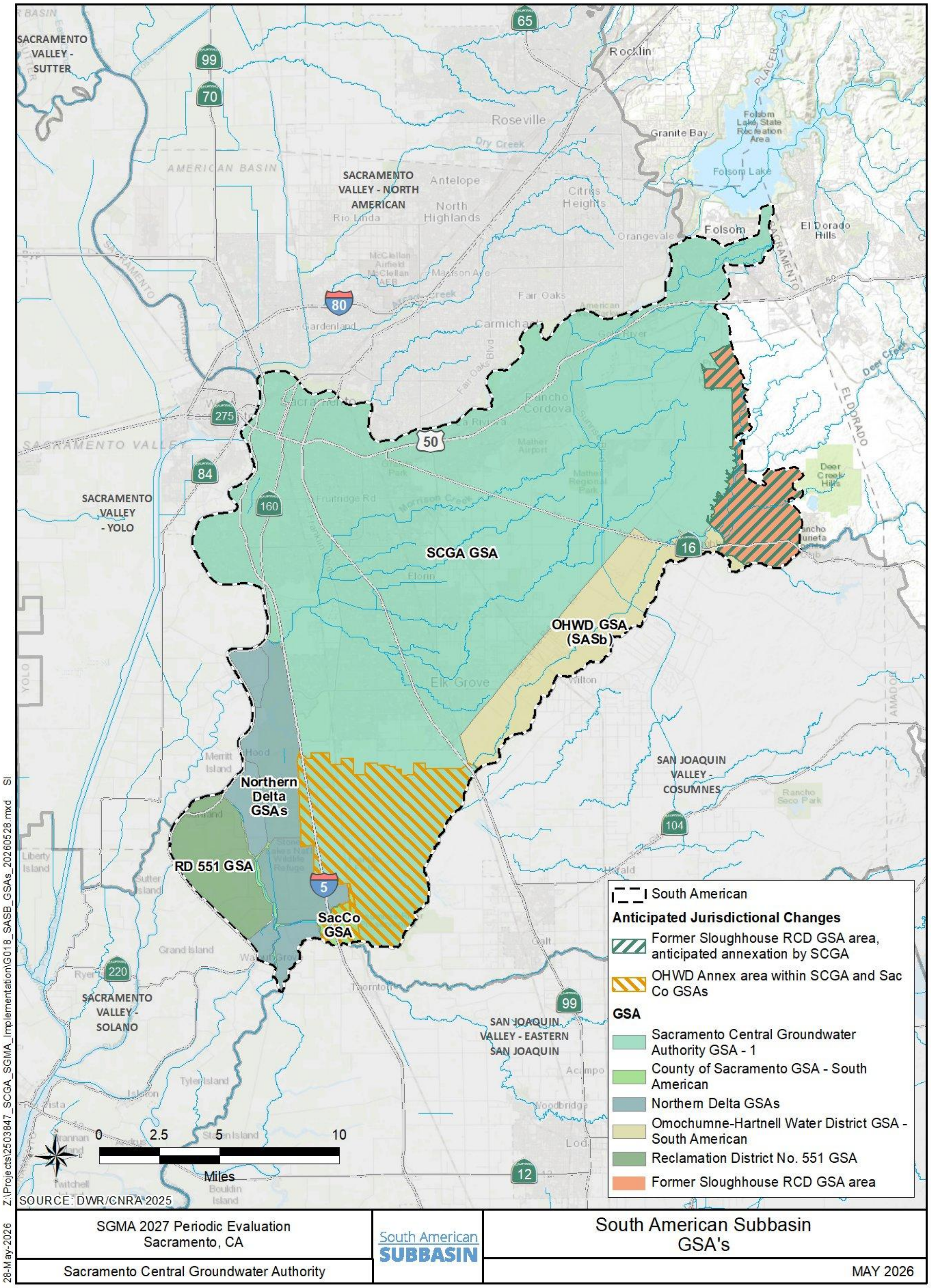


Figure ES-1: GSAs in the South American Subbasin (Figure 2.1-3)

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.

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.

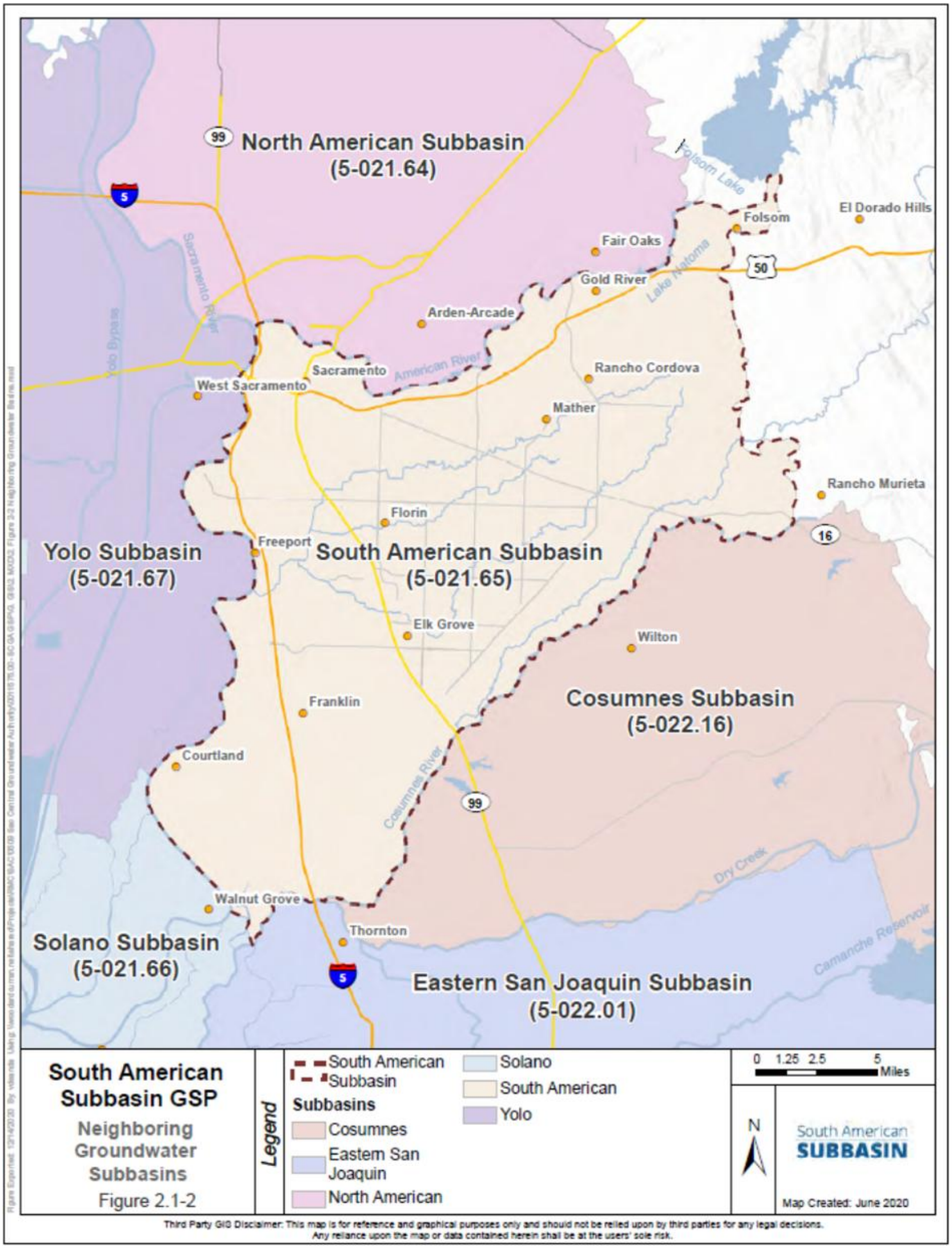


Figure ES-2: SASb and bordering subbasins (Figure 2.1-2)

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

Existing Water Management Plans	Plan Purpose and Goals
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.
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.

Existing Water Management Plans	Plan Purpose and Goals
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.

Since the GSP was submitted to DWR in January 2022, two additional plans have been developed that add to information relevant to the GSP. The two most relevant reports are the American River Basin Study (by the US Bureau of Reclamation) and the Regional Water Authority Watersheds Resilience Plan.

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**.

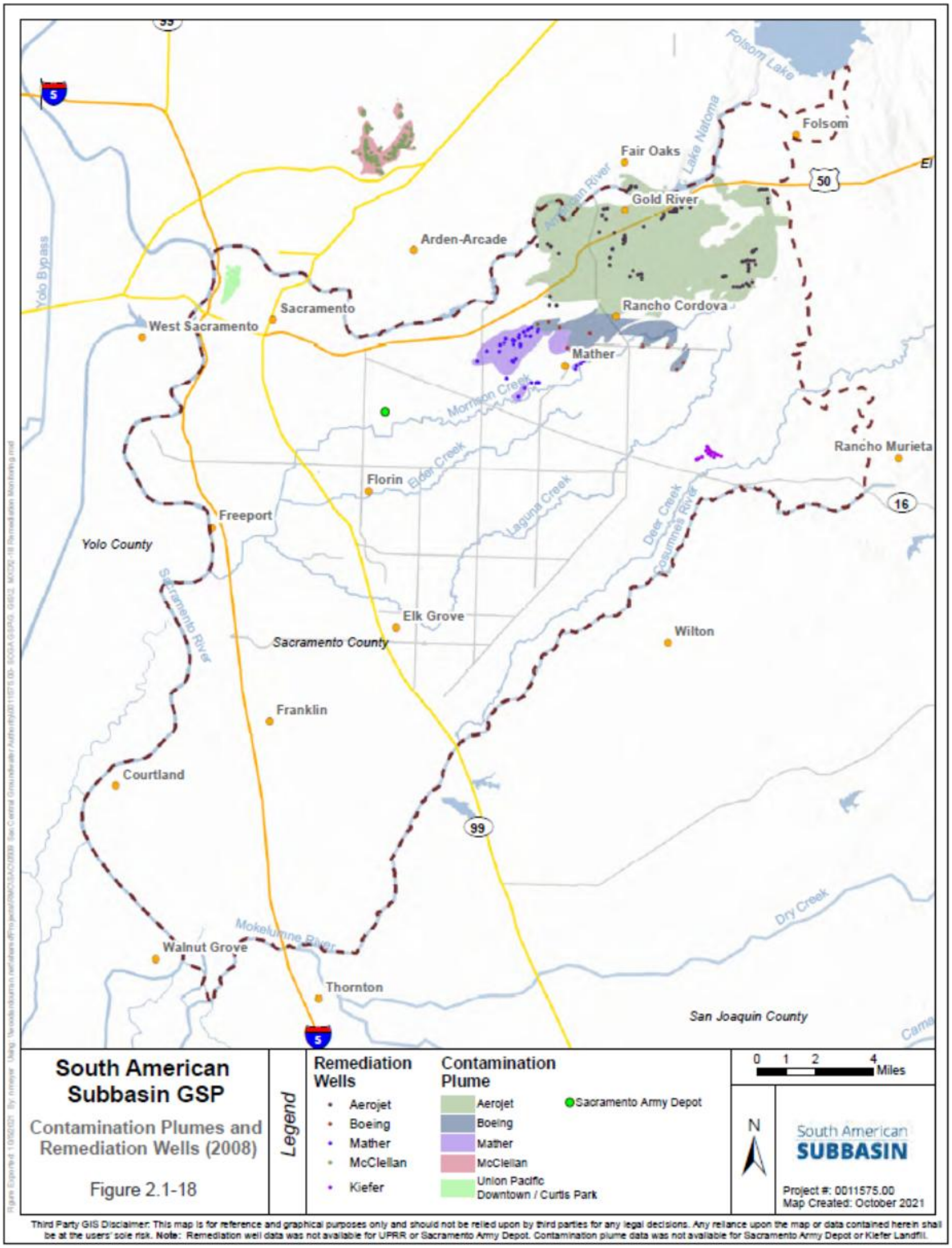


Figure ES-3: Known SASb contaminant plumes and sites (Figure 2.1-18)

Table ES-2: SASb remediation activities

Remediation Site	Description
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.
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.

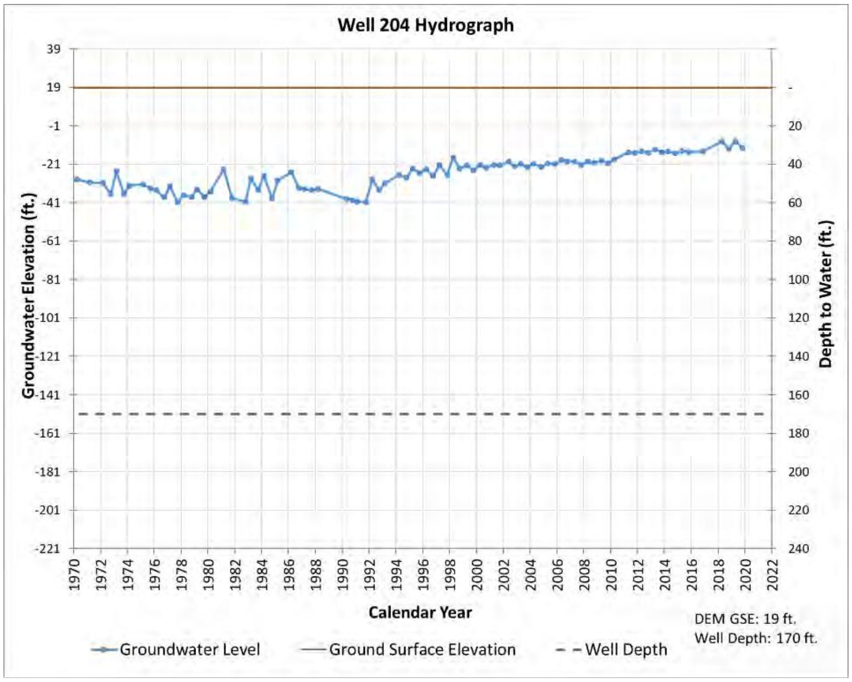
Groundwater Conditions (Section 2.3)

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)

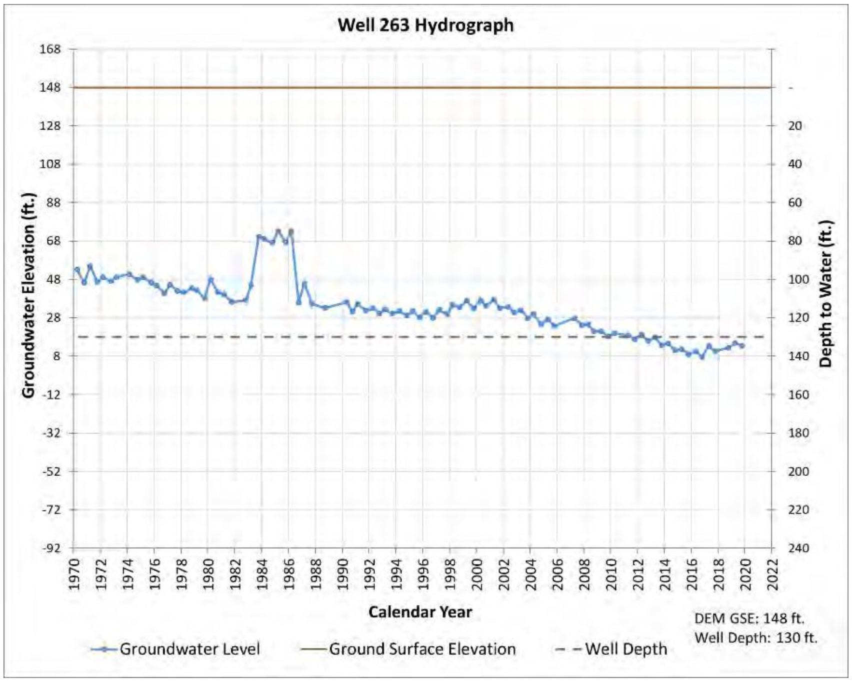
Groundwater levels in the western portion of the SASb have been generally increasing since the 1980s despite a turn towards drier conditions and increasing population (**Figure ES-4)**. The recent increase in groundwater levels has been largely attributed to a combination of conjunctive use projects (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 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.



DEM GSE: 19 ft.
Well Depth: 170 ft.

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



DEM GSE: 148 ft.
Well Depth: 130 ft.

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), specific conductance, 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 and specific conductance have generally been lower than the recommended secondary maximum contaminant level (SMCL) of 500 mg/L and 900 micromhos/cm. 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). An updated evaluation of interconnected surface water conditions was conducted using recent model results to further refine the understanding of groundwater-surface water connectivity. This analysis evaluated the percentage of model timesteps during which groundwater levels exceeded stream invert elevations at individual stream nodes over the period WYs 2015 through 2024 (**Figure ES-6**).

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 50th 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.

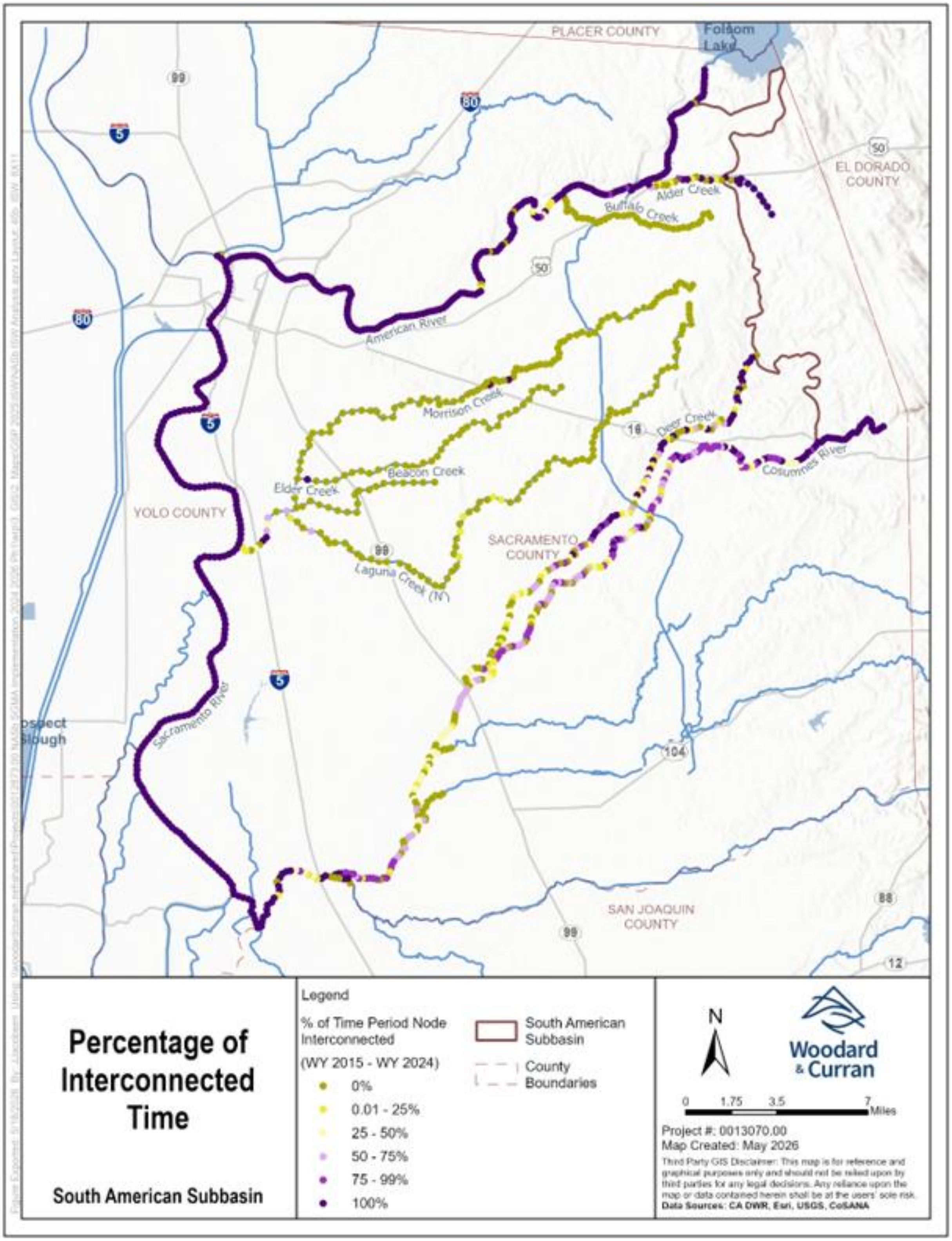


Figure ES-6: Percentage of Interconnected Time (WY 2015–2024) (Figure 2.3-49)

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 2026. 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).

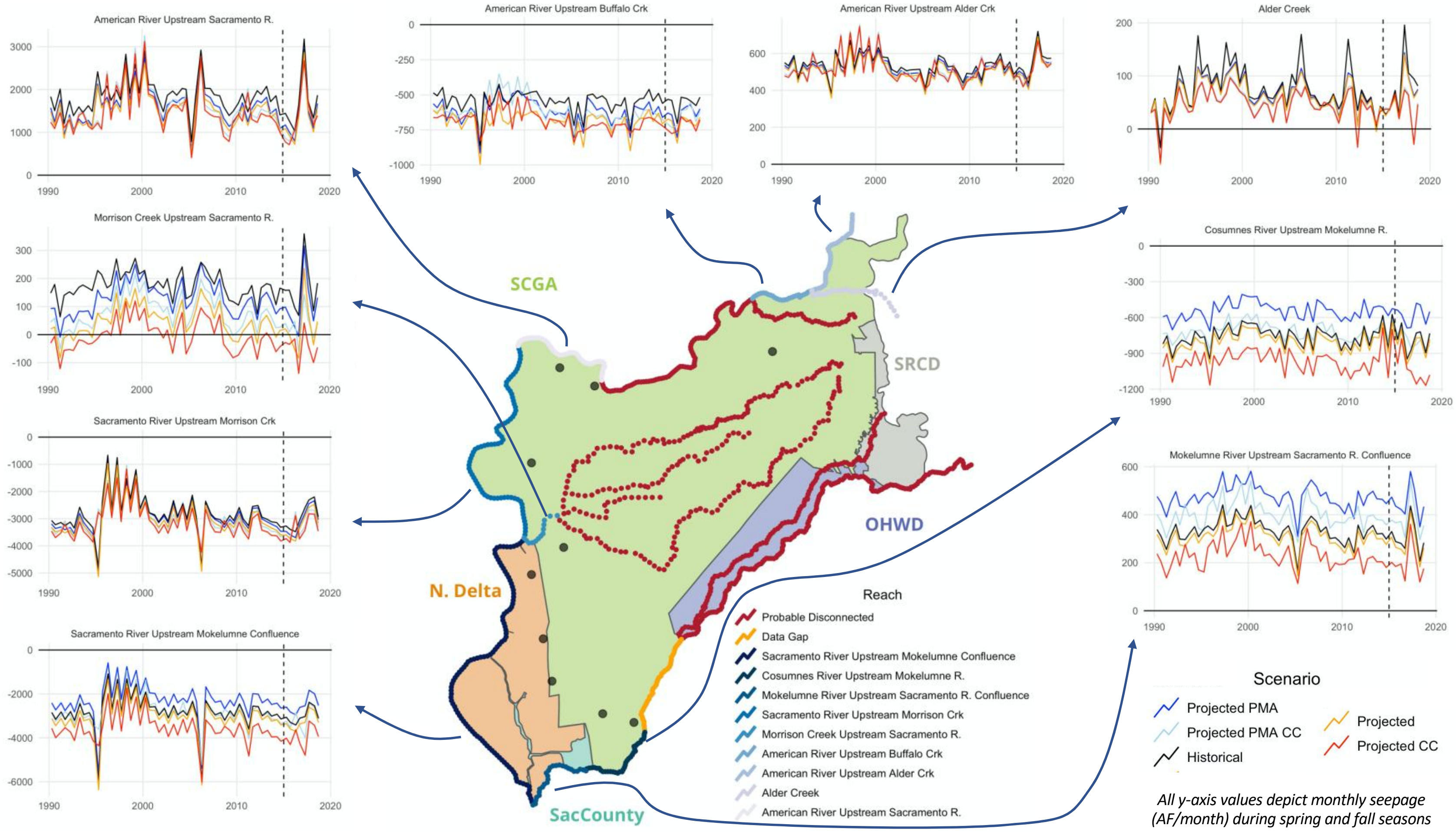


Figure ES-7: Seasonally averaged monthly seepage estimated by CoSANA at ISW designated reaches. The dashed vertical line separates pre- and post-SGMA. See Section 3.3.1.2 for more details on projected scenarios (Figure 2.3-44).

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 historical conditions have been updated with hydrology, water demands, and supply through water year (WY) 2025. The review of land use and water demands and supply since the analyses for the GSP indicated no significant changes to current conditions, so the other three baselines were not updated. 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

Baseline	Average Annual Groundwater Storage Change (AFY)
Historical Conditions. 1995-2025	+4,500
Current Conditions, 1970-2019, 2019 demands	+2,200
Projected Conditions without Climate Change, 2019 demands	-1,100
Projected Conditions with Climate Change, 2019 demands and 2070 central tendency climate	-6,200

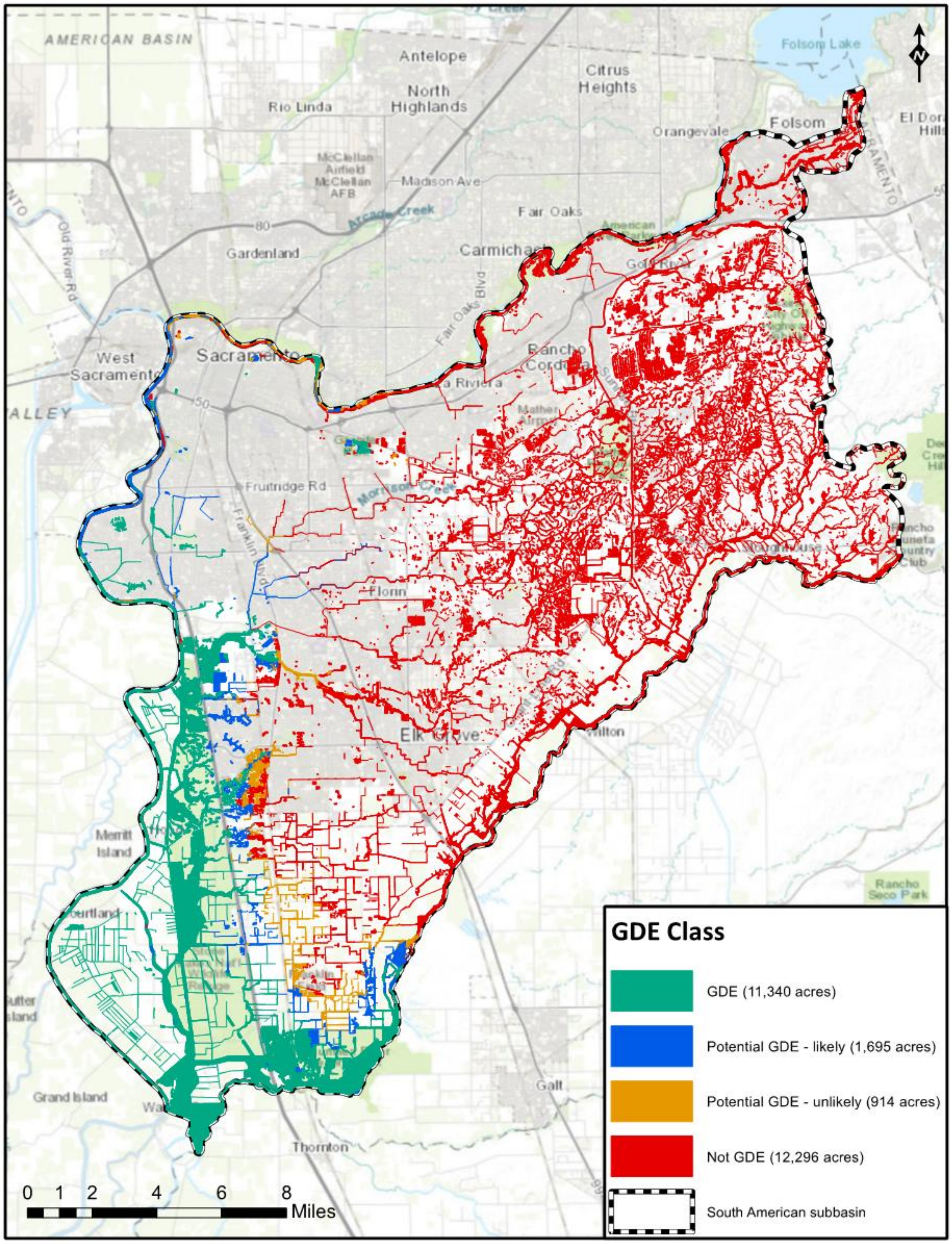


Figure ES-8: **GDE likelihood classification of potential GDEs from 2005-2018 (Figure 2.3-53)**

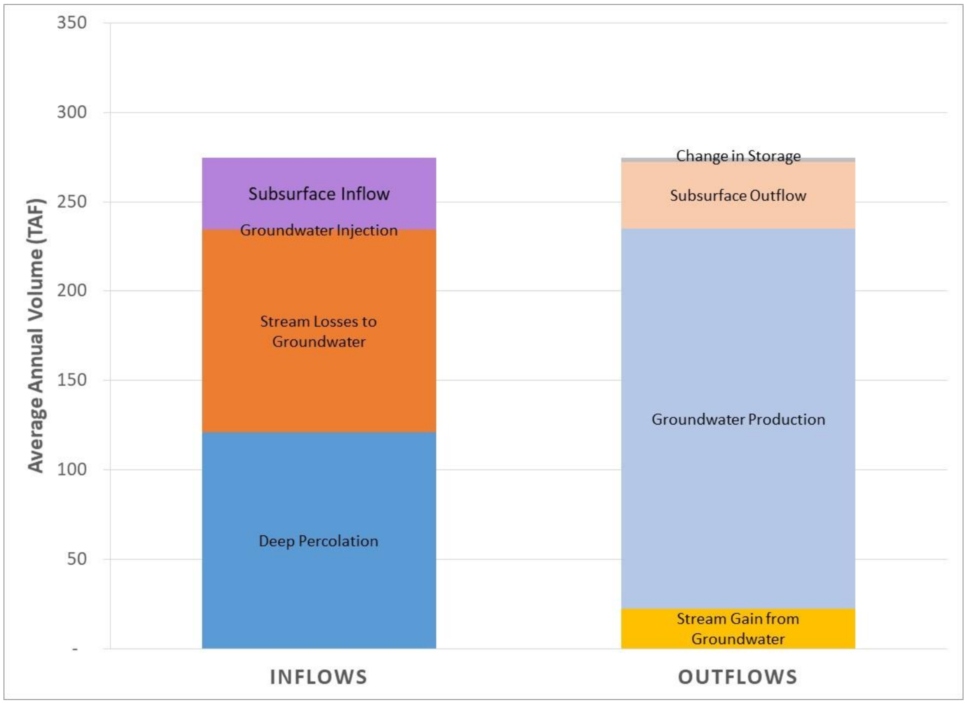


Figure ES-9: Current conditions average annual water budget – groundwater system (Figure 2.4-8)

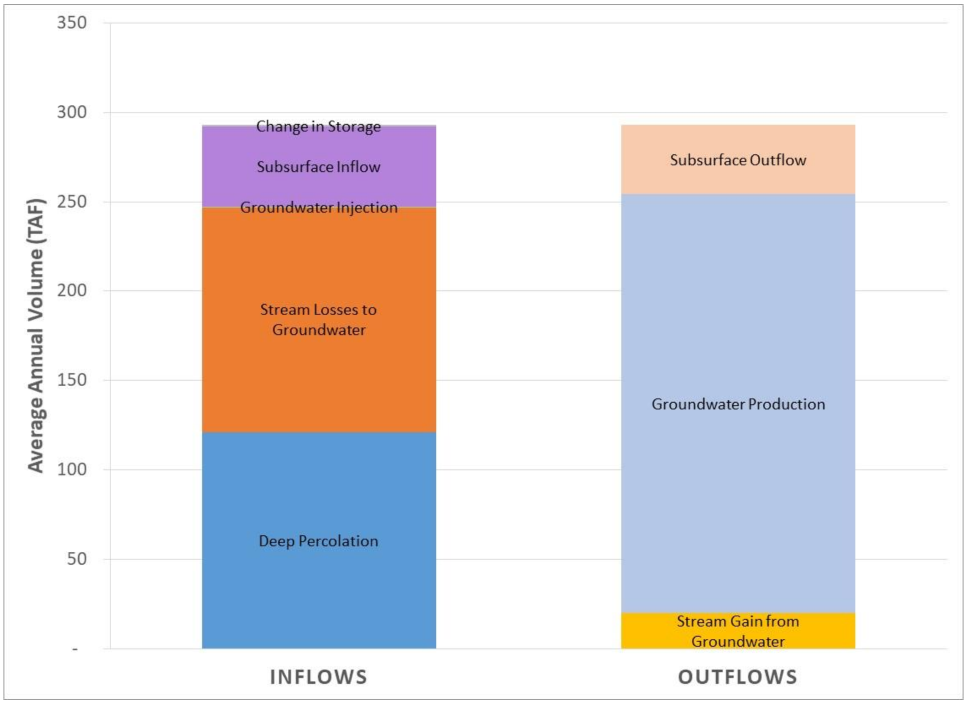


Figure ES-10: Projected conditions *without* climate change average annual water budget – groundwater system (Figure 2.4-11)

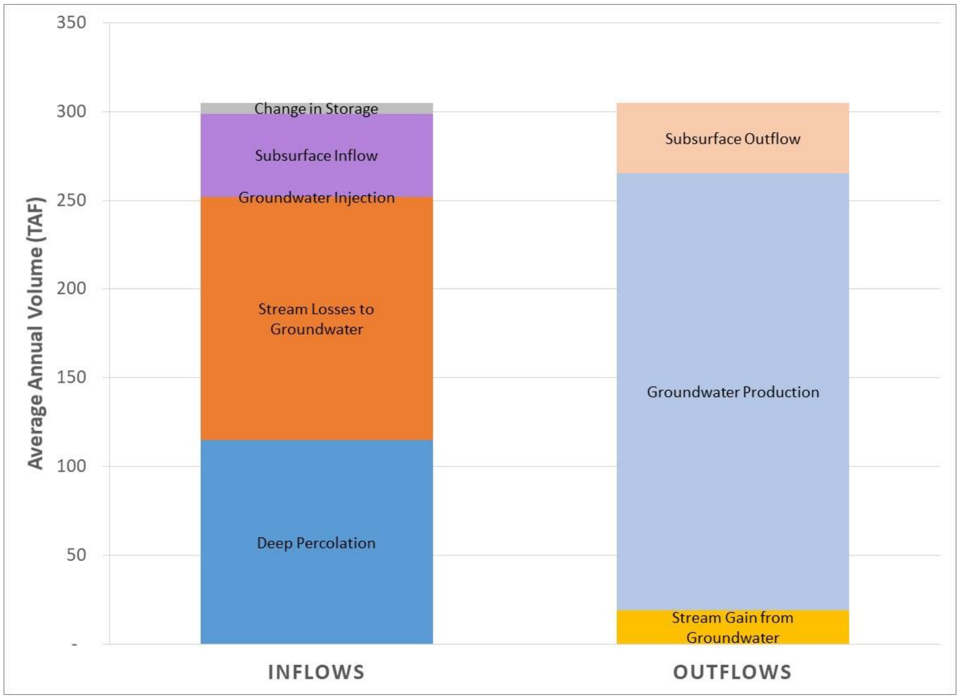


Figure ES-11: **Projected conditions *with* climate change average annual water budget – groundwater system (Figure 2.4-14)**

Groundwater Storage (Section 2.3.2)

The CoSANA model was used to estimate historical changes in storage of groundwater in the SASb from 1995 to 2025. **Figure ES-12** shows annual total groundwater storage for the SASb and the cumulative change in storage over varying water year types. Between 1995 and 2025, the cumulative storage in the subbasin is estimated to have increased by 139,000 acre-feet. For the most recent 10-year period (2016 to 2025), the cumulative storage increase is estimated to be approximately 109,000 acre-feet.

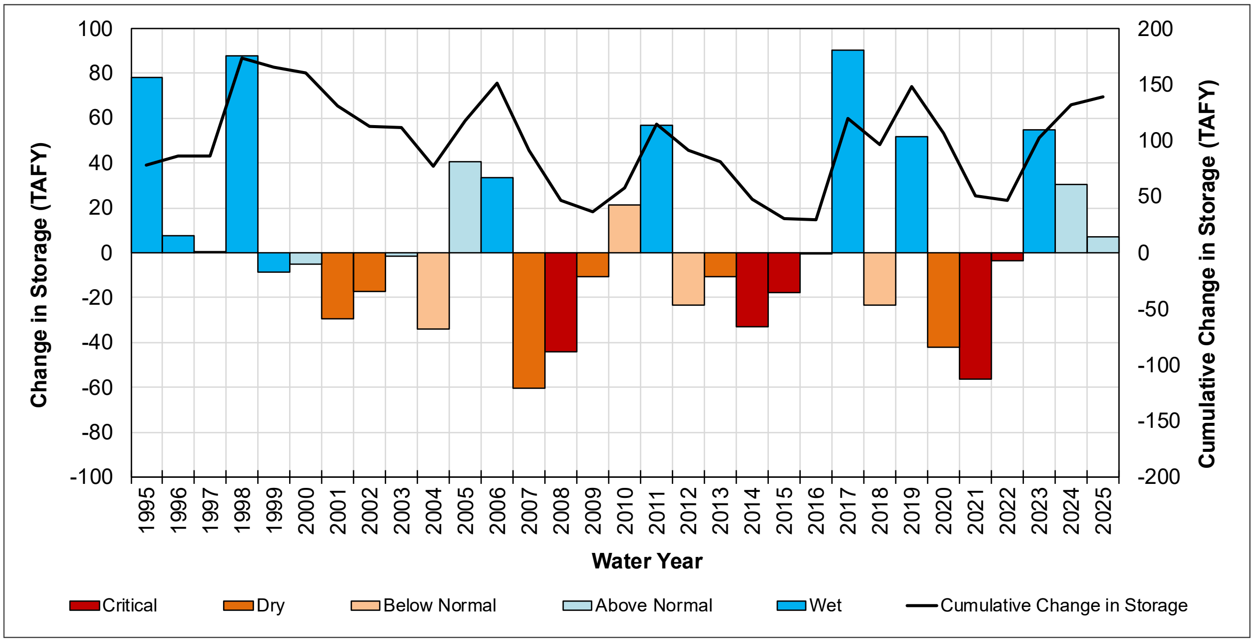


Figure ES-12: Groundwater storage by year, water year type, and cumulative water volume (Figure 2.3-26)

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)

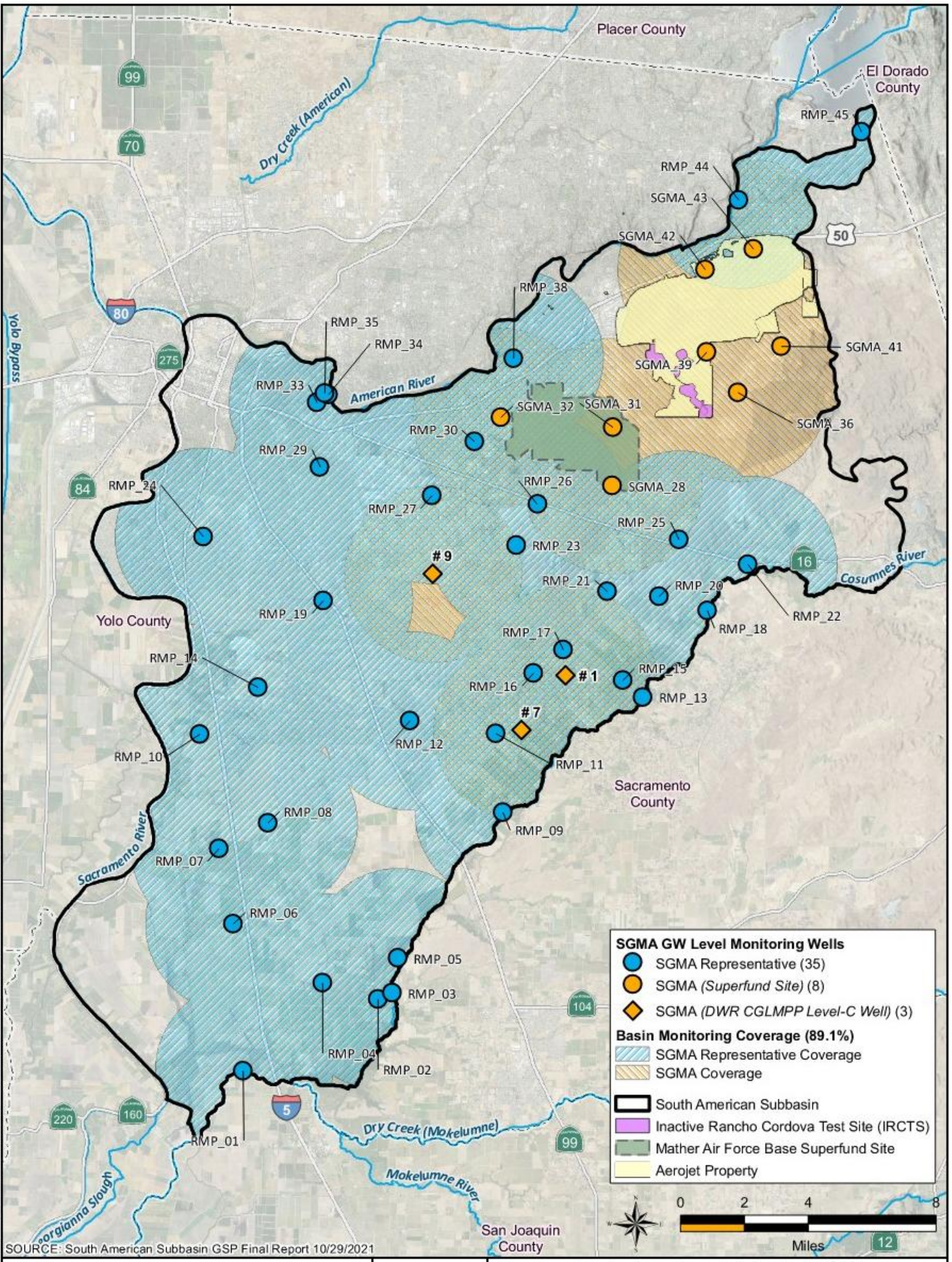
The Sustainability Goal for the SASb is to protect and ensure the long-term viability of groundwater resources for urban, domestic, agricultural, industrial, and environmental beneficial users of groundwater. The Sustainability Goal will be achieved by rigorous monitoring and assessment of potential 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 five 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 46 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**. The eight wells spanning the SASb selected to monitor interconnected surface water sustainability indicators are shown in **Figure ES-15**.

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

Sustainability Indicator	Undesirable Results Definitions
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 two representative monitoring wells exceed the minimum threshold for nitrate, or more than two representative monitoring wells exceed the minimum threshold for specific conductance.
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	When subsidence exceeds 0.1 foot in a single year and a cumulative 0.5 foot [0.15 m] in any five-year period as measured in at least a 5 square mile area of the Subbasin.



SOURCE: South American Subbasin GSP Final Report 10/29/2021

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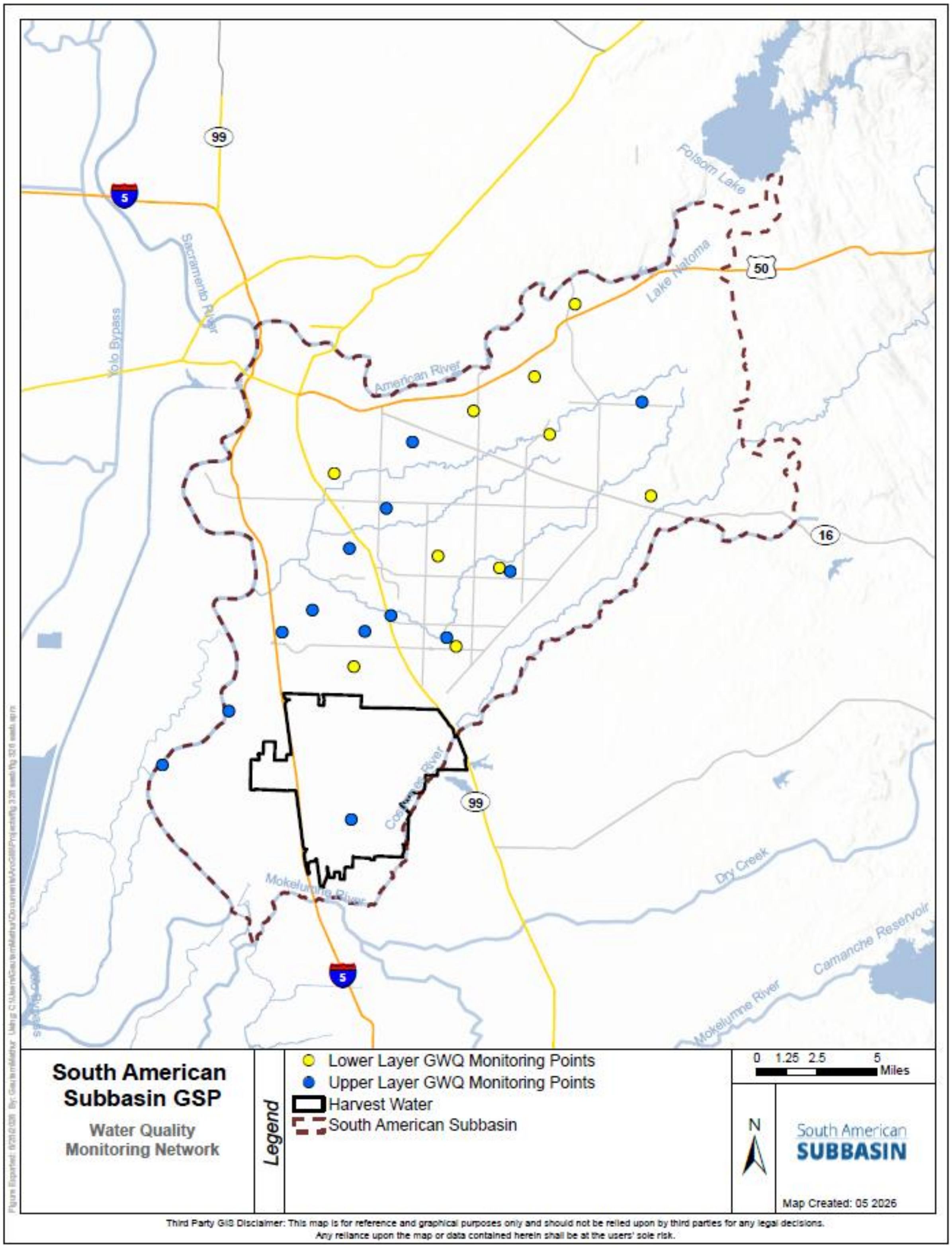
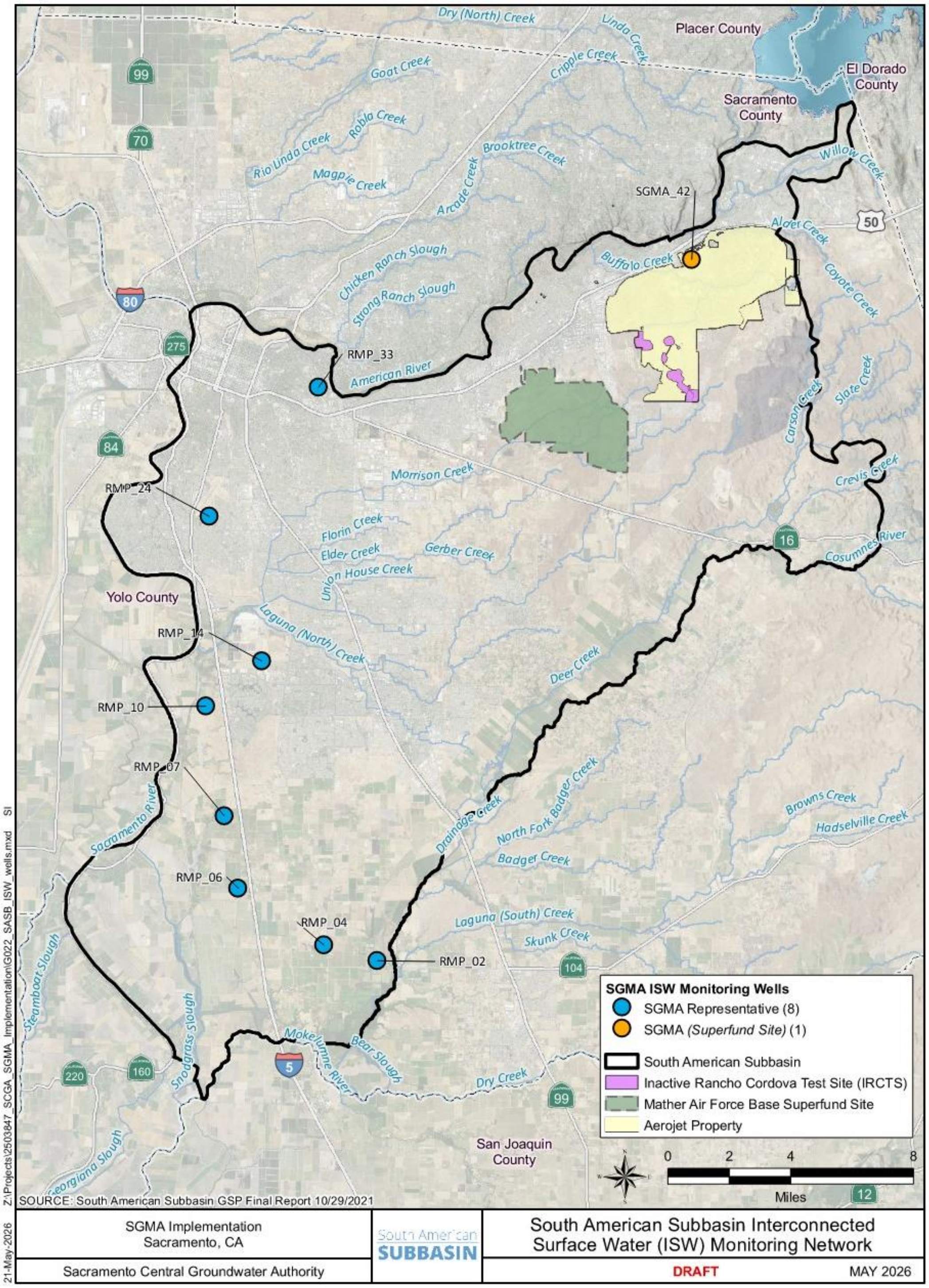
SGMA Implementation Sacramento, CA	South American SUBBASIN	South American Subbasin SGMA GW Level Monitoring Network
Sacramento Central Groundwater Authority		DRAFT MAY 2026

Figure ES-13: Monitoring network for groundwater level and storage, and ISW depletion sustainability indicators for the 46 SGMA and SGMA representative monitoring wells in the SASb (Figure 3-14).



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 ES-14: **Groundwater quality monitoring networks within the upper and lower zones of the aquifer (Figure 3-15)**



SOURCE: South American Subbasin GSP Final Report 10/29/2021

SGMA Implementation
Sacramento, CA

Sacramento Central Groundwater Authority

South American Subbasin Interconnected Surface Water (ISW) Monitoring Network

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MAY 2026

Figure ES-15: Monitoring network for ISW depletion sustainability indicator for the 8 representative monitoring wells in the SASb (Figure 3-18).

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. Two of these projects and one new project have delivered recharge benefits to the Subbasin.
- 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. One new project has been added to this group.

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. Regional Conjunctive Use/Sacramento Regional Water Bank 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 that 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 AFY. Consistent with other conjunctive use projects, this project will increase regional and state water supply reliability and drought resiliency.

4. Omochumne-Hartnell Water District groundwater recharge project will divert up to 4,000 AFY 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. This project recharged 798 AF of water in four of the five water years from 2021 through 2025 for an average recharge of 160 AFY.
5. Sacramento County flood diversion for groundwater recharge project will divert water for recharge and to reduce flooding when Water Code 1242.1 allows for a diversion without a water right. During WY 2025, 220 AF were recharged within Rancho Murieta Community Services District. Sacramento County is working with local stakeholders to expand this project to additional sites.

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. The project is on schedule to deliver recycled water beginning in 2027.

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[1] 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 ([1]Managed Aquifer Recharge).

2. Sacramento County is looking for funding to advance the Wilton Road Floodplain Reconnection project. This conceptual project would connect existing gravel pits to the Cosumnes River and Deer Creek at lower flows and was identified through the California DWR Cosumnes Pilot Study EcoFIP modeling tool. This project would reduce flood risks and impacts, recharge the aquifer an estimated 2,700 AF per average water year and enhance habitat.

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 Harvest Water, OHWD recharge and conjunctive use 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. Given that review of land use and water demands and supply since the analyses above was completed for the GSP and indicated no significant changes to current conditions and projects described are on schedule, these results are still valid.

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

CoSANA Model Scenarios	Description	Average Annual Groundwater Pumping (AFY)	Average Annual Groundwater Storage Change (AFY)
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	227,400	+200
Scenario 5	Harvest Water, OHWD Recharge & Regional Conjunctive Use	205,200	+4,500

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

CoSANA Model Scenarios	Description	Average Annual Groundwater Pumping (AFY)	Average Annual Groundwater Storage Change (AFY)
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. A Volunteer Monitoring Program has been established that has collected groundwater level data from 29 domestic wells over the last three years.

2. GSAs continue to 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 continue to 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). Missing well depths were obtained and added to the DMS. Video logging is not possible for wells without screened interval information due to the access ports being too small. The GSAs are evaluating other solutions to fill this data gap.

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 continue and are summarized in **Table ES-7**.

Table ES-7: GSA coordination activities

GSAs Coordination Activities	Topic/Action
GSAs 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
GSAs 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																						
Agency Administration & Operations	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Management & Coordination																						
Monitoring: Groundwater	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Monitoring: Streamflow	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Data Collection	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Data Management	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
GSP Reporting																						
Annual Reports		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Five-year Assessment Report							▨					▨					▨					▨
Outreach & Education	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

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

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.

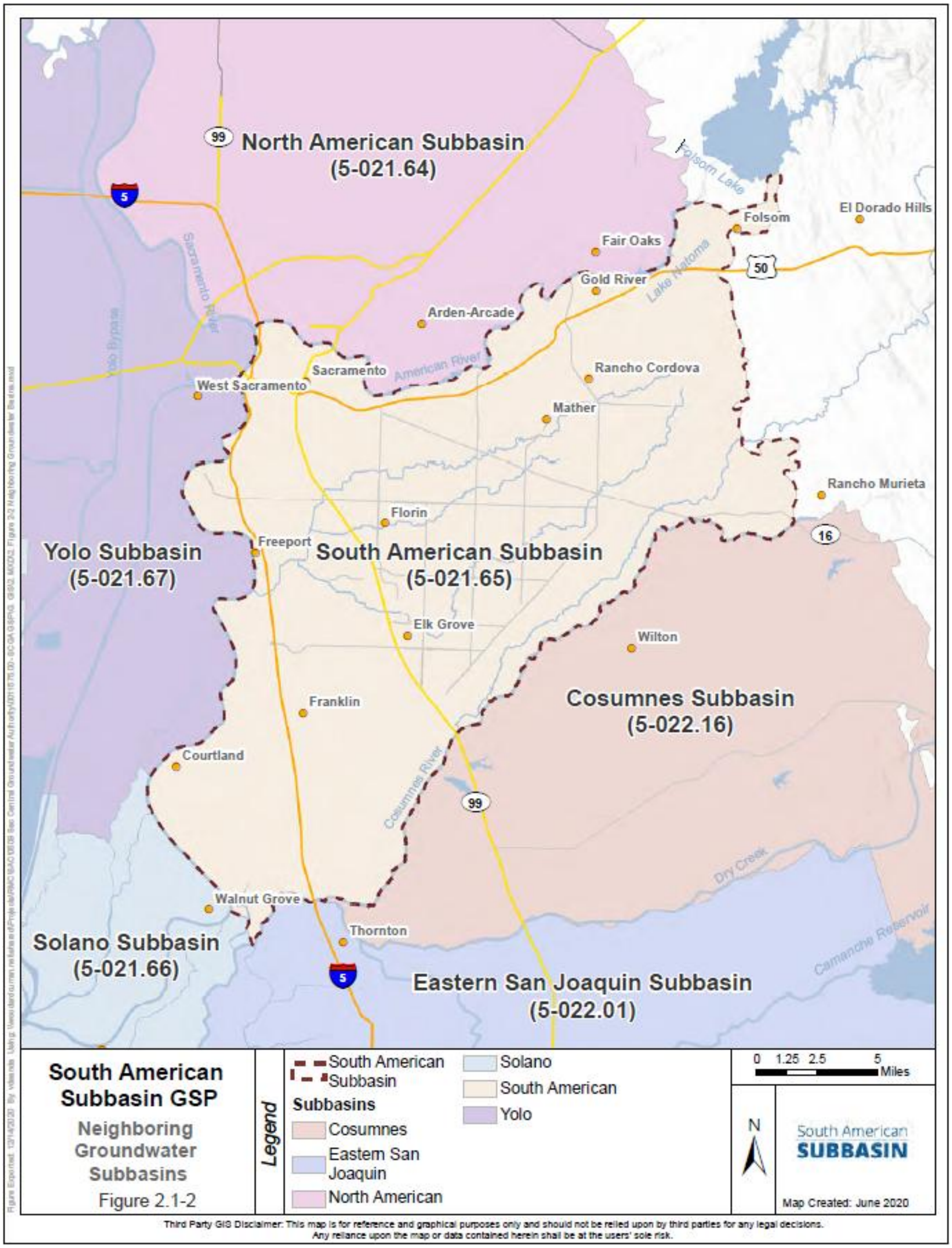

Figure 1-1: SASb and Neighboring Subbasins

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**

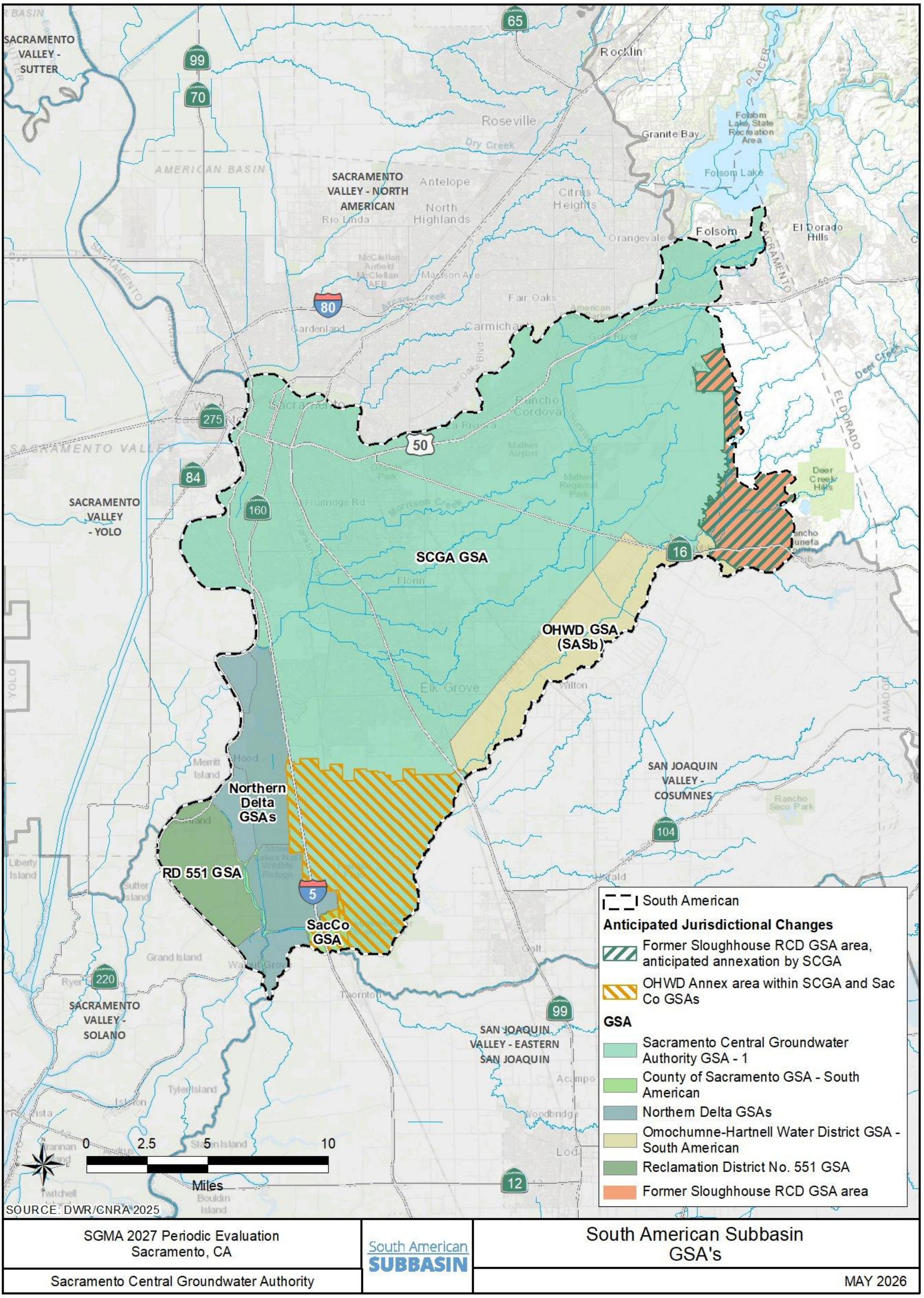

Figure ES-1: Sacramento Central Groundwater Authority (SCGA), Northern Delta GSA (NDGSA), Omochumne-Hartnell Water District (OHWD), Reclamation District (RD) 551, Sloughhouse Resources Conservation District (SRCD), and Sacramento County. SCGA served as the fiscal and administering entity for the development 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.

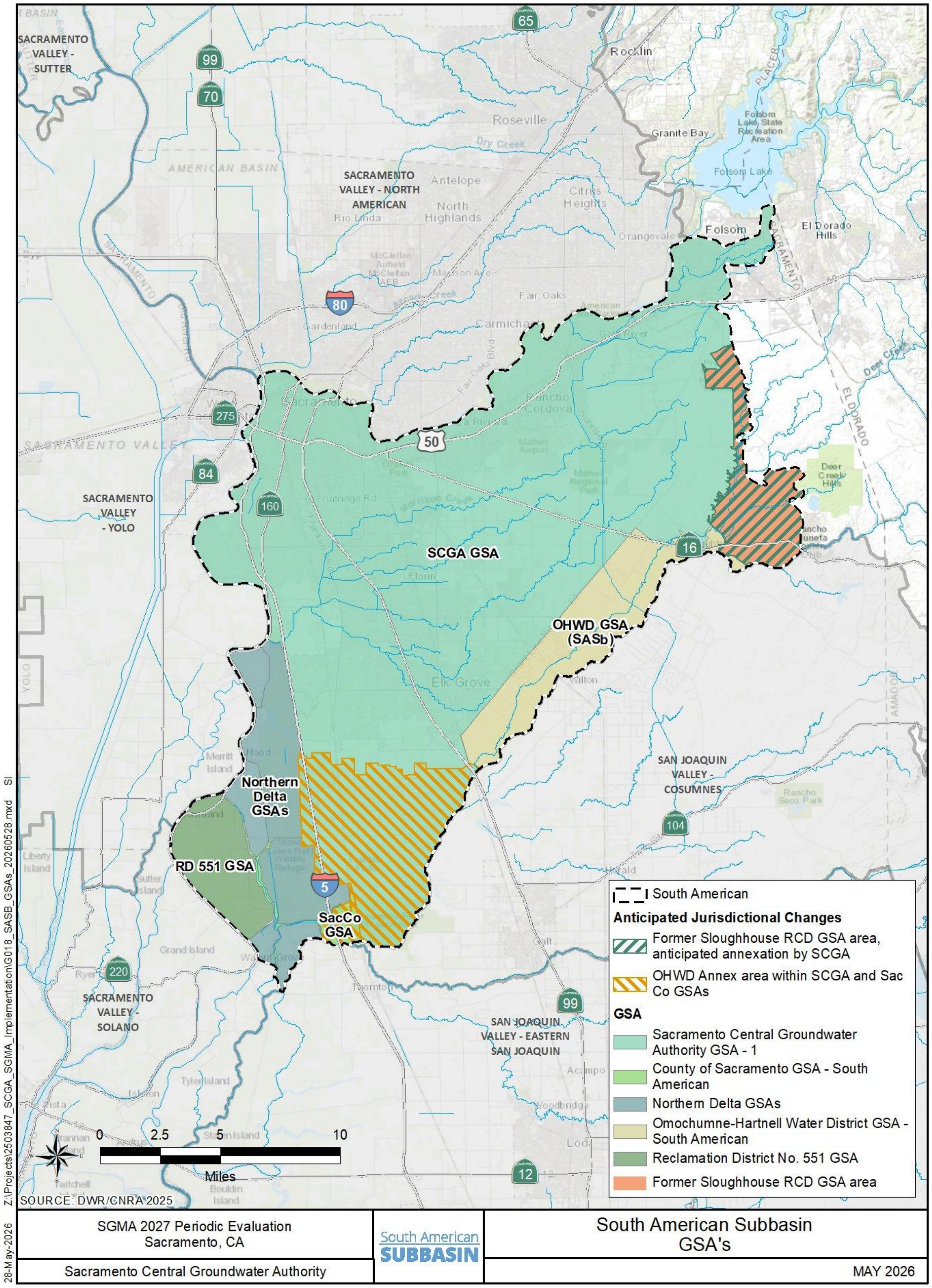

Figure 1-2: GSAs in the SASb

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, Ranch 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

Organization	Appointing Authority
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:

8. Maintaining the long-term sustainable groundwater yield of the Central Basin.
9. Ensuring implementation of the Basin Management Objectives that are prescribed by the current version of the GMP.
10. Overseeing the operation of any Well Protection Program that may be prescribed by the GMP.
11. Managing the use of groundwater in the Central Basin and facilitating implementation of an appropriate conjunctive use program by water purveyors.
12. Coordinating efforts among those entities represented on the governing body of the Joint Powers Authority to devise and implement strategies to safeguard groundwater quality.
13. 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 7th Street, Sacramento, CA 95814
Website: https://scgah2o.saccounty.net/pages/default.aspx
Phone: (916) 812-9118
Email Address: 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

Member Agency	Subbasin	Board Member
Reclamation District 1002 – Glannvale	South American	Jeff McCormack
Reclamation District 813 – Ehrheardt 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

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

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

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

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

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

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[1]. 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 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.

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[1] www.sasbgroundwater.org

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[2], 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

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

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[2] http://www.sasbgroundwater.org/assets/pdf/SASb_CE_Plan_Draft_Final_20200720-Final.pdf

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[3] and were announced via email.

Table 1-3: GSA Website and Board Meeting Information

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

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[3] 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[4]. 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[5].
- **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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[4] http://www.sasbgroundwater.org/meetings.html
[5] http://www.sasbgroundwater.org/meetings.html

Table 1-4: Outreach Activities

Format	Date	Detail	Participation	Purpose
Public Meetings	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
Postcard Mailings/Other Direct Mailings/ Notifications	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
Press Releases	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
Sacramento County Electronic Subscription	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
Emails to Stakeholders	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
SASb GSA Public Board Meetings	November 2015 to October 2021	51 GSA public Board meetings	Varied	SGMA/SASb GSP updates
SASb GSP Working Group Meetings	May 2020 to October 2021, monthly	21 meetings held via Zoom video conference	35-50	GSP Development
Website	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[6] from July 23, 2021 through August 18, 2021. Comments received were posted to the website and entered into the Comment Log (**Appendix 1-G**).

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[6] 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

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** 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.

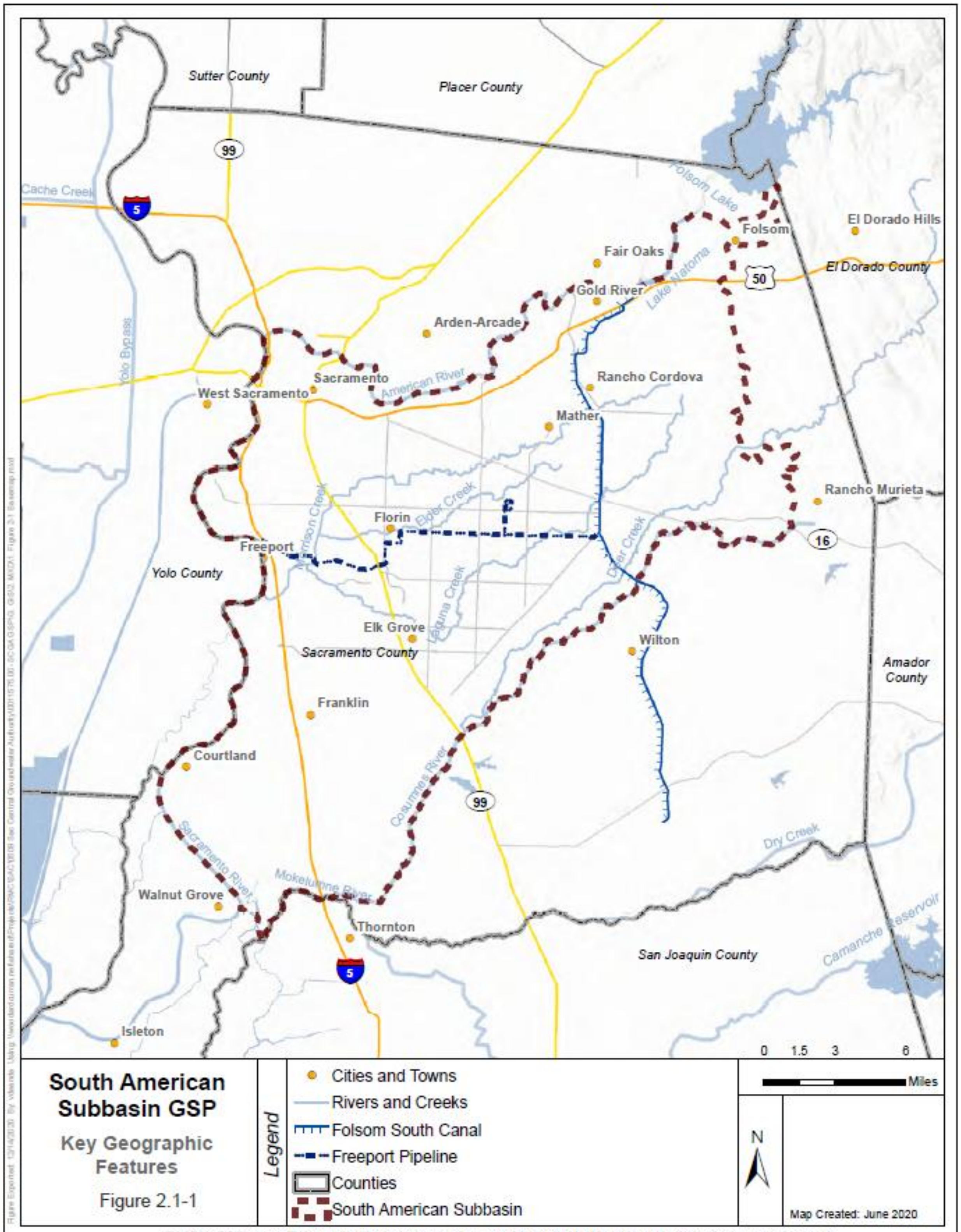

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Figure 2-1: Key Geographic Features within the South American Subbasin

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 2-2** 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 2-3, 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 2-4**.

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 2-5** 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).

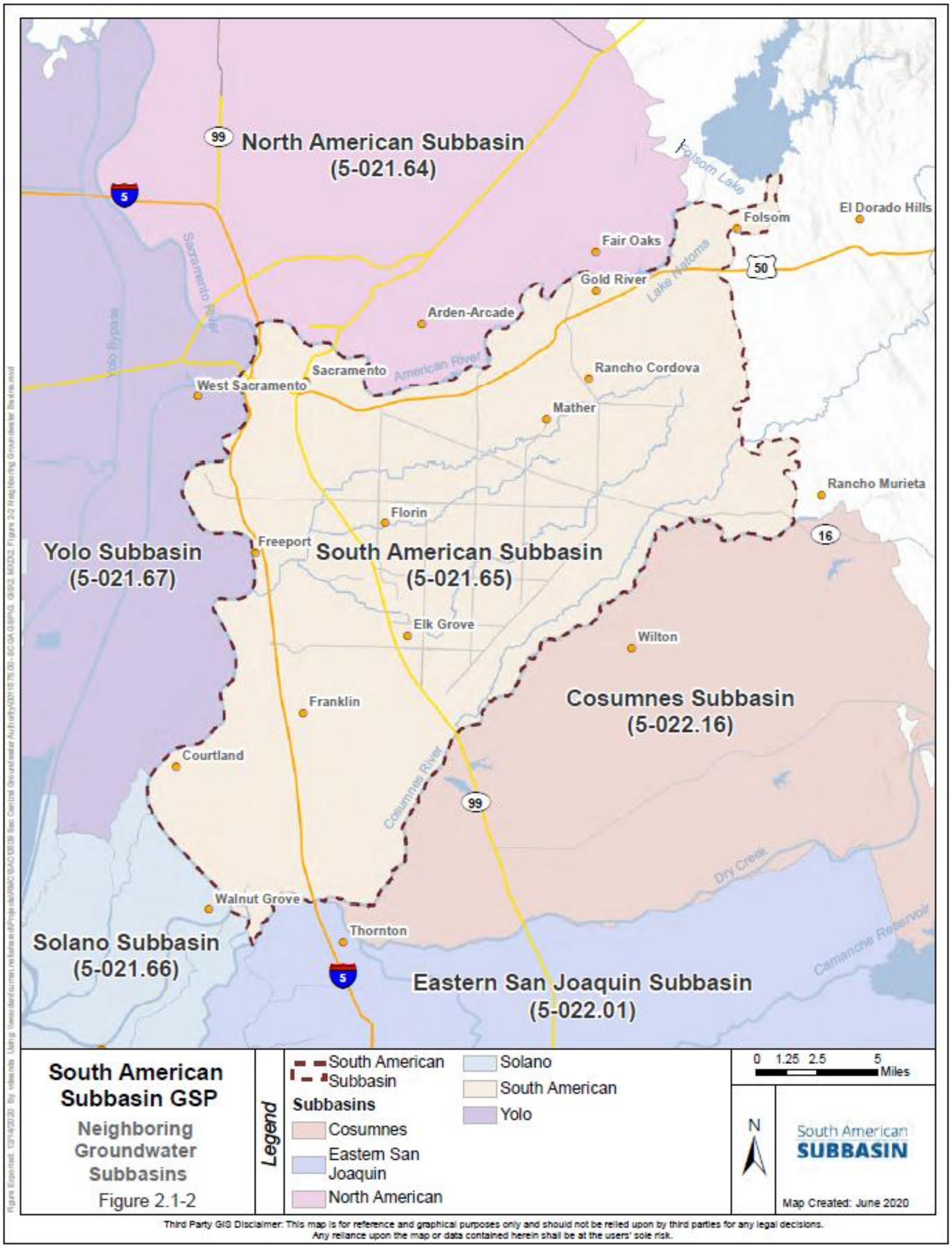

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Figure 2-2: Neighboring Groundwater Subbasins

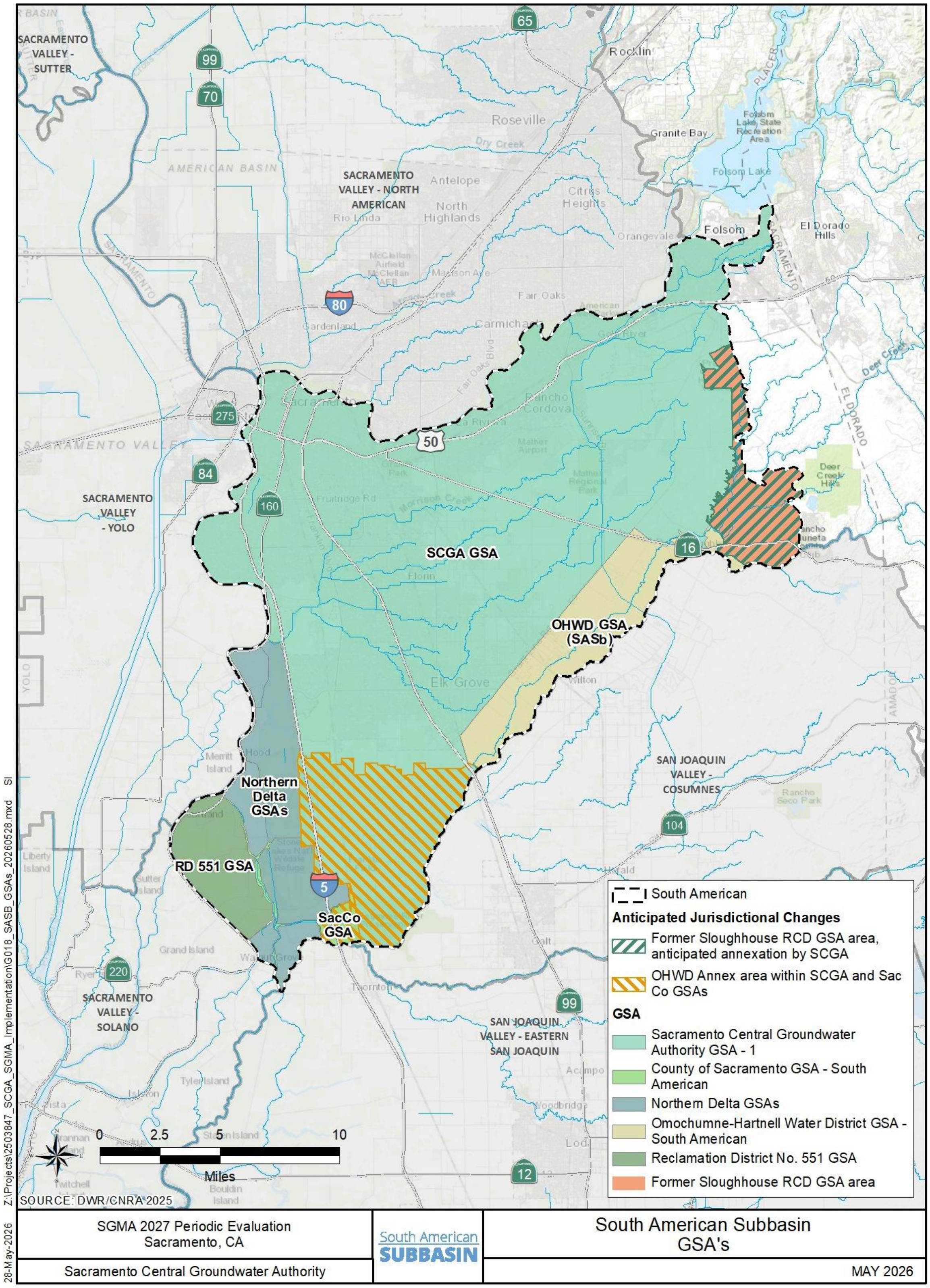

Figure 2-3: South American Subbasin GSAs

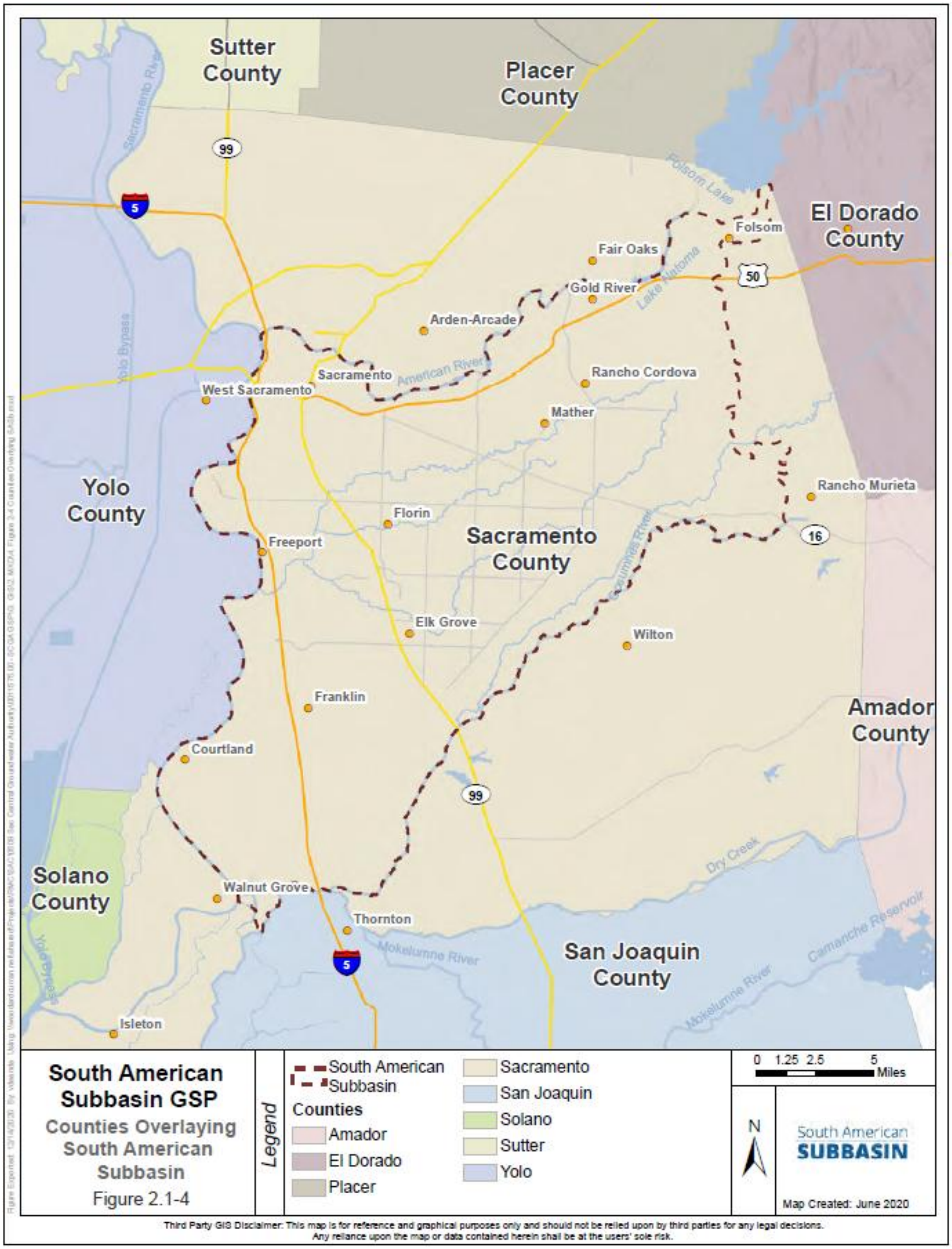

Figure 2-4: **Counties Overlying South American Subbasin**

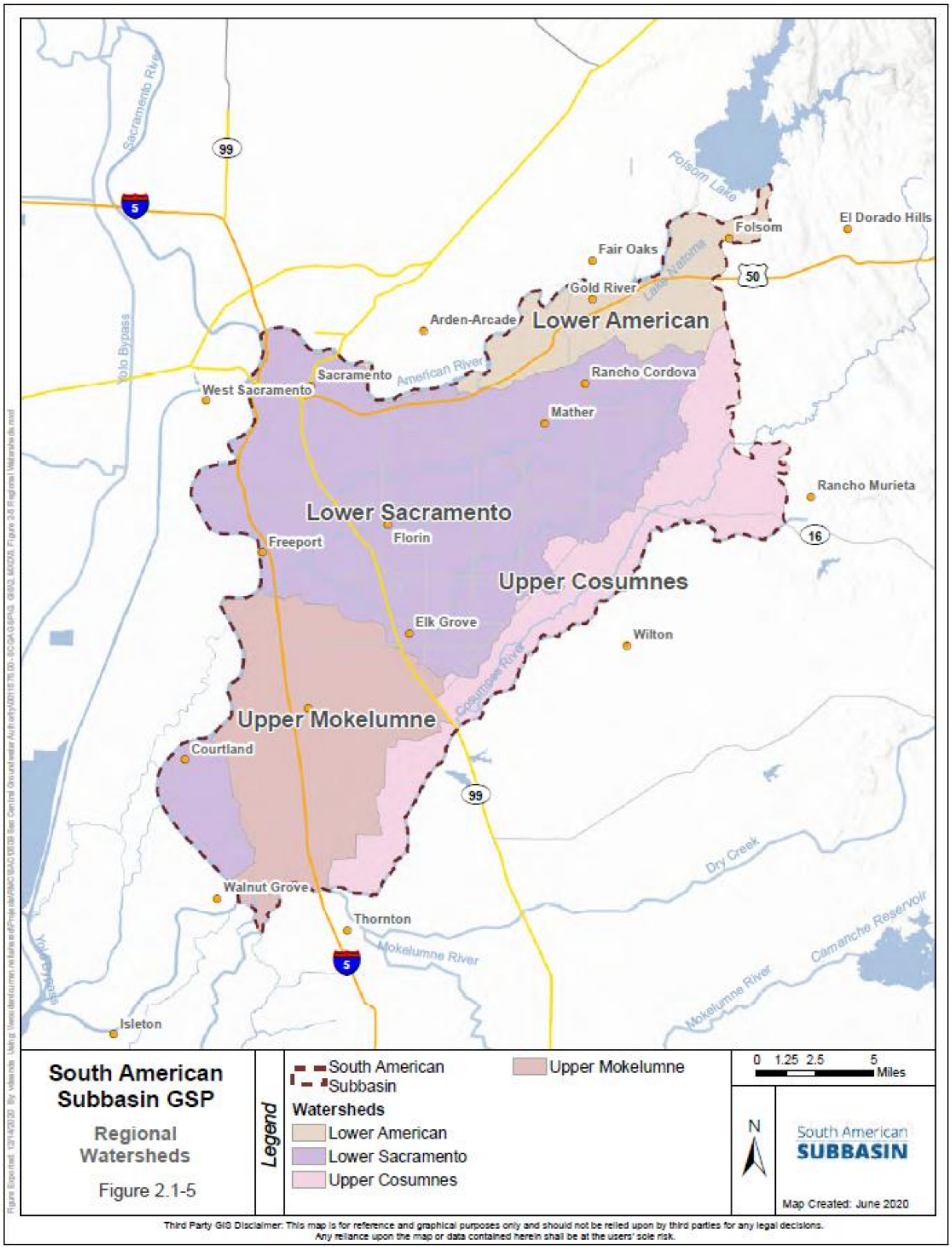

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Figure 2-5: **Regional Watersheds**

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

Water Purveyor	2018 Water Year (AF/year)
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

Caucus	Members
Business	• AKT Development • Associated General Contractors • North State Building Industry Association • Sacramento Association of Realtors • Sacramento Metropolitan Chamber of Commerce • Sacramento Sierra Building and Construction Trades Council
Environmental	• Environmental Council of Sacramento • Friends of the River • Save the American River Association, Inc. • Sierra Club Mother Lode Chapter
Public	• City of Sacramento • Sacramento County • League of Women Voters of California • Sacramento County Taxpayers League • Sacramento Municipal Utility District

Caucus	Members
Water	• California American Water Company • Carmichael Water District • Citrus Heights Water District • City of Folsom • City of Roseville • Clay Water District • Del Paso Manor Water District • El Dorado County Water Agency • El Dorado Irrigation District • Fair Oaks Water District • Galt Irrigation District • Georgetown Divide Public Utility District • Golden State Water Company/Arden-Cordova Water District • Natomas Central Mutual Water Company • OHWD • Orange Vale Water Company • Placer County Water Agency • Rancho Murieta Community Services District • Regional Water Authority • Rio Linda/Elverta Community Water District • Sacramento County Farm Bureau • Sacramento Suburban Water District • San Juan Water District

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 2-6 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 2-7** 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

Crop	Acres (2015)	Acres (2024)
Alfalfa	5,059	2,999
Almonds and pistachios	204	1,559
Corn	4,365	5,748
Citrus	57	6
Cucurbits	416	533
Dry beans	673	351
Field crops	1,211	5
Grain	11,873	7,651
Idle	1,142	4,347
Orchards	3,119	3,427
Pasture	10,064	8,693
Rice	821	612
Safflower	677	165
Tomatoes	2,307	1,471
Truck crops	1,388	823
Vineyards	13,713	13,486
TOTAL	**57,089**	**51,876**

Source: DWR 2015 & 2024

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 2-8**.

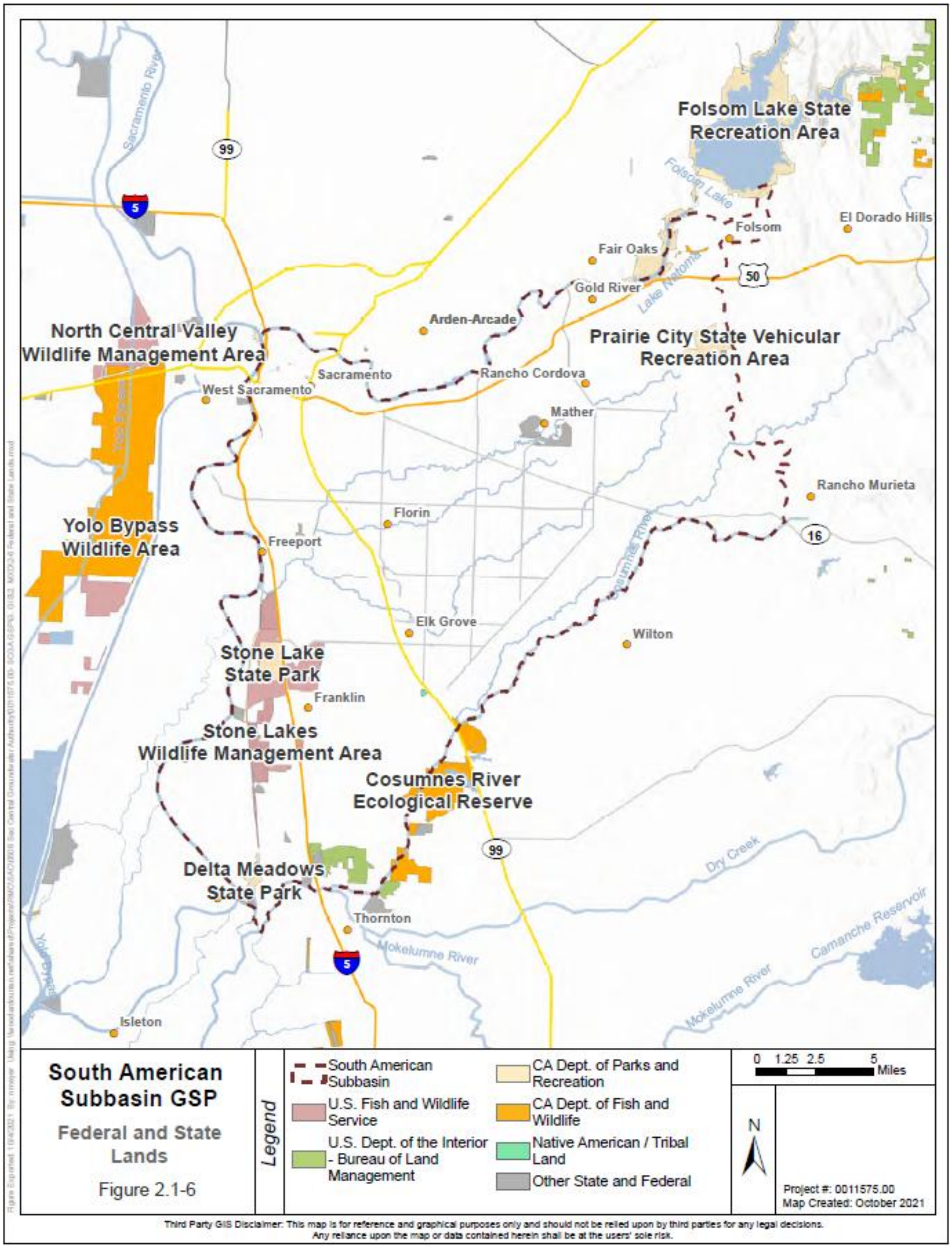
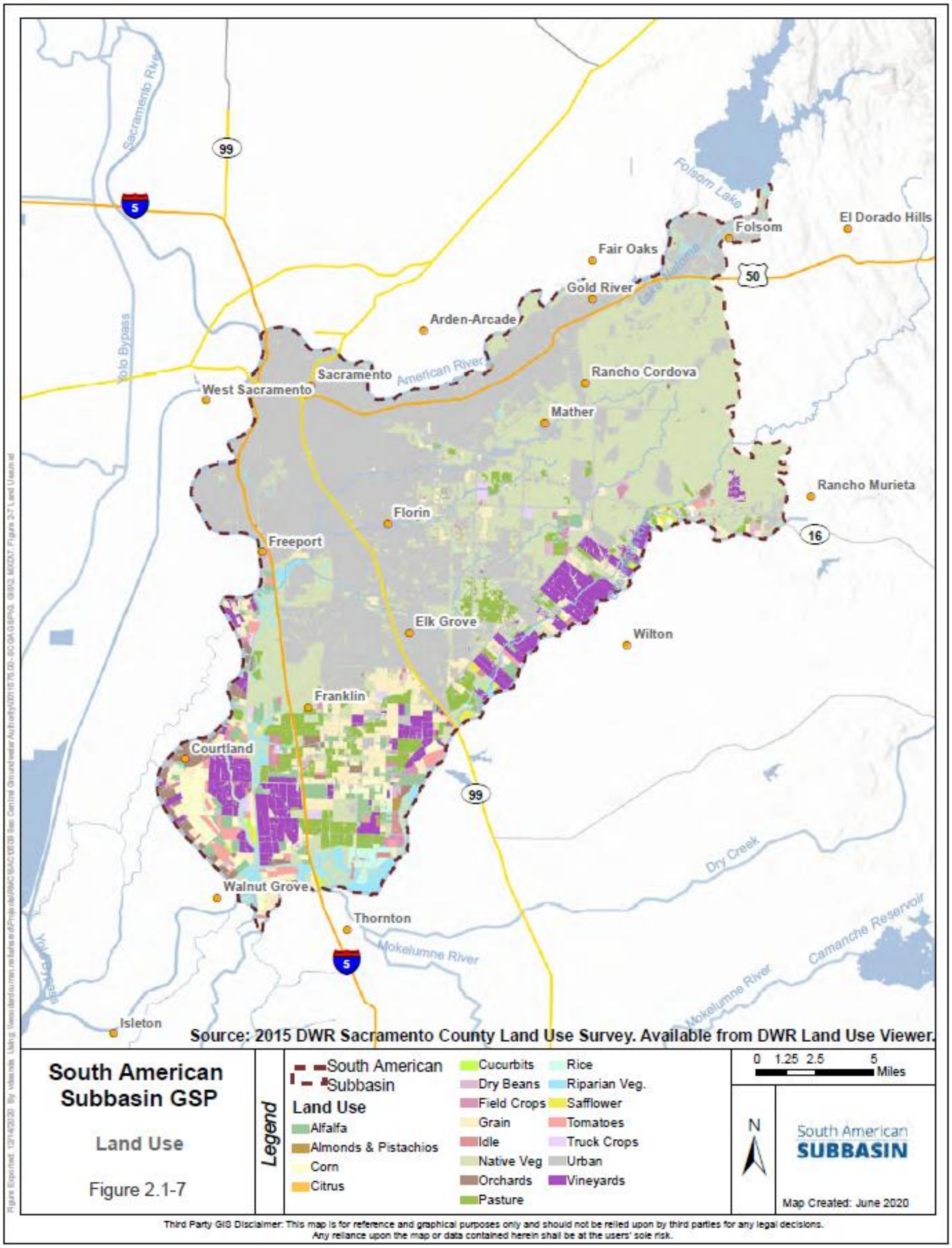


Figure 2-6: Preserved Lands



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

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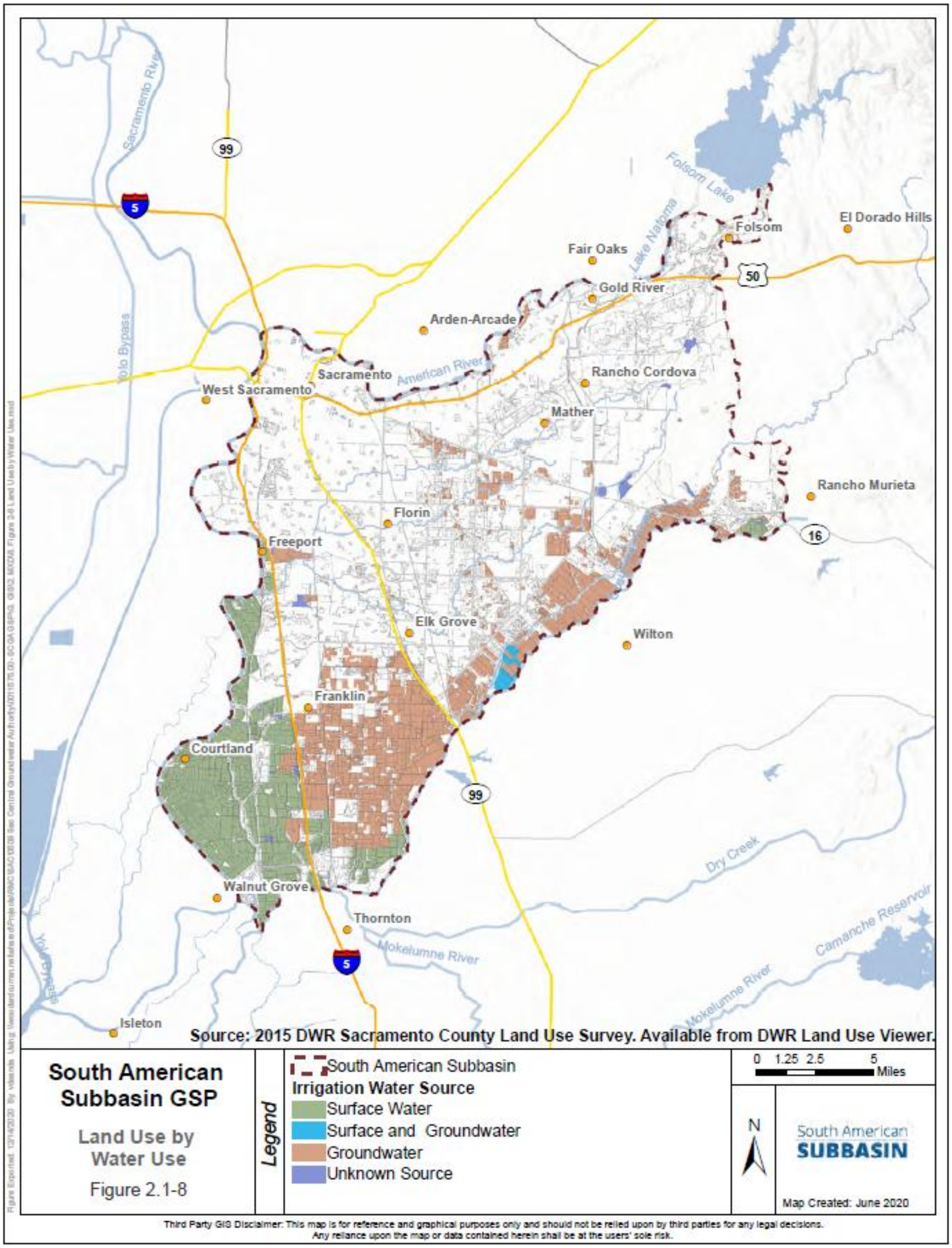
Figure 2-7: Land Use



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

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Figure 2-8: Land Use by Water Use

2.1.2.7 Wells

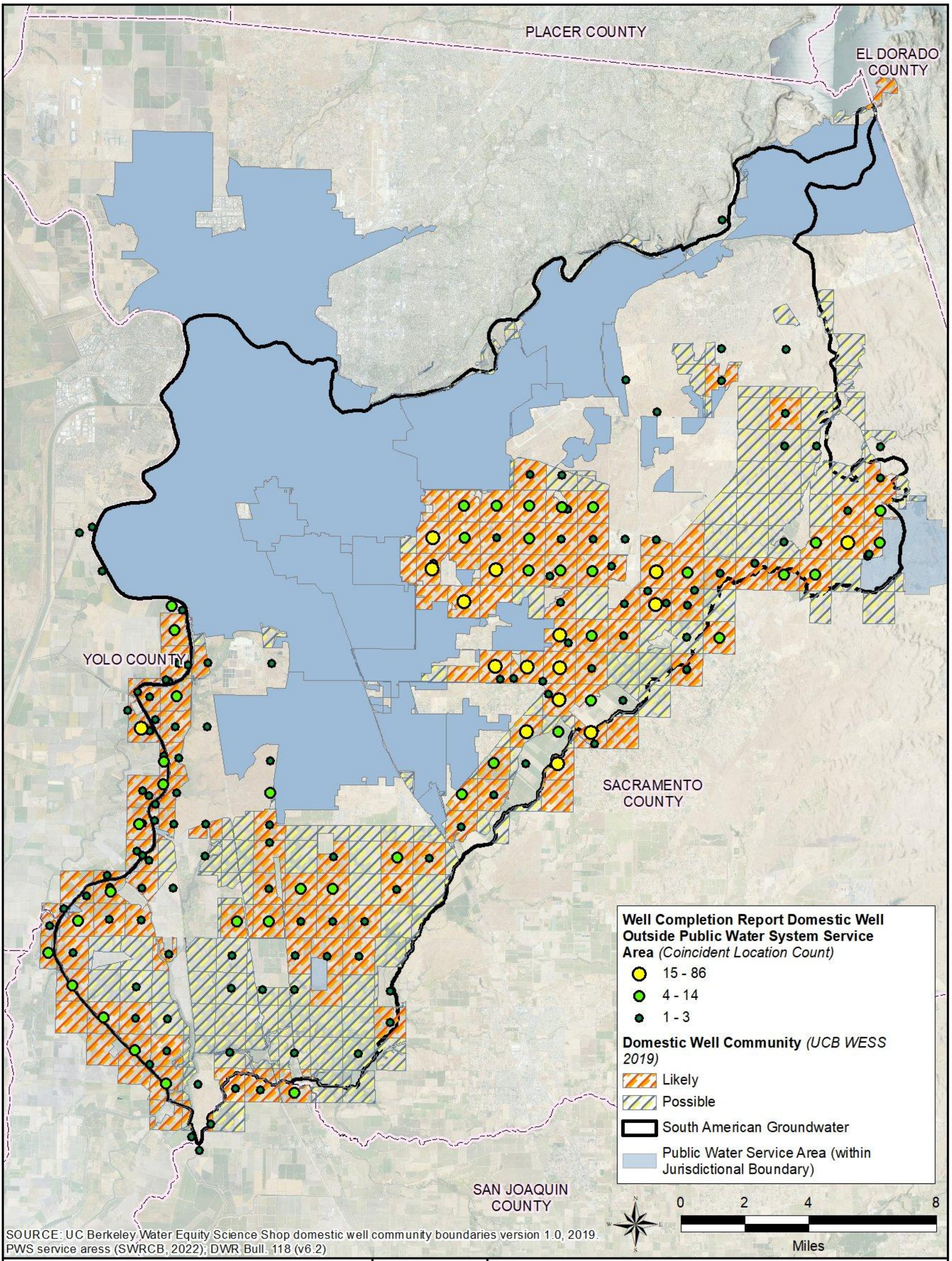
Figure 2-9 through **Figure 2-11** show the estimated total number of domestic, production, and public wells in each square mile of the SASb and was downloaded from DWR's Well Completion Report Map Application. This application allows government agencies and the public to review these data as well density 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.

DWR's Well Completion Report Map Application (OSWCR) provides well location and construction data and is the main source for information on the location, depth, and number of domestic wells in the Subbasin. It is widely recognized that many older domestic wells are not included in the OSWCR. The University of California, Berkeley Water Equity Science Shop (UCBWESS) published a domestic well data set in 2019. The primary goal of the dataset was to identify 'communities' likely or possibly dependent on domestic wells for water supplies. The analysis started with the domestic wells downloaded from the OSWCR. Because these wells are located at the PLSS section centroids, all wells that were located more than a half-mile outside of the Subbasin were removed. Those that were located within 150 feet of a SWRCB identified public water service area were also removed. The analysis identified PLSS sections as "likely" and "possible" Domestic Well Areas (DWAs) (**Figure 2-9**). PLSS sections defined as "likely" DWAs were defined as sections with all the following four conditions true: (1) not within the service boundary of a community water system, (2) estimated population greater than one, (3) contains at least one domestic well; 4) intersects with at least one residential parcel. PLSS sections defined as "possible" DWAs were defined as sections with only the first two criteria true. The OSWCR database reports 2,653 domestic wells in the Subbasin compared to 3,872 likely and 1,254 possible households dependent on domestic wells reported by the UCBWESS report.

Figure 2-10 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 2-11 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.



SOURCE: UC Berkeley Water Equity Science Shop domestic well community boundaries version 1.0, 2019.
PWS service aress (SWRCB, 2022); DWR Bull. 118 (v6.2)

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09-Jun-2026

2027 GSP
Sacramento, CA

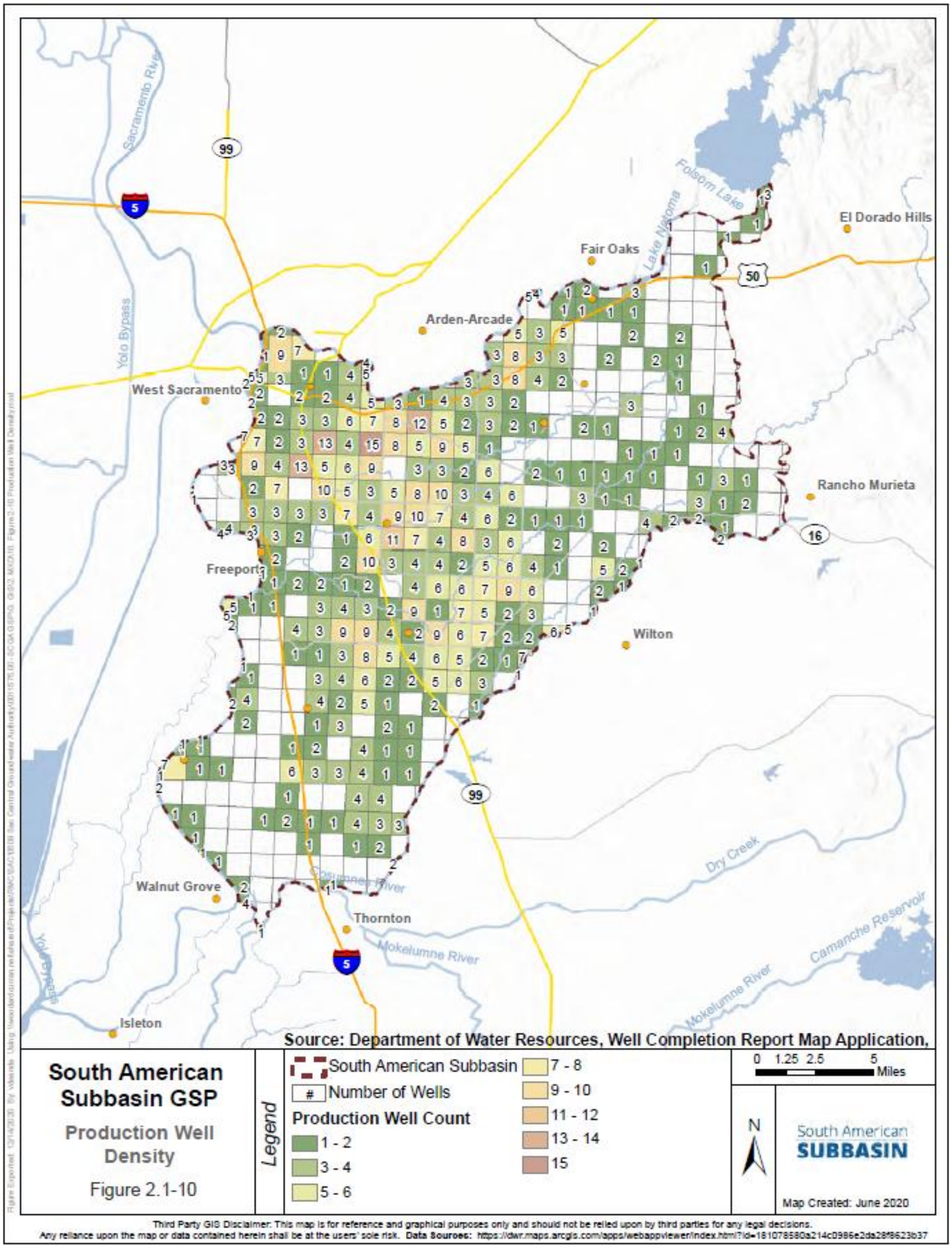
Sacramento Central Groundwater Authority

South American SUBBASIN

Domestic Wells Outside of
Public Water System Service Areas

NOV 2022

Figure 2-9: Domestic Well Density



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

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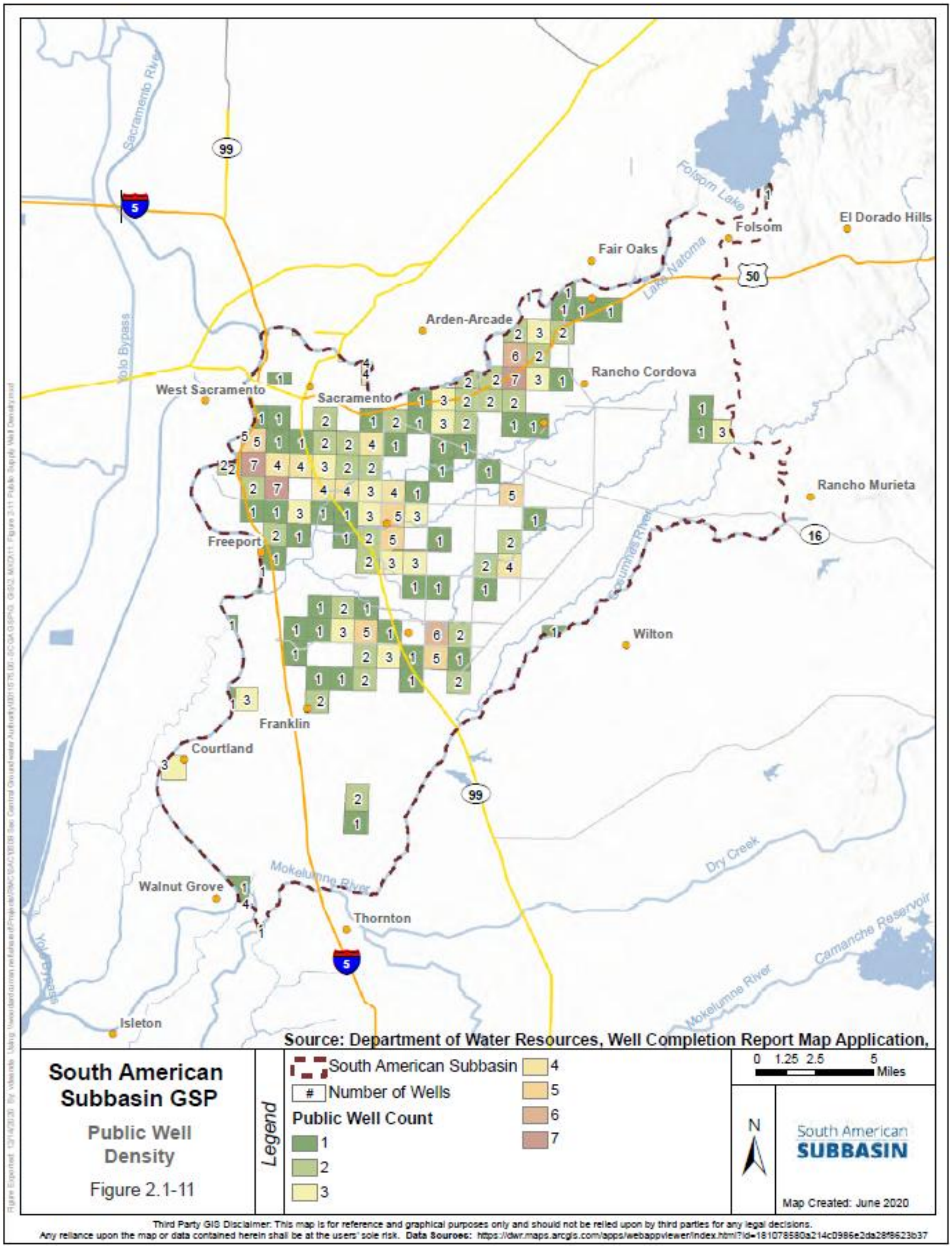
Figure 2-10: Production Well Density



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

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Figure 2-11: Public Well Density

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

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

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 2-12**). 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 2-12** 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 2-13**). 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.

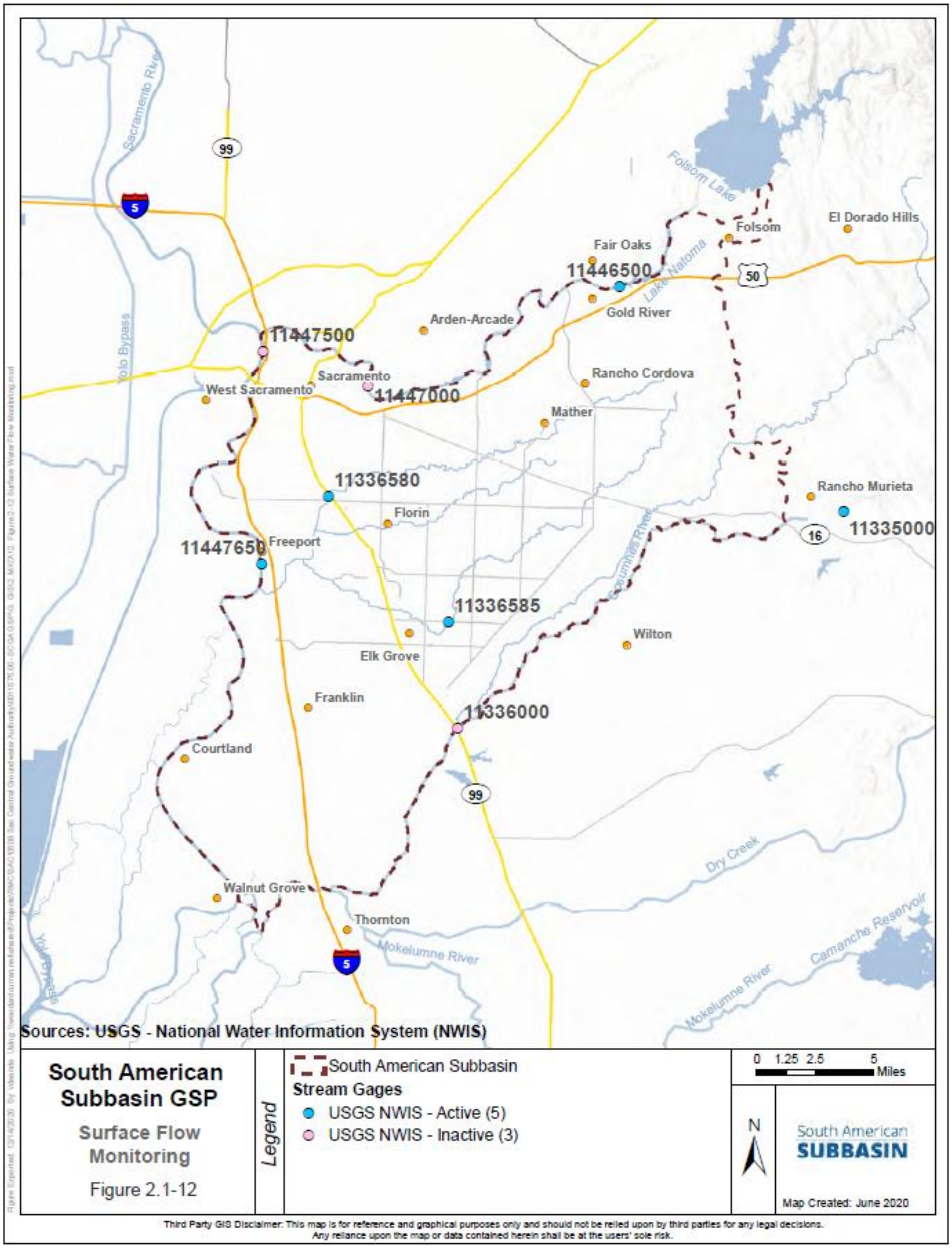

Figure 2-12: Surface Water Flow Monitoring

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

Station	Station Name	Monitoring Agency	Active
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

Station	Station Name	Monitoring Agency	Active
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

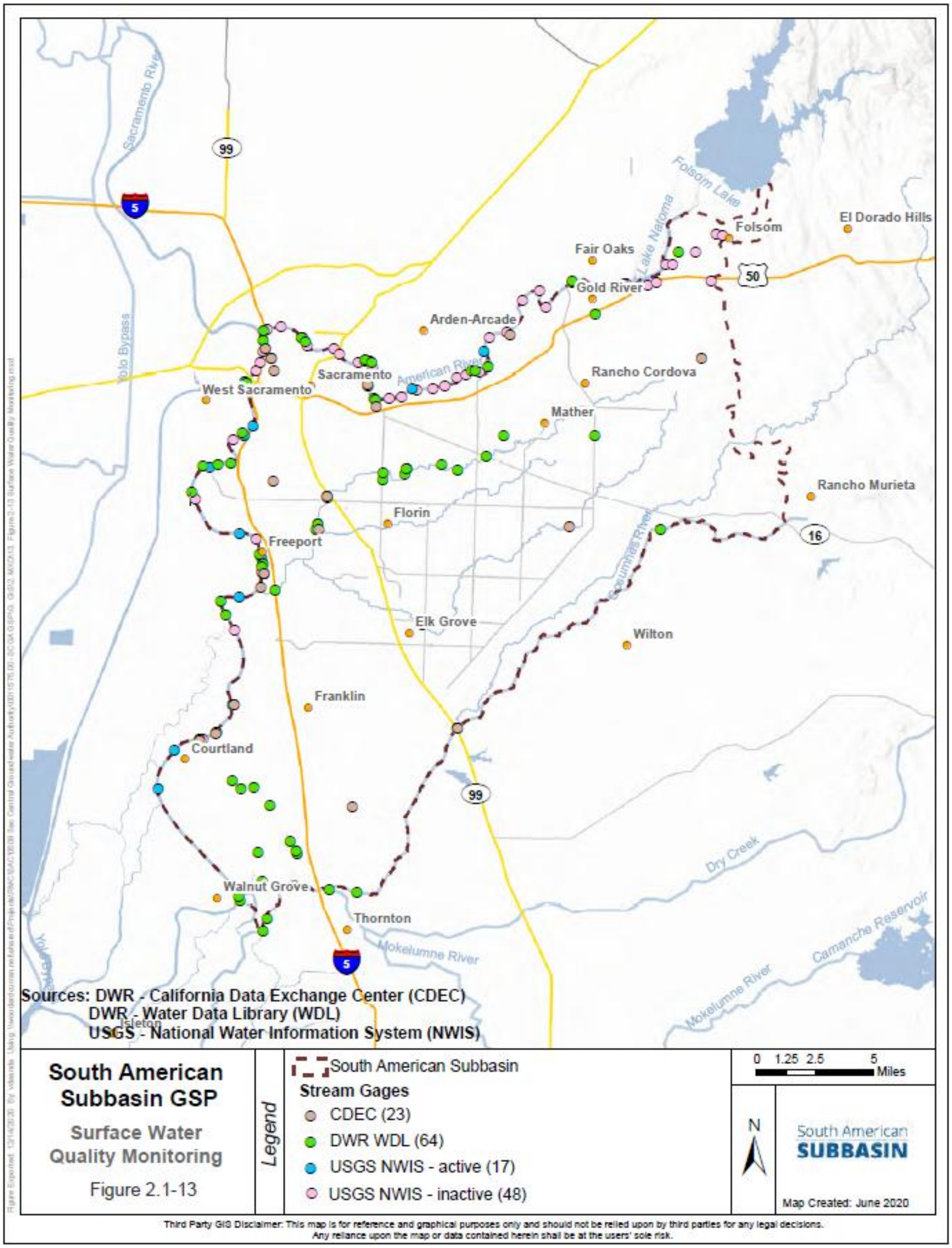

Figure 2-13: Surface Water Quality Monitoring

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 2-13**). 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 2-14**. 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)[7] 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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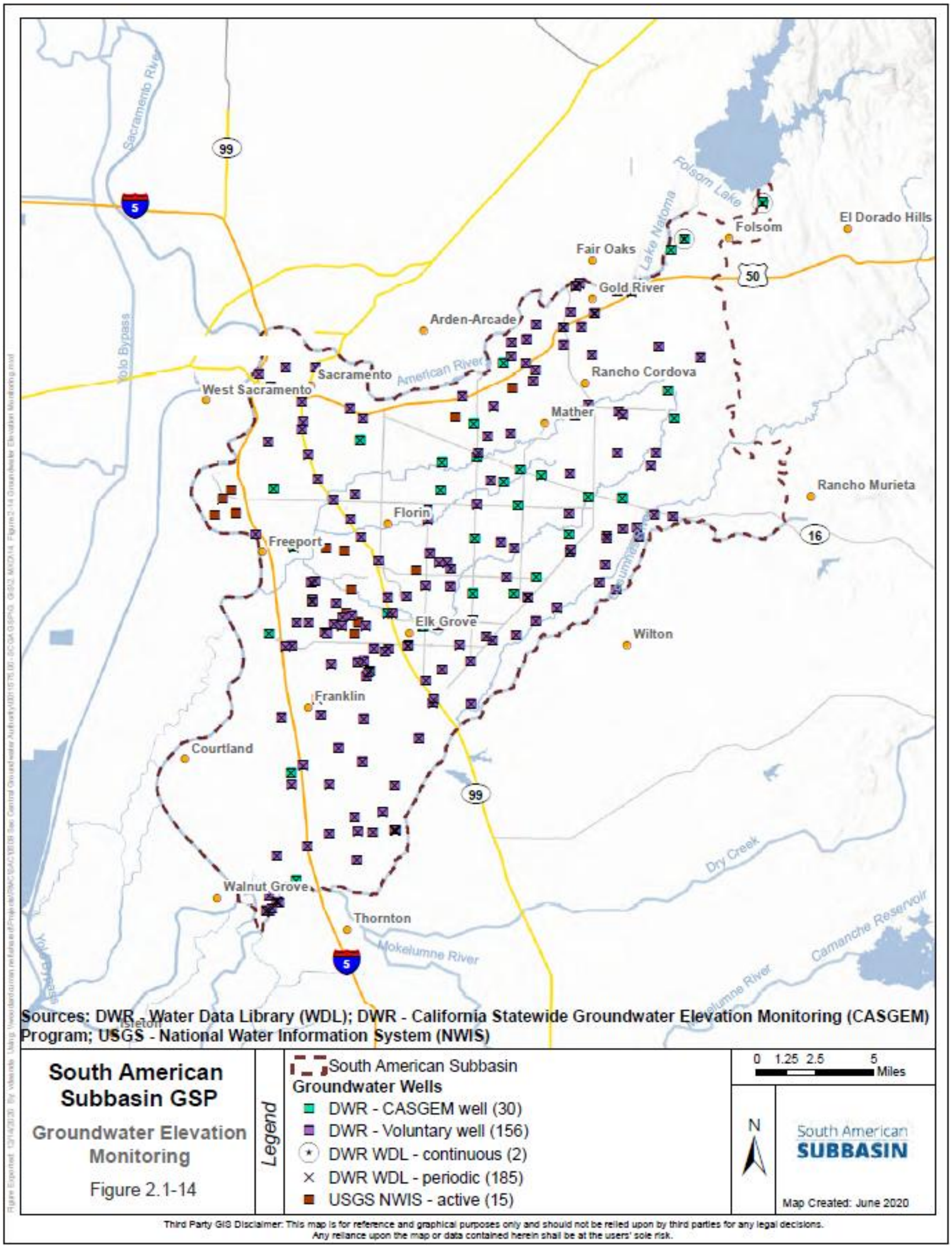
[7] https://wdl.water.ca.gov/



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

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Figure 2-14: Groundwater Elevation Monitoring

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[a]	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:

[a] 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 2-15**. 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).

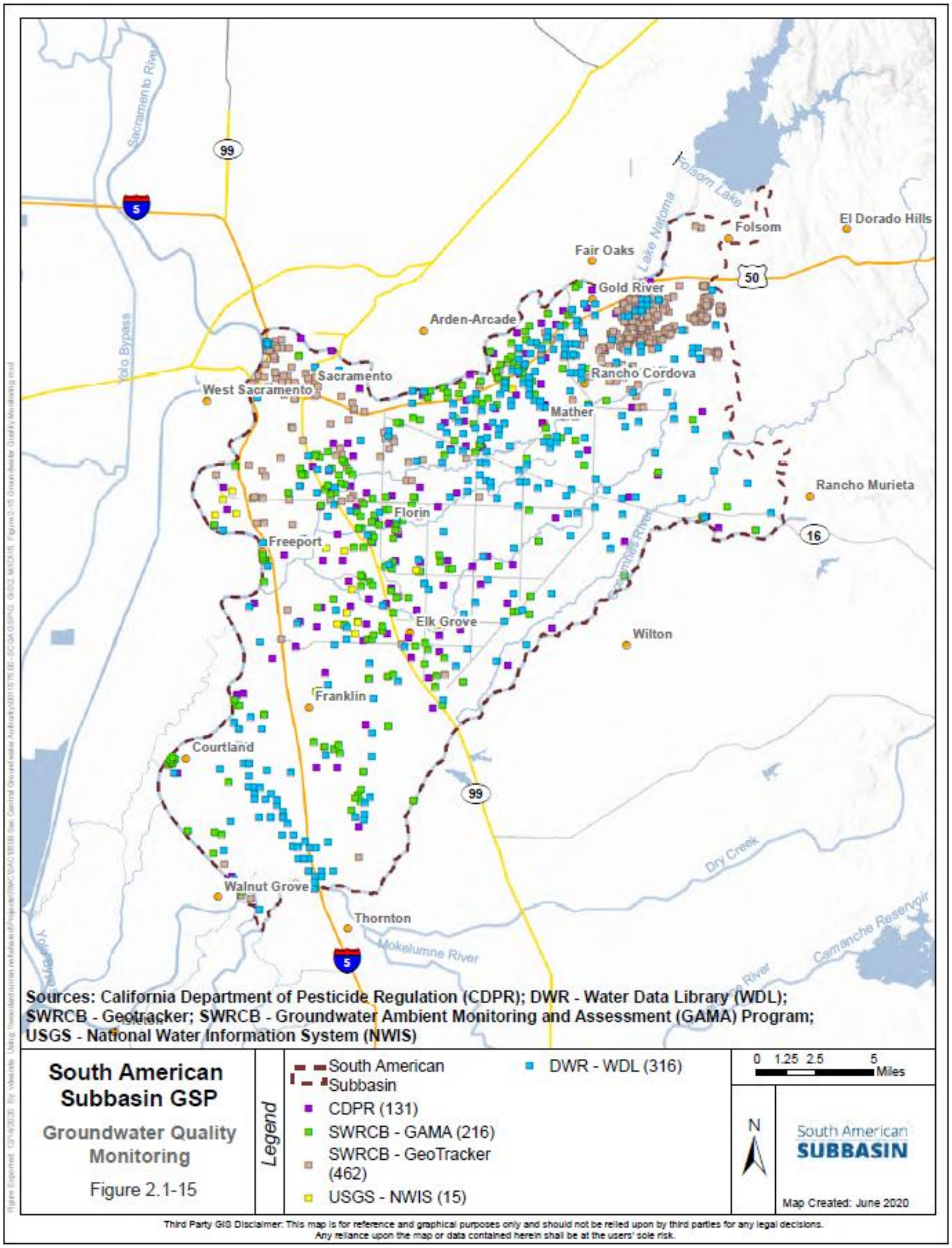


Figure 2-15: **Groundwater Quality Monitoring**

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

Status	Cleanup Site	LUST Site	Total
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
Total	**417**	**45**	**462**

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

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

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 2-16** shows the location of these stations within the Basin.

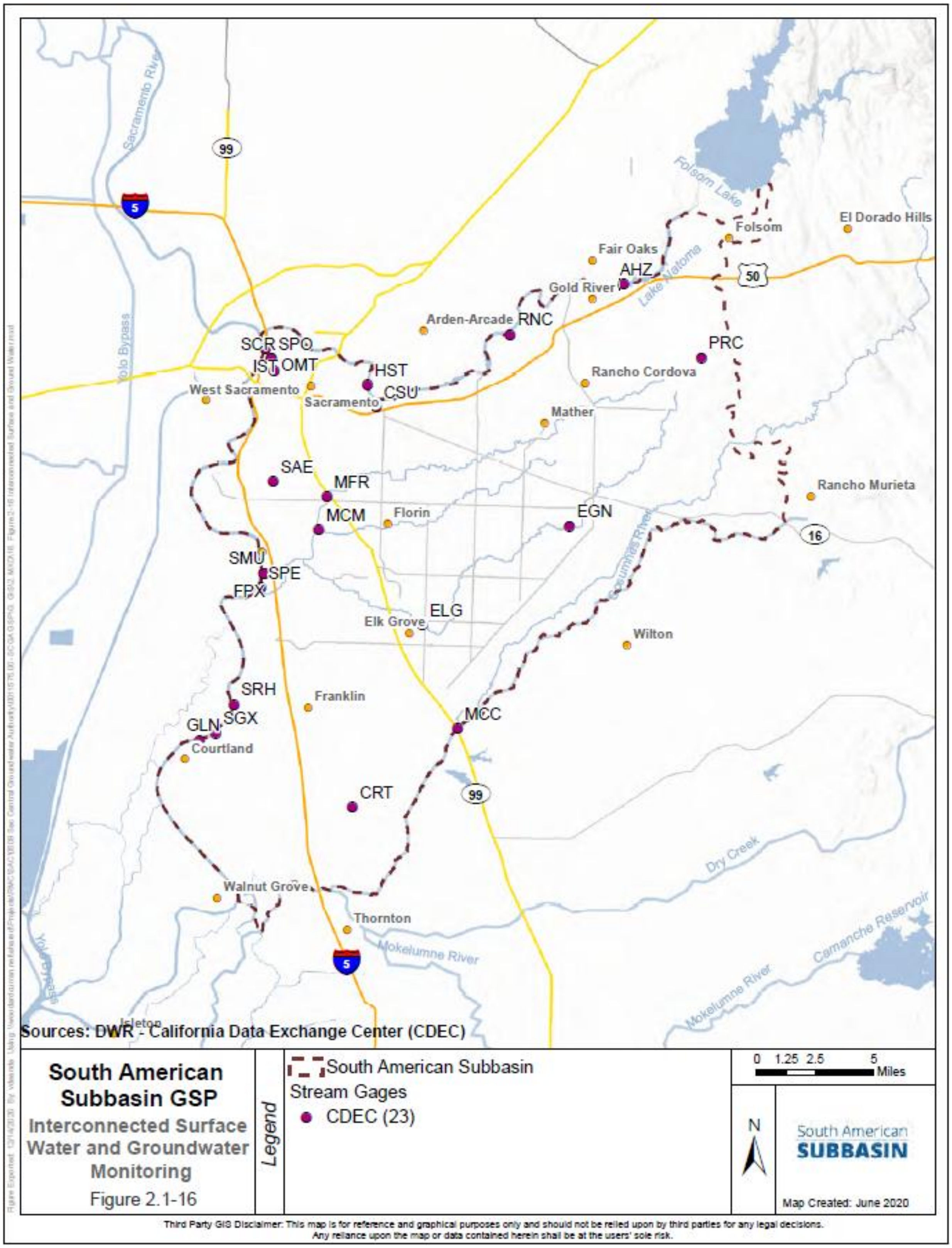
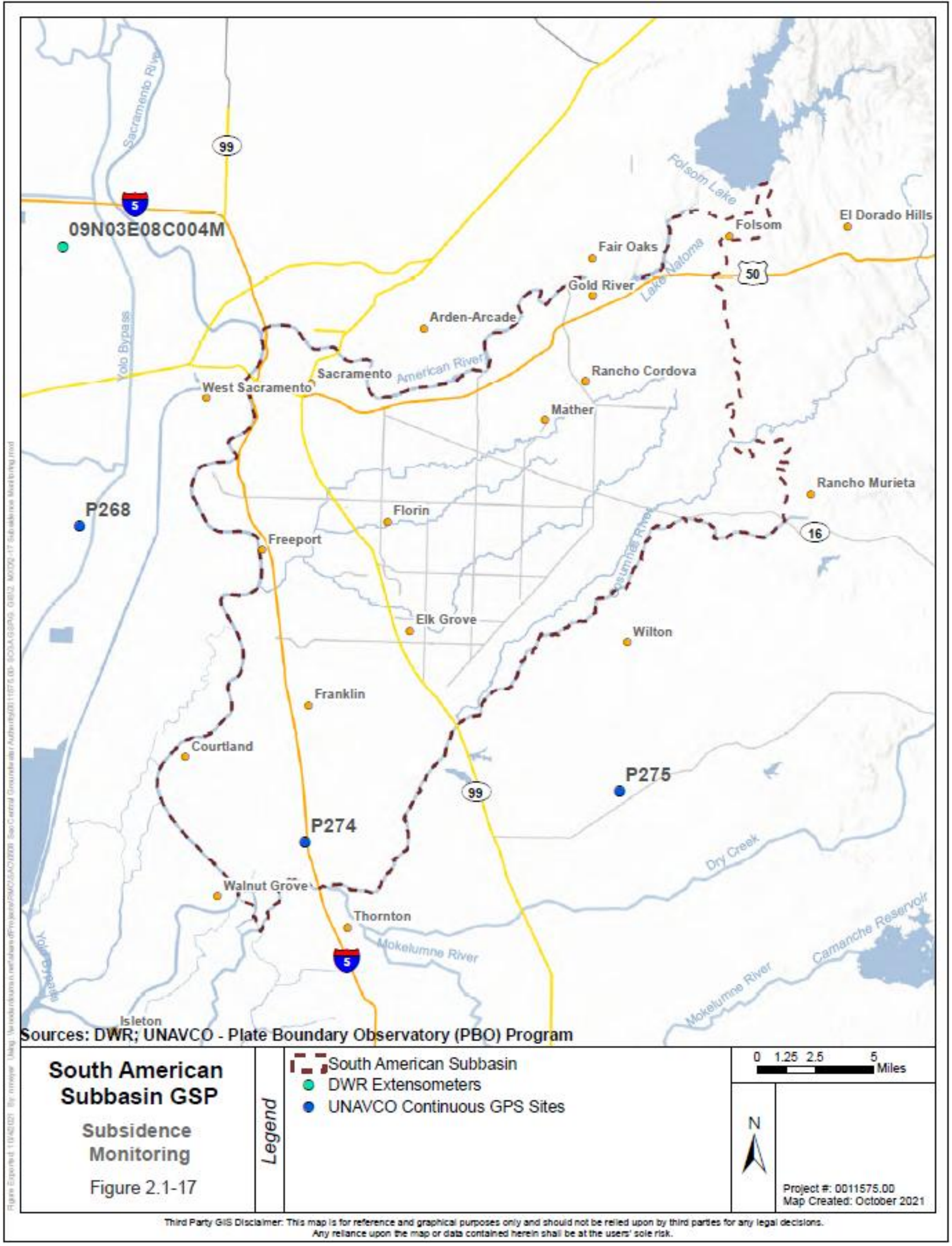


Figure 2-16: Interconnected Surface Water and Groundwater Monitoring

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 2-17**



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

South American Subbasin GSP

Subsidence Monitoring

Figure 2.1-17

Project #: 0011575.00
Map Created: October 2021

Figure 2-17. 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). This project has been discontinued, and the most recent available data are included in the findings for 2008-2017.

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. This site was discontinued in May 2024. 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 present with measurements ongoing.

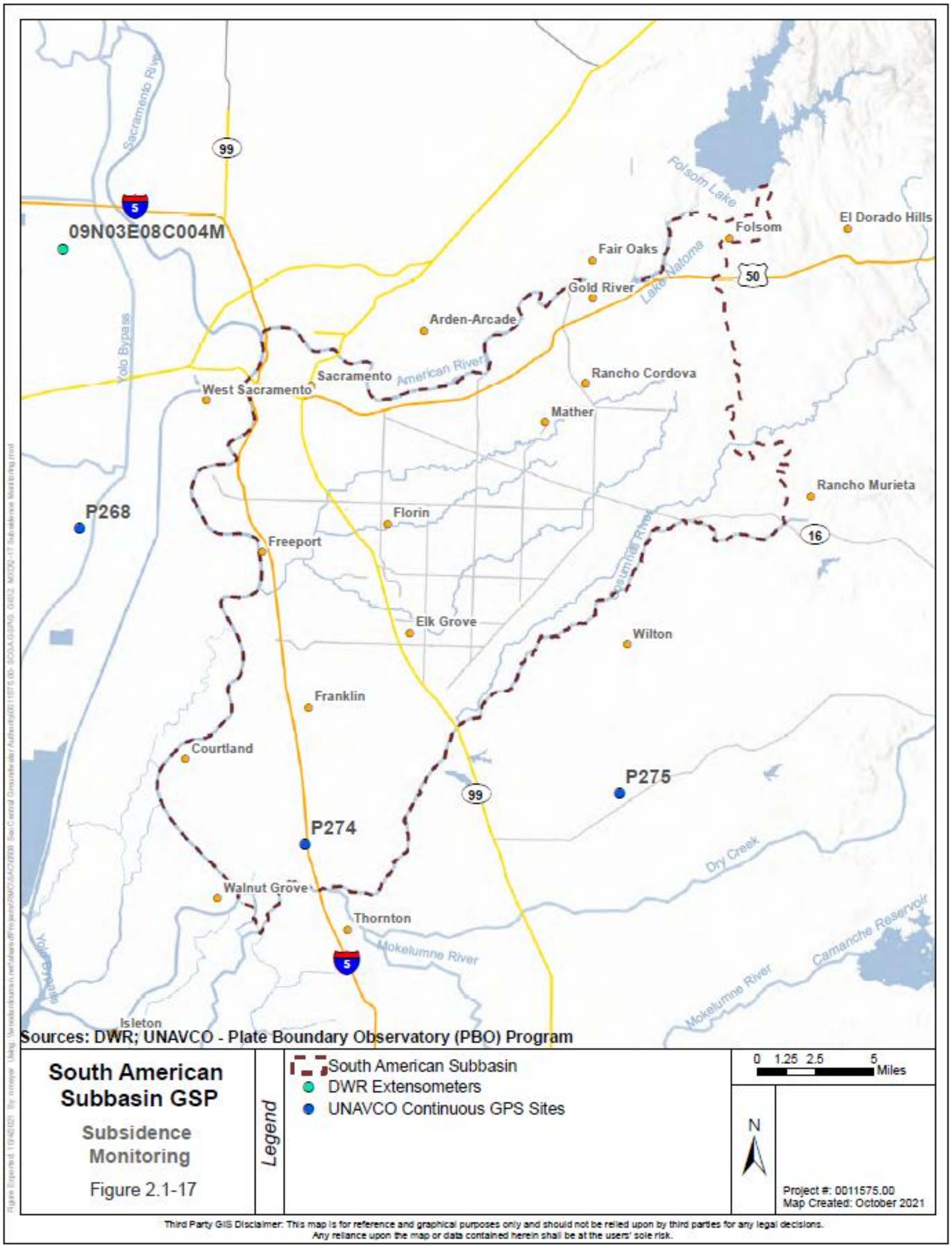


Figure 2-17: Subsidence Monitoring

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 2-18**. 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.

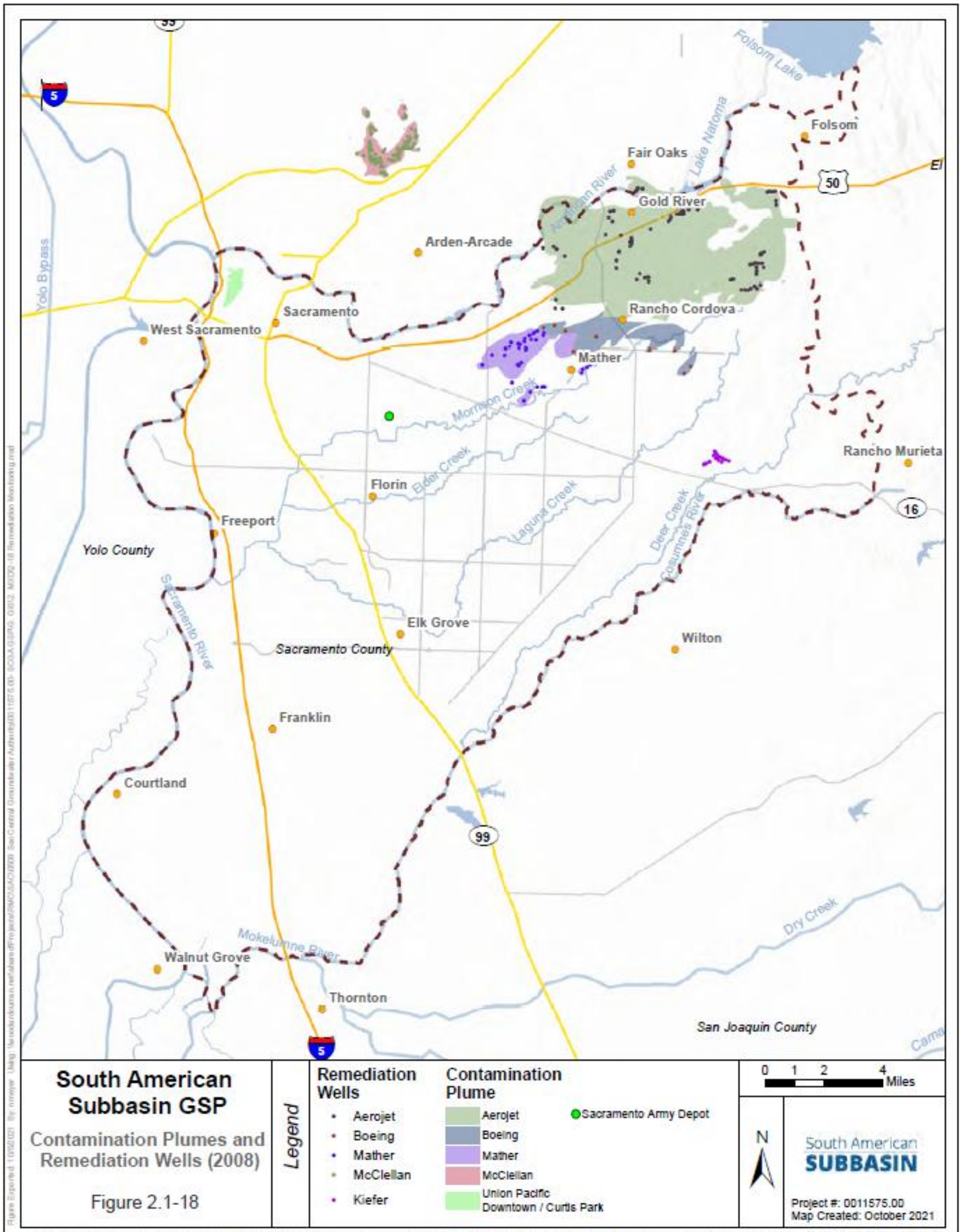
Table 2.1-13: Estimated Remediation Water Use

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
Total	**34,451**

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.



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.

Figure 2-18: Known Contaminant Plumes in the Subbasin

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 2-18**. 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

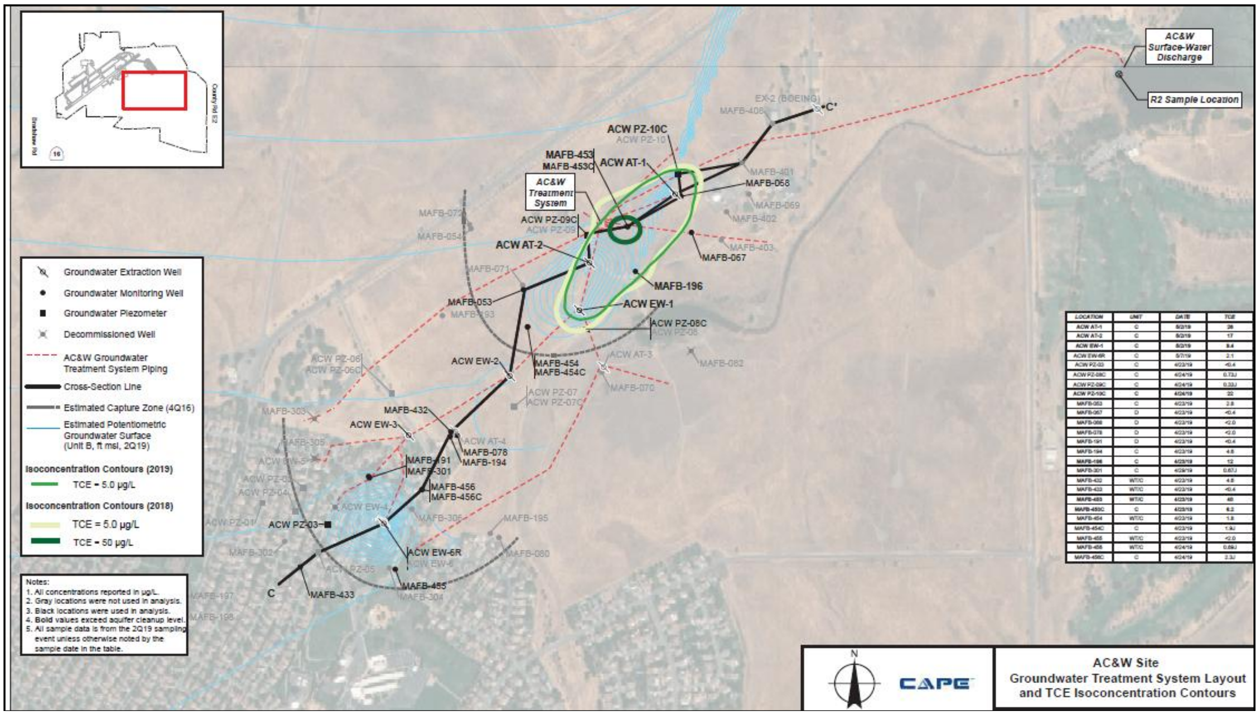
Pumping data was only available for Mather Air Force Base during the period from 2017-2019. During this period, an average of 1,221 AFY of water was pumped and discharged, as displayed in **Table 2.1-14.**

Table 2.1-14: Mather Air Force Base Groundwater Pumping

Year	Amount (AFY)
2017	1,683
2018	1,218
2019	763
2020	209
2021	209
2022	209
2023	209
2024	209
2025	209
Average	**546**

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 2-19**.

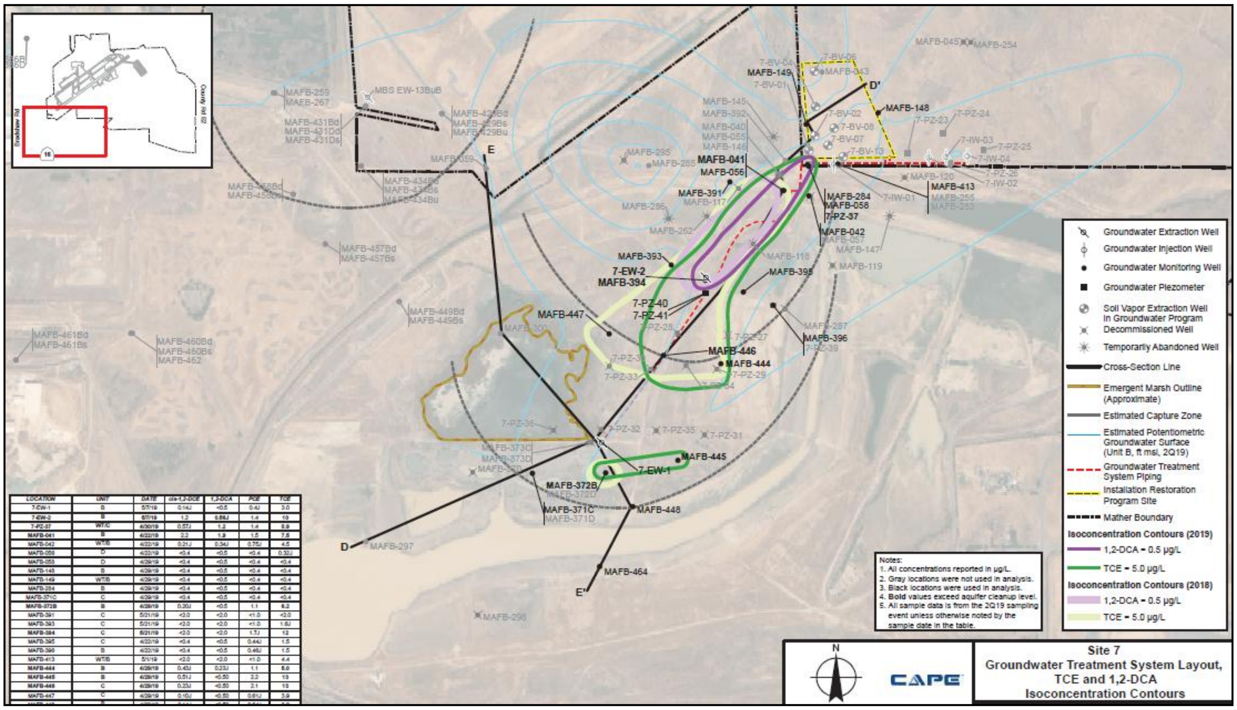


LOCATION	UNIT	DATE	TCE
ACW AT-1	C	8/2/19	36
ACW AT-2	C	8/2/19	17
ACW EW-1	C	8/2/19	9.4
ACW EW-6R	C	5/7/19	2.1
ACW PZ-03	C	4/23/19	<0.4
ACW PZ-08C	C	4/24/19	0.73J
ACW PZ-09C	C	4/24/19	0.33J
ACW PZ-10C	C	4/24/19	22
MAFB-053	C	4/23/19	2.8
MAFB-067	D	4/23/19	<0.4
MAFB-068	D	4/23/19	<2.0
MAFB-078	D	4/23/19	<2.0
MAFB-191	D	4/23/19	<0.4
MAFB-194	C	4/23/19	4.8
MAFB-196	C	4/25/19	12
MAFB-301	C	4/29/19	0.67J
MAFB-432	WT/C	4/23/19	4.8
MAFB-433	WT/C	4/23/19	<0.4
MAFB-453	WT/C	4/25/19	40
MAFB-453C	C	4/25/19	6.2
MAFB-454	WT/C	4/23/19	1.8
MAFB-454C	C	4/23/19	1.9J
MAFB-455	WT/C	4/23/19	<2.0
MAFB-456	WT/C	4/24/19	0.69J
MAFB-456C	C	4/24/19	2.3J

Source: Mather Annual and Fourth Quarter 2019 Groundwater Monitoring Report_Figure 4-1_pg210

Figure 2-19: Mather AC&W Site TCE Concentrations

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 2-20**). Progress is being made toward achieving the objectives of the remedial action at this site.

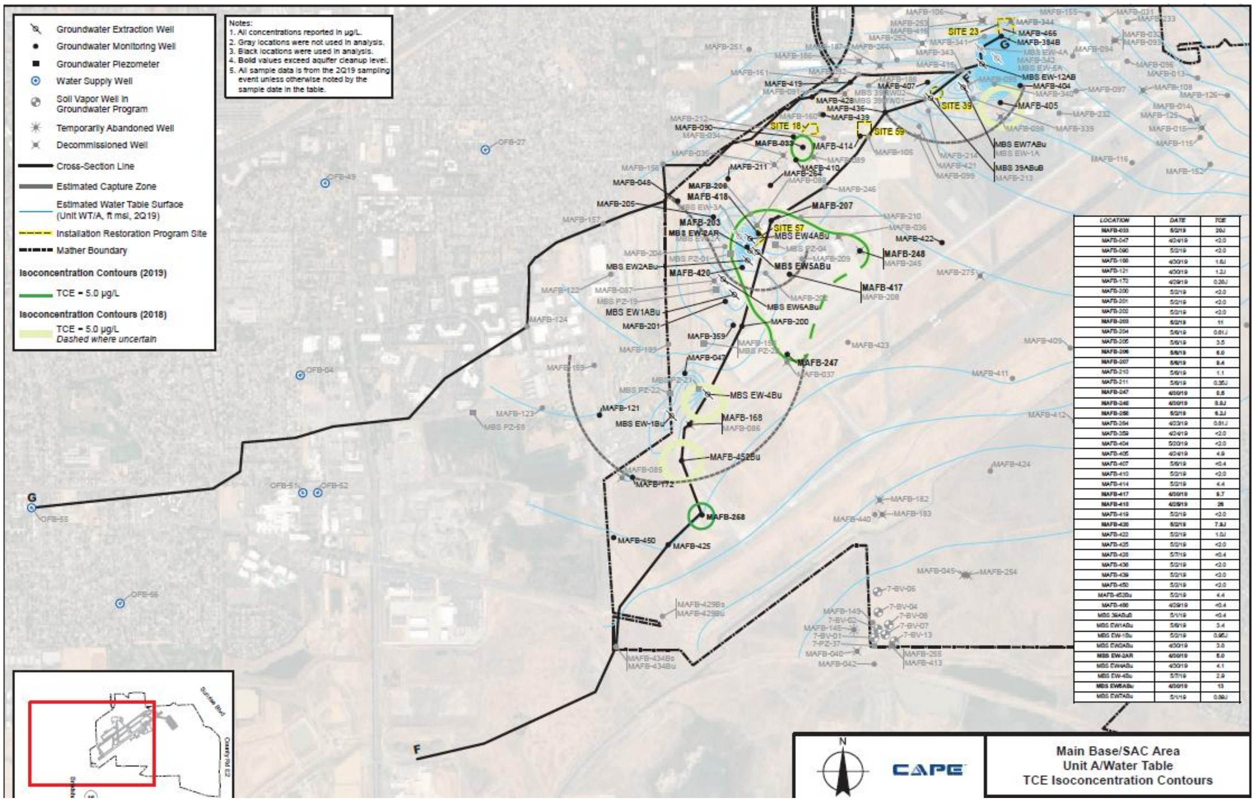


LOCATION	UNIT	DATE	cis-1,2-DCE	1,2-DCA	PCE	TCE
7-EW-1	B	5/7/19	0.14J	<0.5	0.4J	3.0
7-EW-2	B	5/7/19	1.2	0.86J	1.4	10
7-PZ-37	WT/C	4/30/19	0.57J	1.2	1.4	5.9
MAFB-041	B	4/22/19	2.2	1.9	1.5	7.8
MAFB-042	WT/B	4/22/19	0.21J	0.34J	0.75J	4.5
MAFB-056	D	4/22/19	<0.4	<0.5	<0.4	0.32J
MAFB-058	D	4/29/19	<0.4	<0.5	<0.4	<0.4
MAFB-145	B	4/29/19	<0.4	<0.5	<0.4	<0.4
MAFB-149	WT/B	4/29/19	<0.4	<0.5	<0.4	<0.4
MAFB-284	B	4/29/19	<0.4	<0.5	<0.4	<0.4
MAFB-371C	C	4/29/19	<0.4	<0.5	<0.4	<0.4
MAFB-372B	B	4/29/19	0.20J	<0.5	1.1	6.2
MAFB-391	C	5/21/19	<2.0	<2.0	<1.0	<2.0
MAFB-393	C	5/21/19	<2.0	<2.0	<1.0	1.6J
MAFB-394	C	5/21/19	<2.0	<2.0	1.7J	12
MAFB-395	C	4/22/19	<0.4	<0.5	0.44J	1.5
MAFB-396	B	4/22/19	<0.4	<0.5	0.46J	1.5
MAFB-413	WT/B	5/1/19	<2.0	<2.0	<1.0	4.4
MAFB-444	B	4/29/19	0.43J	0.23J	1.1	5.6
MAFB-445	B	4/29/19	0.51J	<0.50	2.2	13
MAFB-446	C	4/29/19	0.23J	<0.50	2.1	13
MAFB-447	C	4/29/19	0.10J	<0.50	0.61J	3.9

Source: Mather Annual and Fourth Quarter 2019 Groundwater Monitoring Report_Figure 5-1_pg213

Figure 2-20: Mather Site 7 TCE Concentrations

The MBSA plume areas and TCE and Tetrachloroethylene (PCE) concentrations have remained the same over the past year. See **Figure 2-21**. 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.



Source: Mather Annual and Fourth Quarter 2019 Groundwater Monitoring Report_Figure 6-1_pg219

Figure 2-21: Mather MBSA Site TCE Concentrations

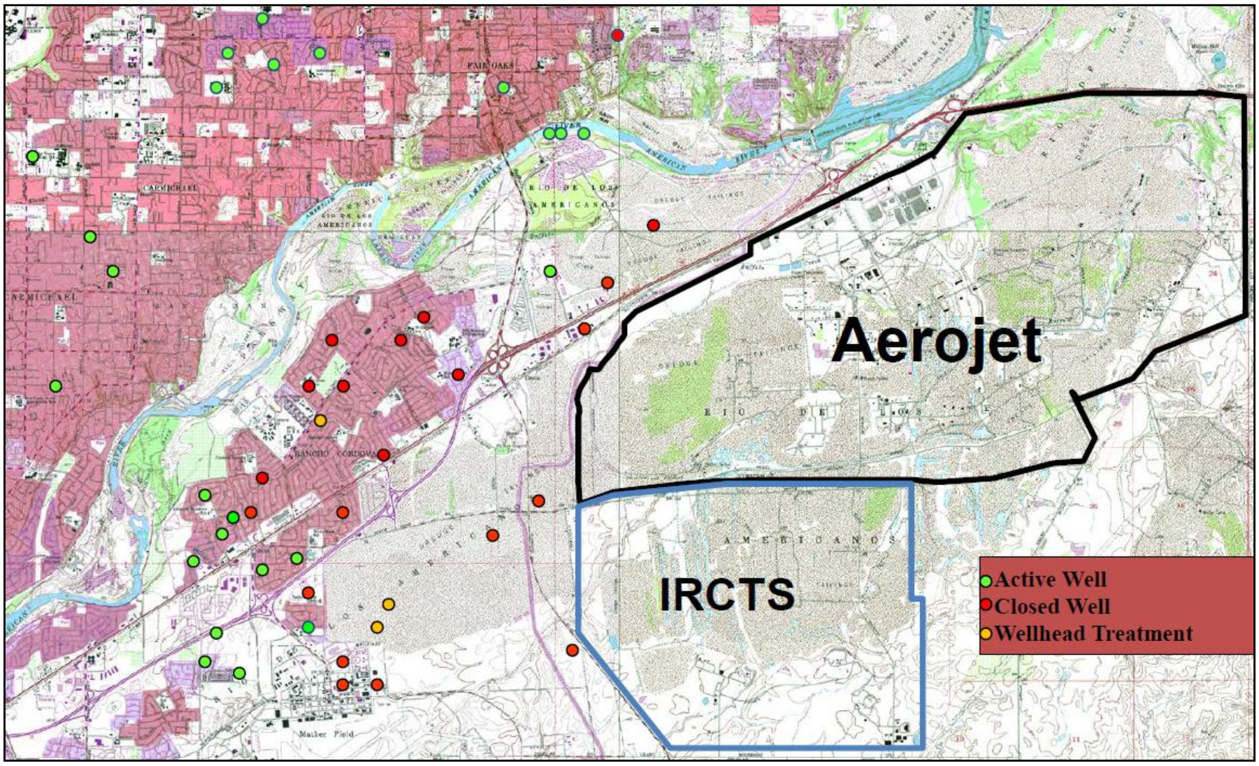
2.1.8.2 Aerojet Superfund Site

The EPA designated the Aerojet General Corporation site as a designated Superfund Site. Additional information can be found here:
https://cumulis.epa.gov/supercpad/CurSites/csitinfo.cfm?id=0901718&msspp=med

The Aerojet Superfund Site is a complicated facility located in the northeastern quadrant of the subbasin and was used to manufacture and test rocket propulsion systems and for chemical manufacturing. The site currently covers 5,900 acres and is located 15 miles east of Sacramento in Rancho Cordova, and half a mile from the American River as shown in **Figure 2-22**. The figure also includes the IRCTS which was a late 1950s to early 1970s rocket assembly and testing facility operated by the McDonnell Douglas Corporation.

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).



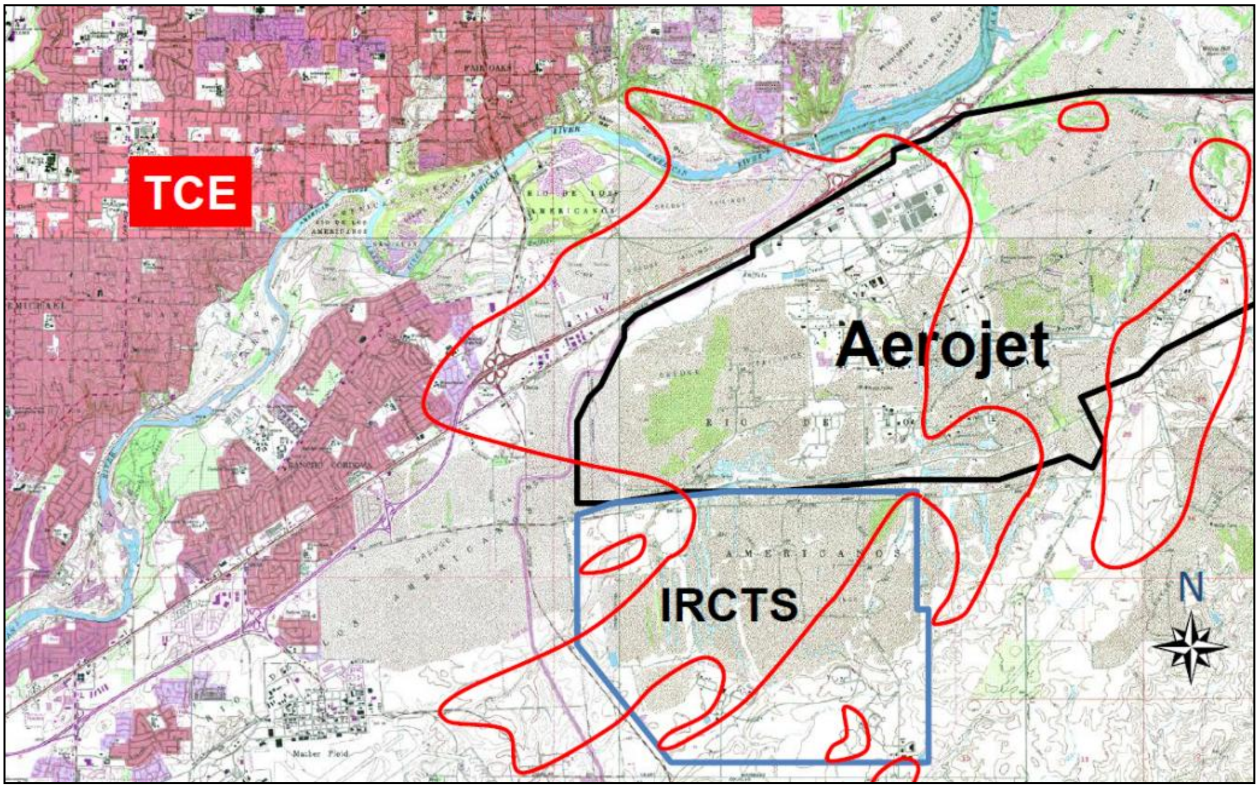
Source: Central Basin Groundwater Presentation 2019_Pg 3

Figure 2-22: Aerojet Site Location Map

2.1.8.2.1 Historical, Current, and Future Operations

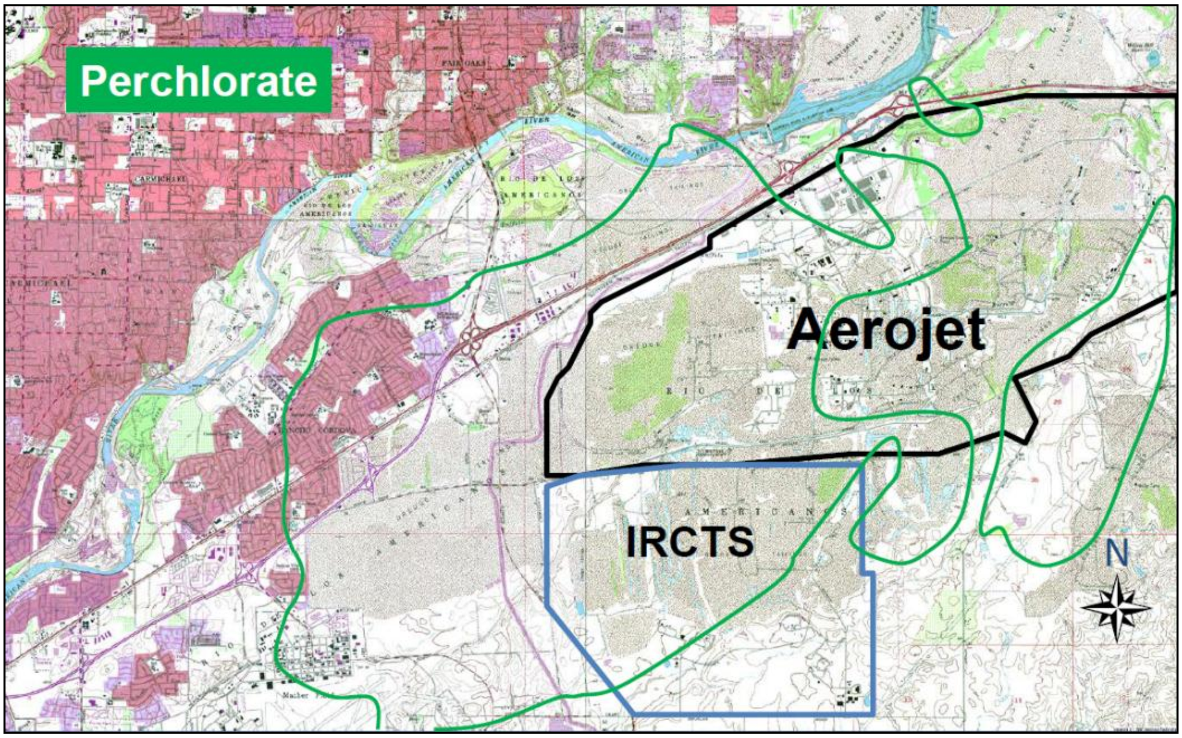
The Aerojet Superfund Site was one the first sites added to the USEPA's National Priorities in 1983 and is one of the largest and most extensive Superfund groundwater cleanups in California. Over the past 37 years, multiple cleanup efforts have been mandated under the direction of the U.S. Environmental 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 2-23**), Perchlorate (**Figure 2-24**), and/or NDMA (**Figure 2-25**). 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.



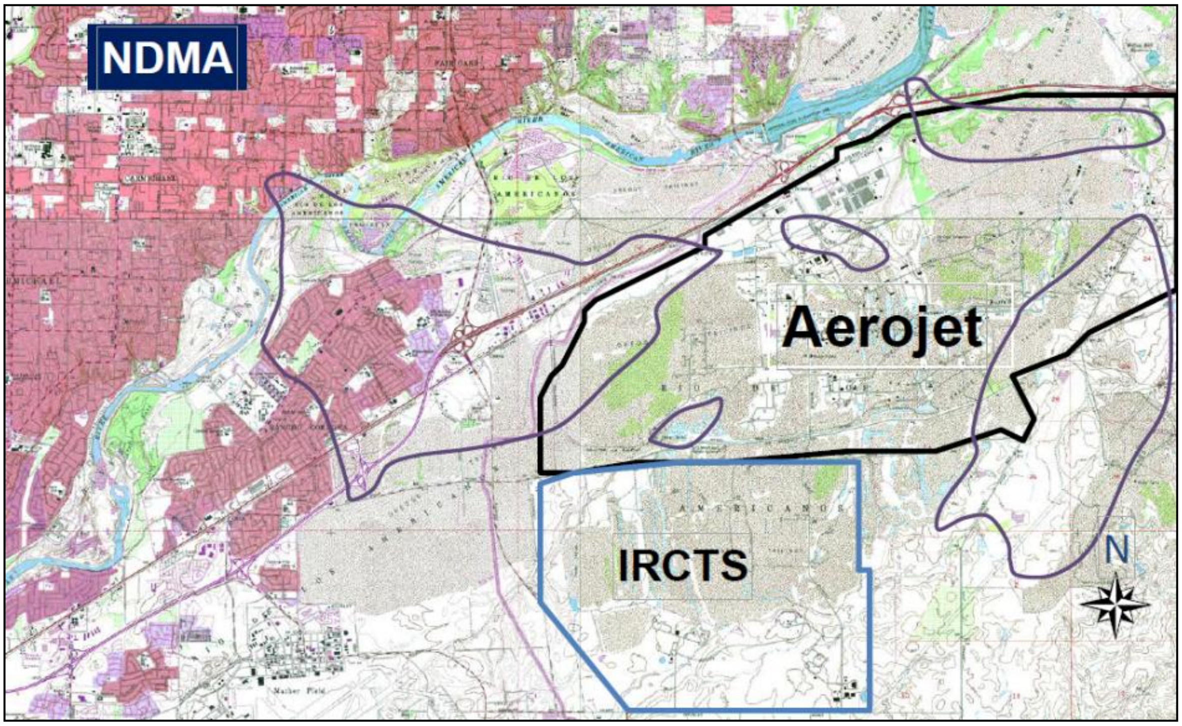
Source: Central Basin Groundwater Presentation 2019_Pg 4

Figure 2-23: Aerojet and IRCTS TCE Plumes 2019



Source: Central Basin Groundwater Presentation 2019_Pg 5

Figure 2-24: Aerojet and IRCTS Perchlorate Plume

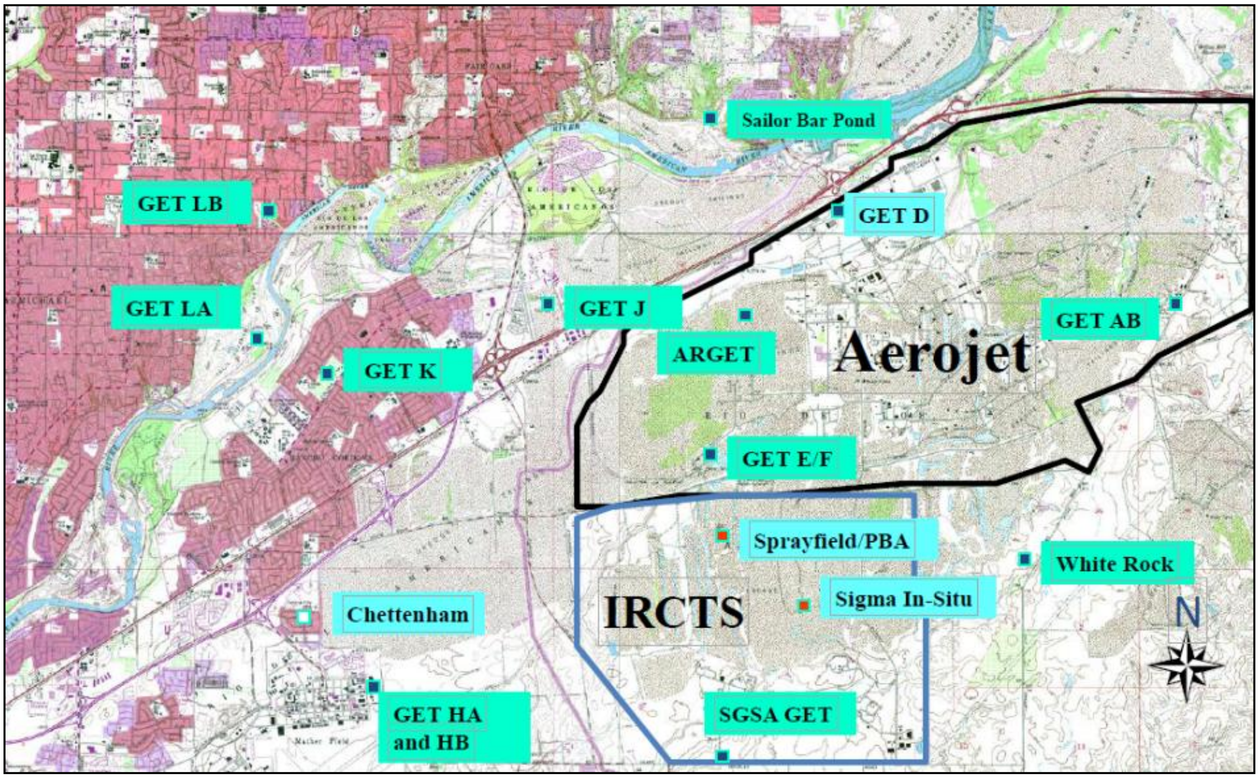


Source: Central Basin Groundwater Presentation 2019_Pg 6

Figure 2-25: Aerojet NDMA Plume

Aerojet has installed several groundwater extraction and treatment systems (GETs) (see **Figure 2-26**) 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.



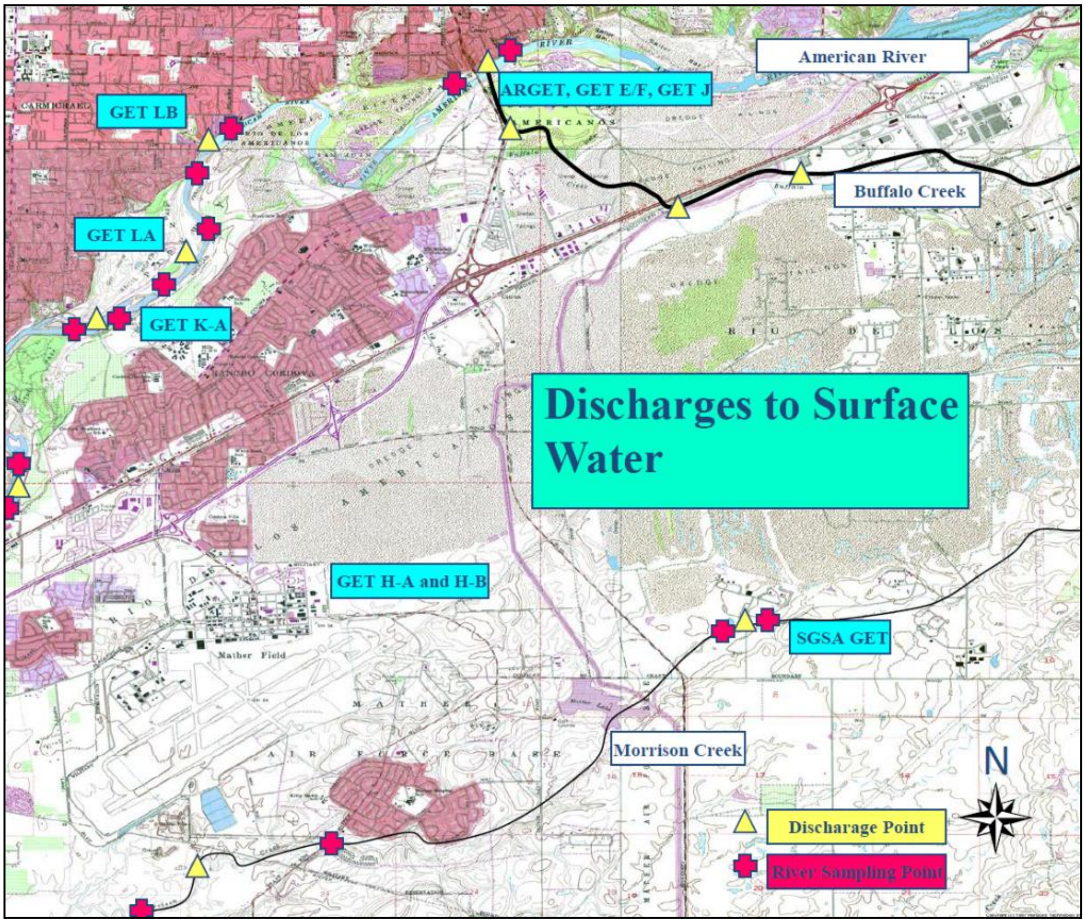
Source: Central Basin Groundwater Presentation 2019_Pg 7

Figure 2-26: Aerojet and IRCTS Groundwater Extraction and Treatment Systems

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 2-27**) 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.



Source: Central Basin Groundwater Presentation 2019_Pg 11

Figure 2-27: Aerojet and IRCTS Surface Water Discharges

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 Ione

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

Year	Amount (AFY)
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
2020	29,251
2021	28,352
2022	23,829
2023	26,757
2024	27,412
2025	27,067
Average	**27,089**

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

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 2-28**). 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.

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

Figure 2-28: Kiefer Landfill Site Map

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

Year	Amount (AFY)
2010	1,099
2011	1,142
2012	391
2013	518
2014	507
2015	460
2016	380
2017	475
2018	599
2019	650
2020	792
2021	612
2022	618
2023	586
2024	643
2025	673
Average	**634**

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.
- 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)	2021 – 2025 Average Amount (AFY)
Aerojet & IRCTS	27,089	26,683
Mather AFB	546	209
Kiefer	634	626
Total	**28,269**	**27,518**

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
Conservation Element		
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
Delta Protection Element		
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
Land Use Element		
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
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

Goal	Policy	Action
Natural Resources		
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
Disaster and Emergency Risk Reduction		
ER-6—An Adaptable and Resilient Community	Loss of Snowpack and Decreased Water Supplies	ER-6-6 through ER-6-8
Urban Infrastructure		
ER-6—An Adaptable and Resilient Community	Water Service	INF-1-1 through INF-1-3
	Recycled Water	INF-1-4
Rural Area Community Plan		
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
Natural and Cultural Resources	
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
Land Use	
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
Public Facilities and Services	
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
Land Use	
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
Natural Resources	
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
Citywide Land Use and Urban Design	
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
Utilities: Water Systems	
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
Environmental Resources: Water Resources	
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.

2.1.11.6 Regional Water Authority Watersheds Resilience Plan

The Regional Water Authority (RWA) Watersheds Resilience Plan was released to the public in late March 2026. It is available at: https://rwawatershedsresilience.com/plan/. Policies that capture and store excess water during wet and above normal years are described as critical. One of 19 adaptation strategies the plan describes is to Implement Sustainable Groundwater Management. This strategy lists 10 adaptation actions including: Implement conjunctive use, in-lieu groundwater recharge, and aquifer storage and recovery projects where feasible to achieve regional sustainable groundwater management; Identify key recharge areas (floodplains, paleo channels, and quarries) and protect via zoning; Use cropland for stormwater recharge; and Partner with farmers to flood fields and recover water later.

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

	Senate Bill X7-7 2020 Target				
Reporting Agency	**10-Year Baseline (GPCD)**	**10-Year Baseline (Years)**	**Actual 2015 (GPCD)**	**Actual 2020 (GPCD)**	**Target 2020 (GPCD)**
California American Water Company–Sacramento District[1]	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:

[1] *Includes the Antelope, Arden, Dunnigan, Isleton, Lincoln Oaks, Parkway, Security Park, Suburban-Rosemont, Walnut Grove, and West Placer service areas*

[2] *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.

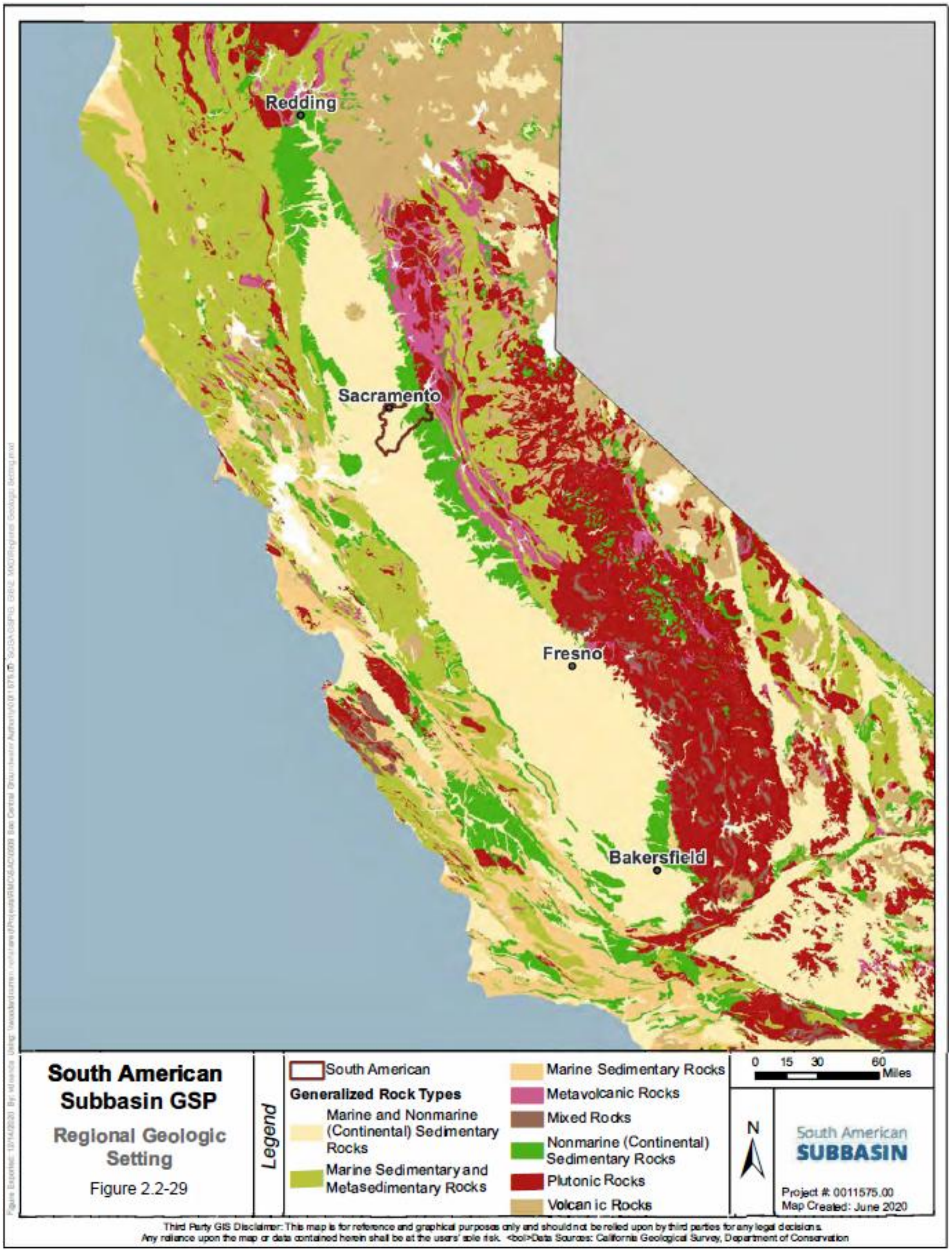


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Figure 2-29: Regional Geologic Setting

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.

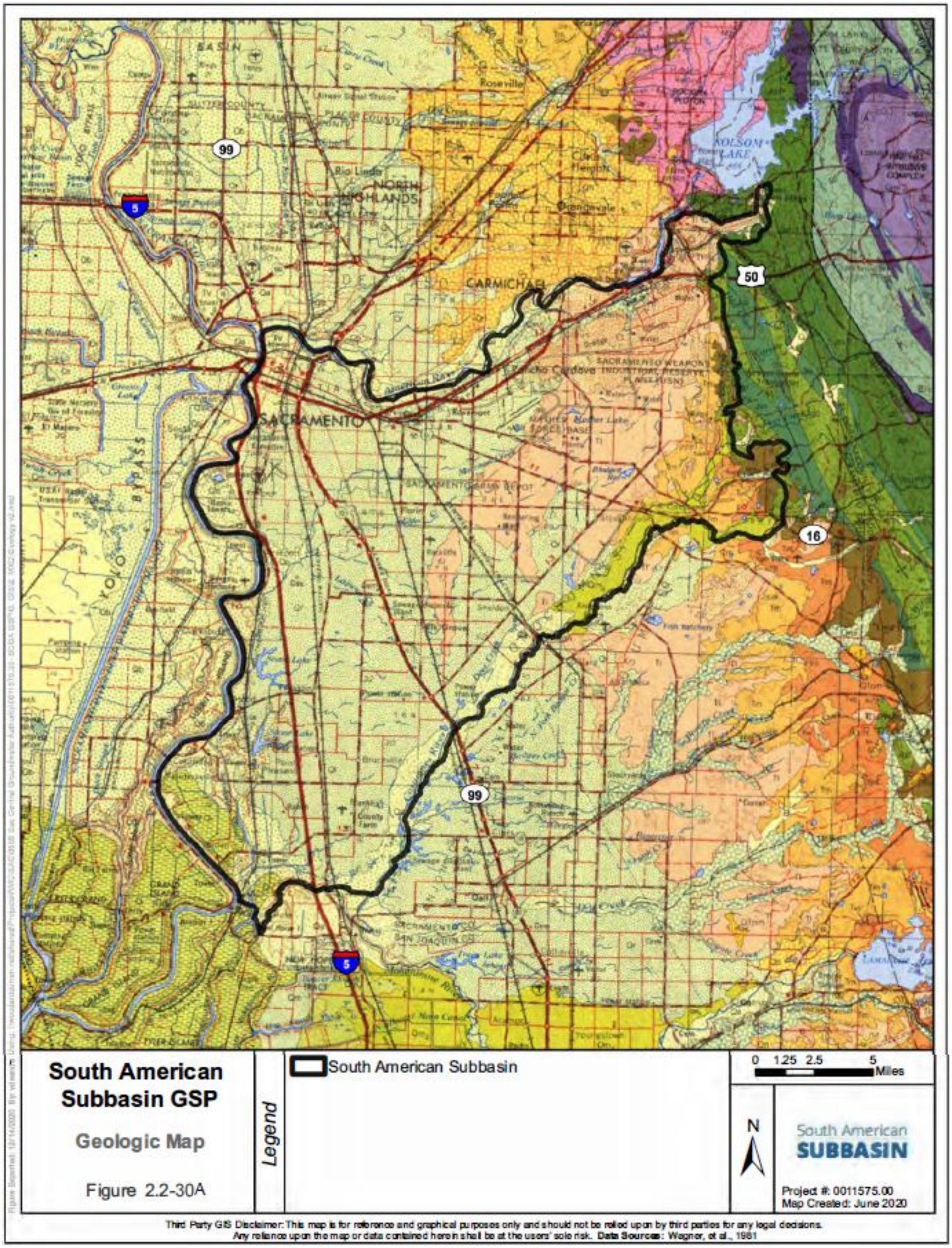
Geologic units mapped at the surface are shown in **Figure 2.2-30A**. The associated geologic map legend is shown in **Figure 2.2-30B**. A generalized stratigraphic column of geologic formations in the SASb is shown in **Figure 2.2-31**, and is based on older literature with formation names that are 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 Ione model layers (green, blue, purple, respectively) are correlated with the Mehrten, Valley Springs and Ione Formations, respectively.



South American Subbasin GSP

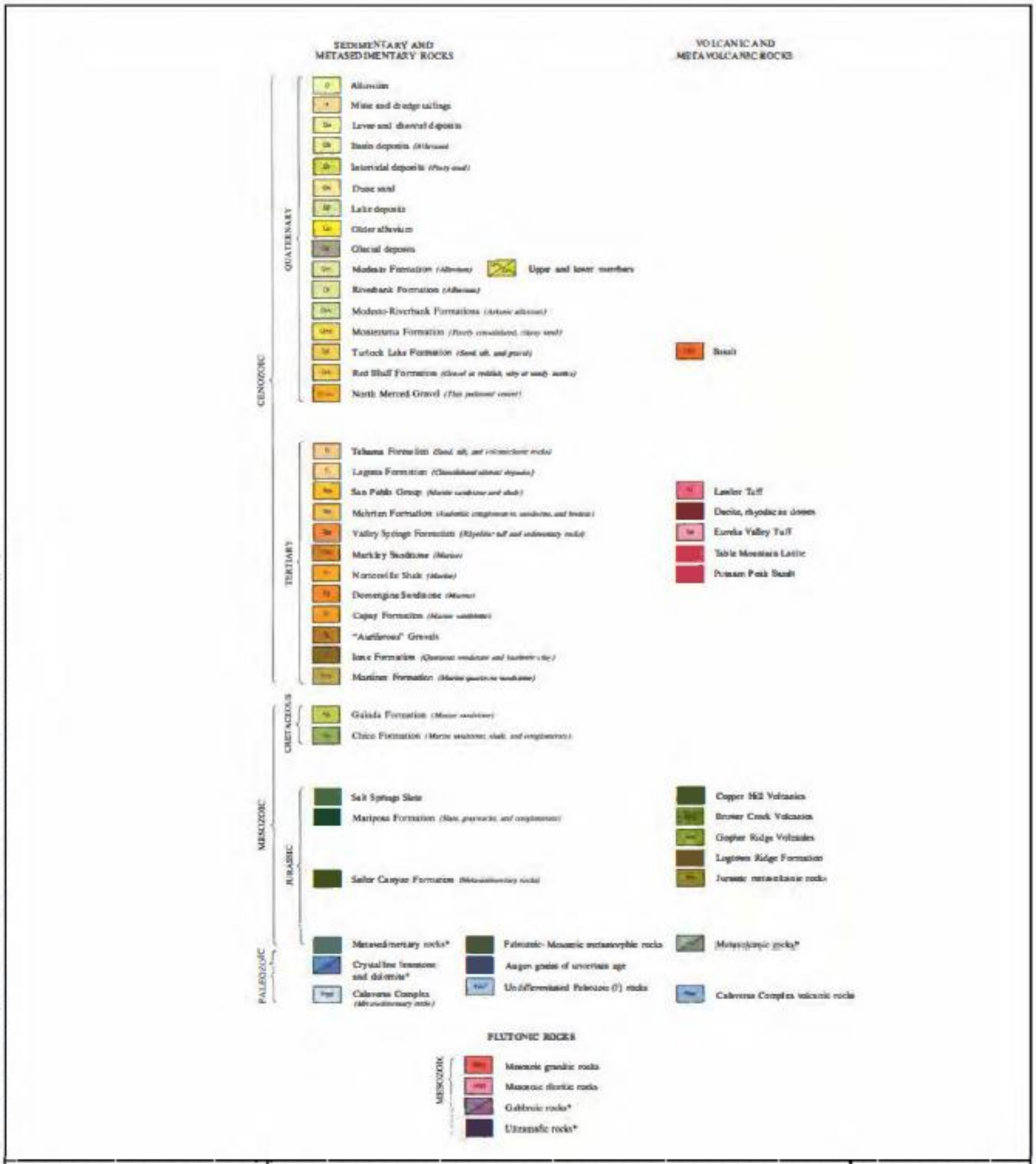
Geologic Map

Figure 2.2-30A

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. Data Sources: Wagner, et al., 1981

Figure 2-30A: Geologic Map



South American Subbasin GSP

Geologic Map Legend

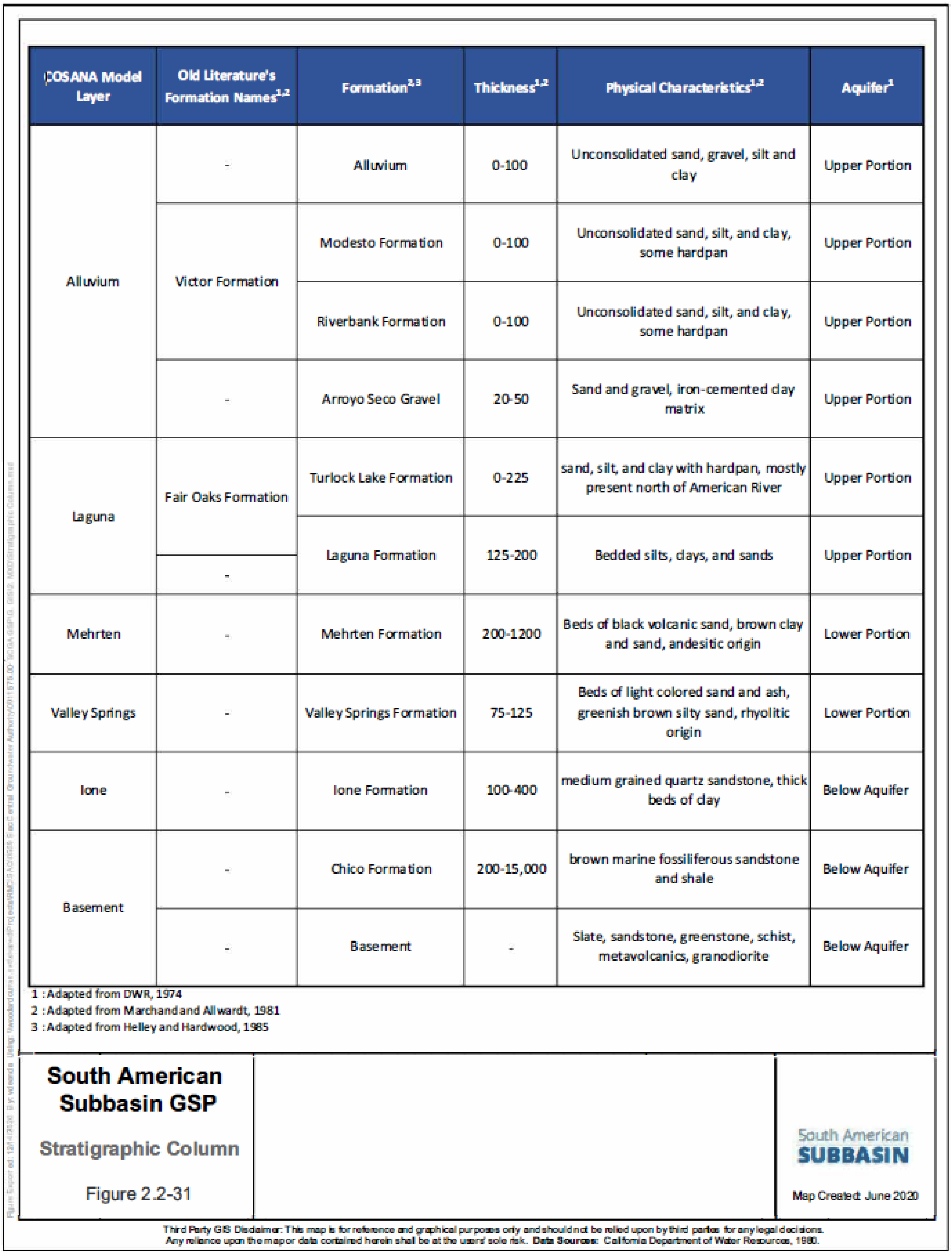
Figure 2.2-30B

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. Data Sources: Wagner, et al., 1981

Figure 2.2-30B: Geologic Map Legend



COSANA Model Layer	Old Literature's Formation Names[1,2]	Formation[2,3]	Thickness[1,2]	Physical Characteristics[1,2]	Aquifer[1]
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

Data Sources: California Department of Water Resources, 1980.

Figure 2-31: Stratigraphic Column

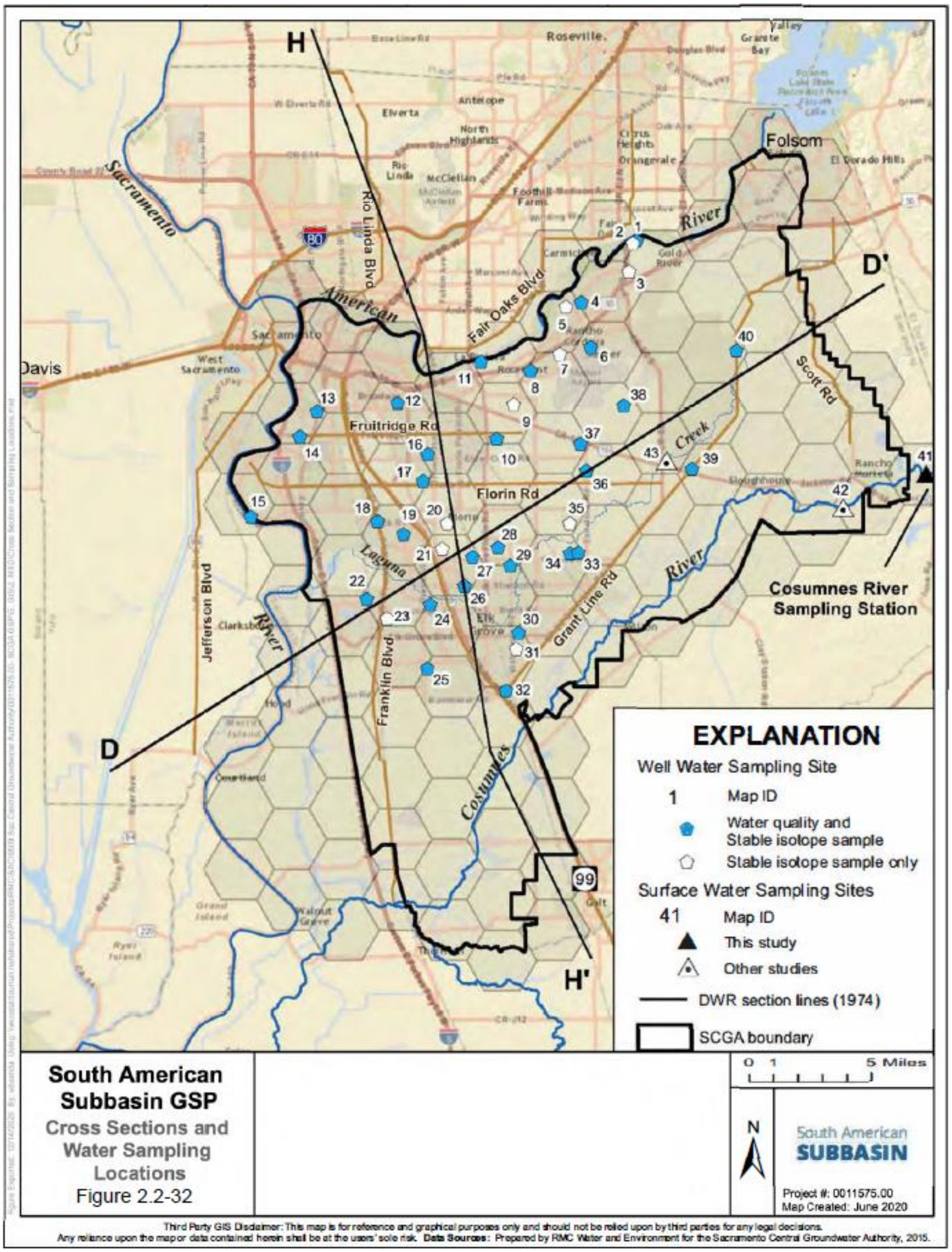


Figure 2-32: Cross Sections and Water Sampling Locations

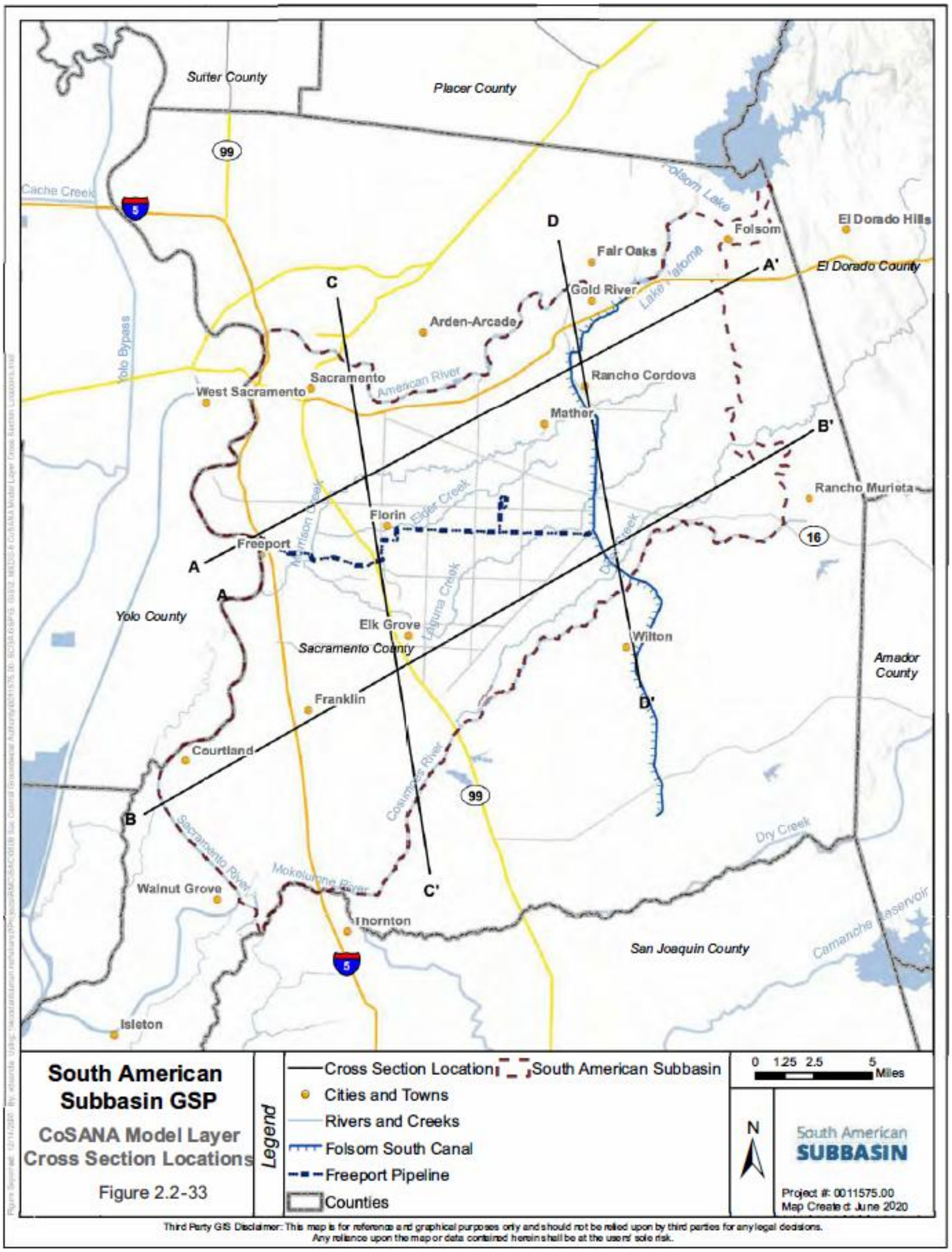
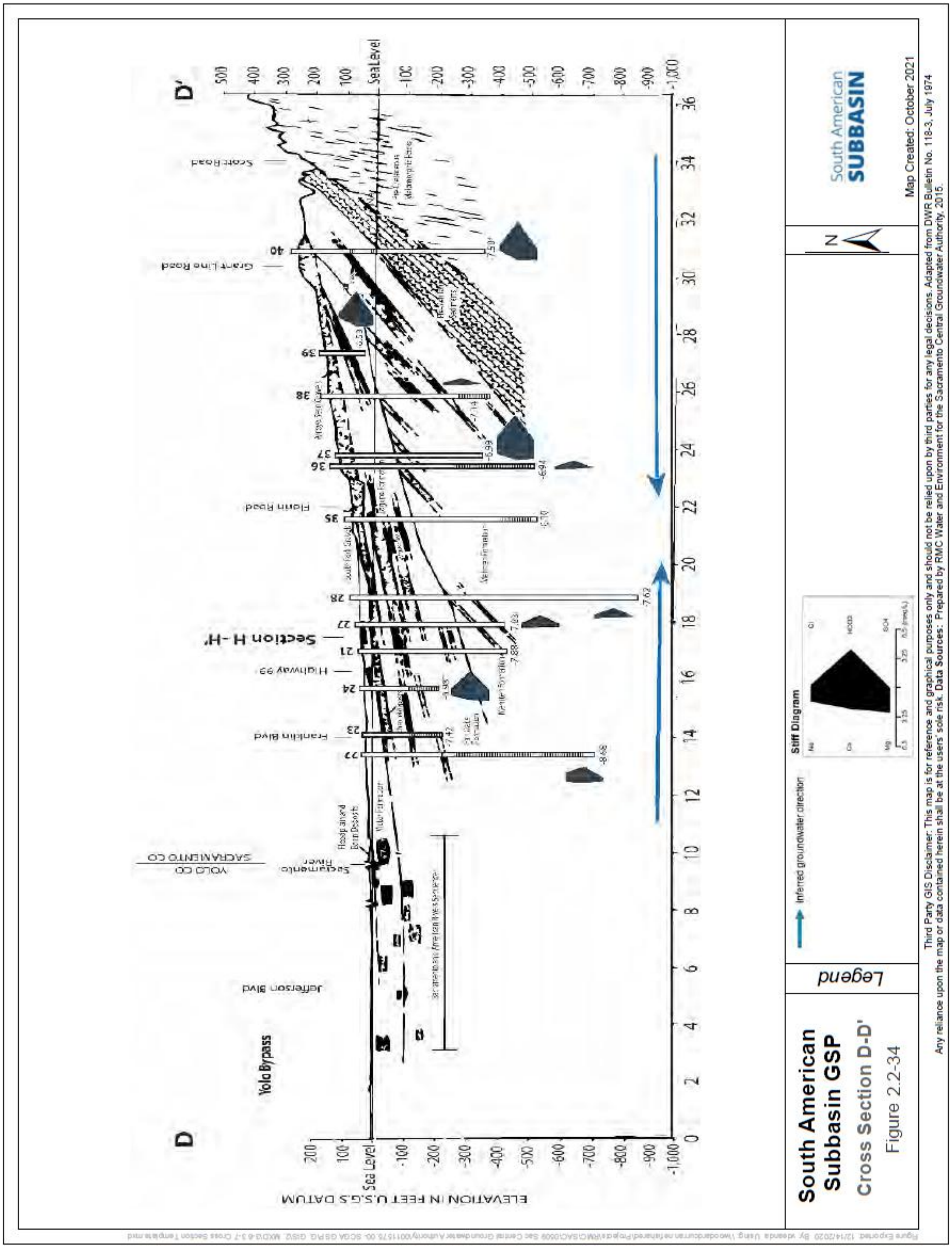


Figure 2-33: CoSANA Model Layer Cross Section Locations



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Any reliance upon the map or data contained herein shall be at the users' sole risk. **Data Sources:** Prepared by RMC Water and Environment for the Sacramento Central Groundwater Authority, 2015.

Figure 2-34: Cross Section D-D'

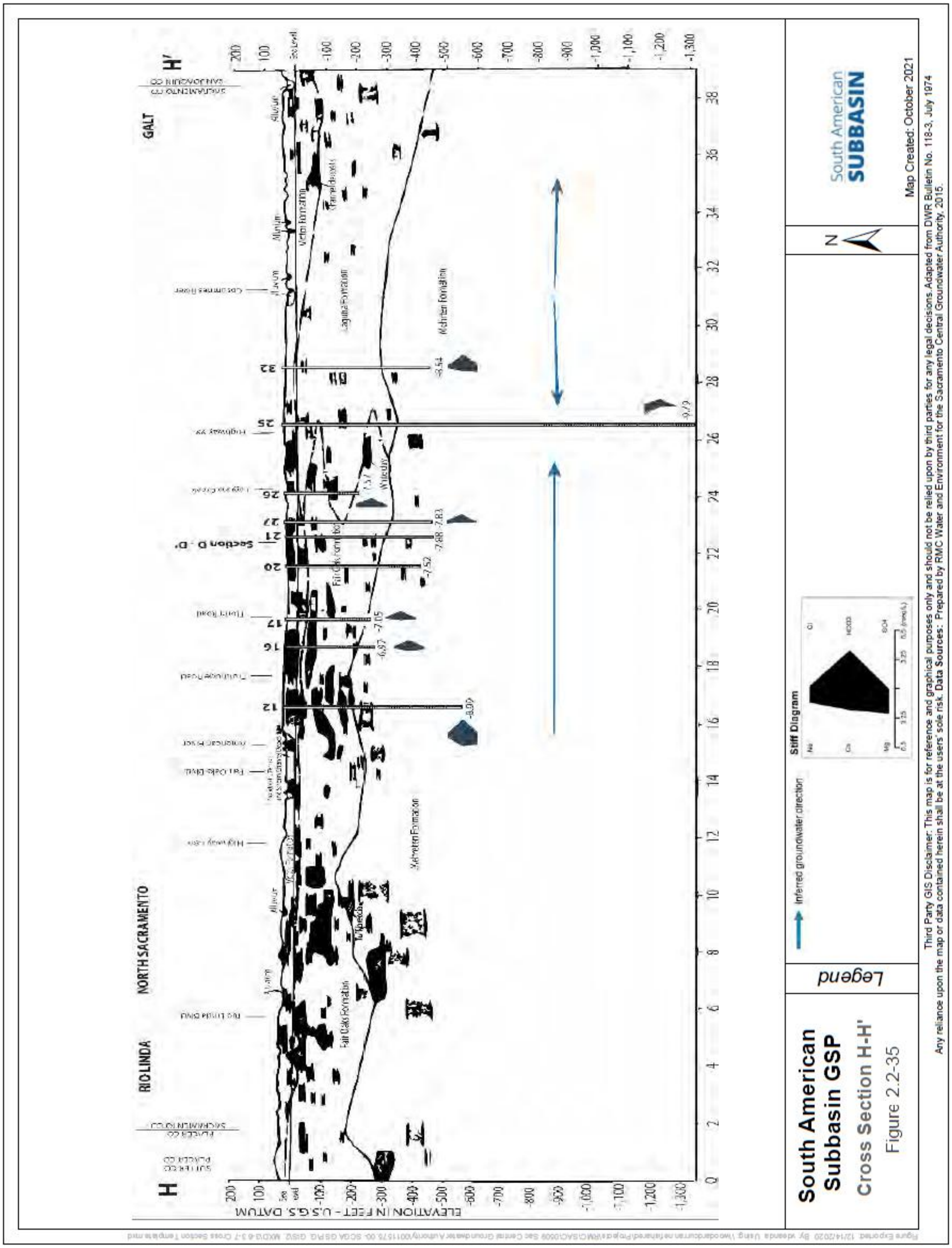


Figure 2-35: Cross Section H-H'

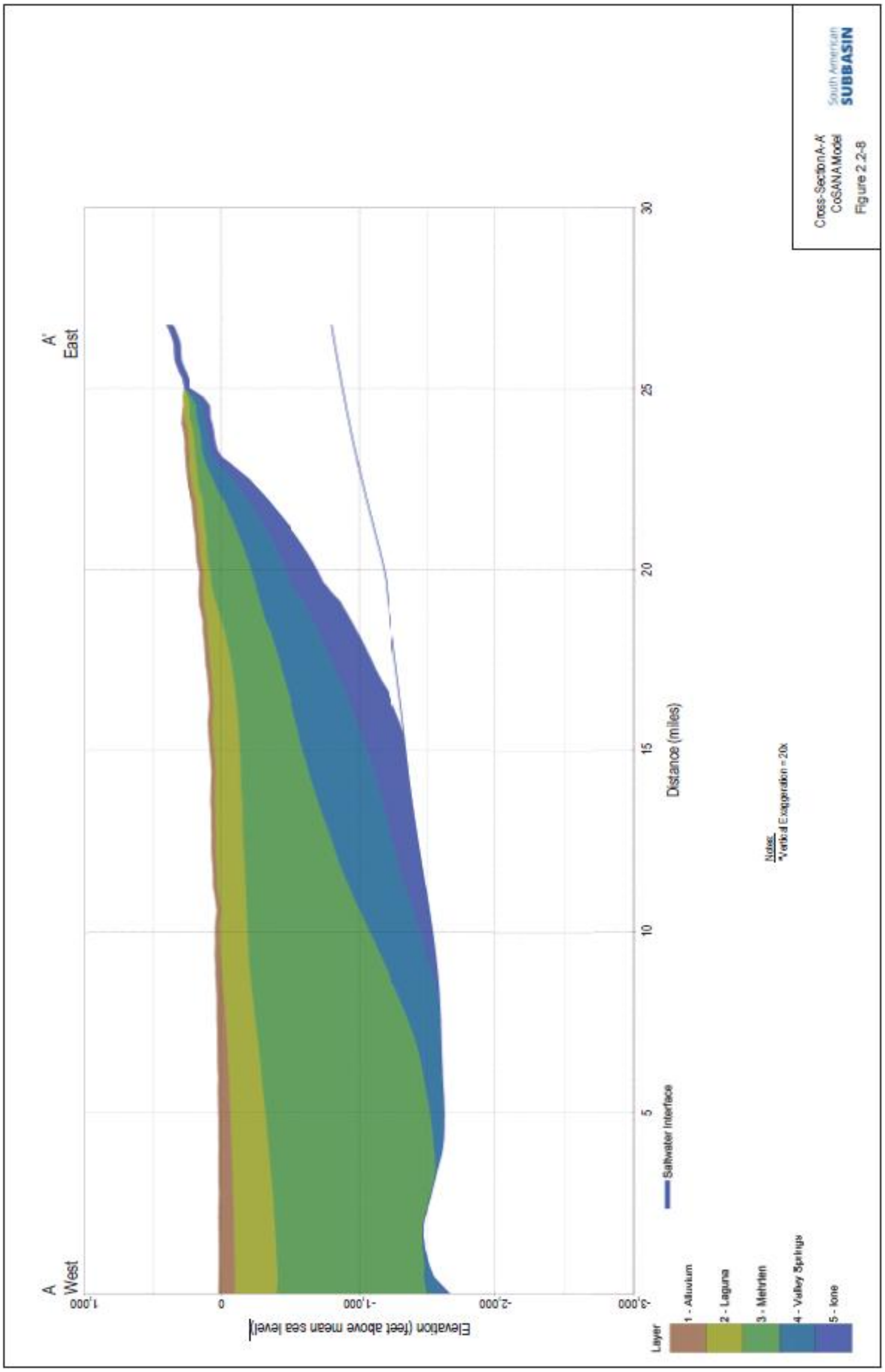


Figure 2-36: CoSANA Model Cross Section A-A

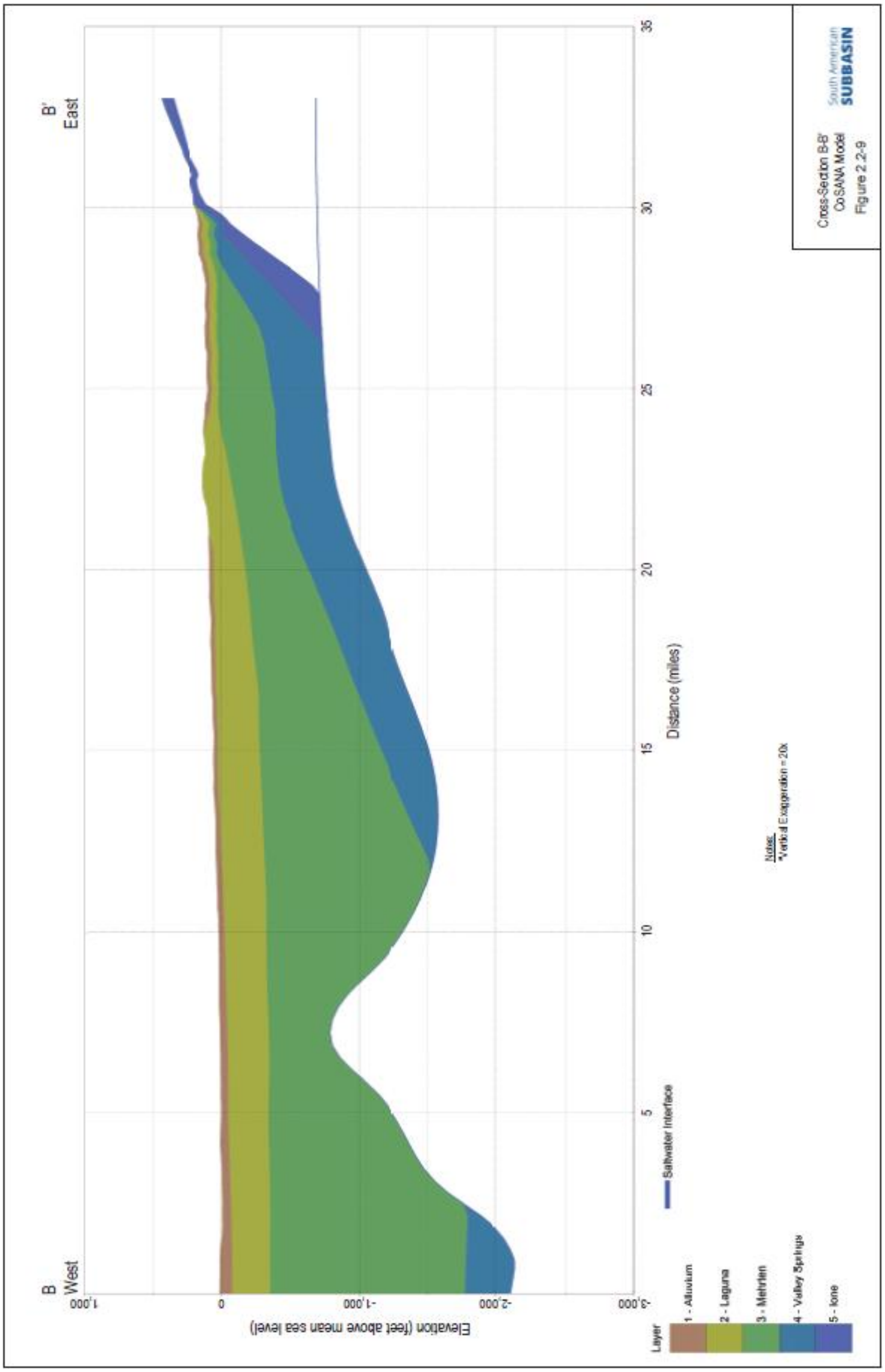


Figure 2-37: CoSANA Model Cross Section B-B

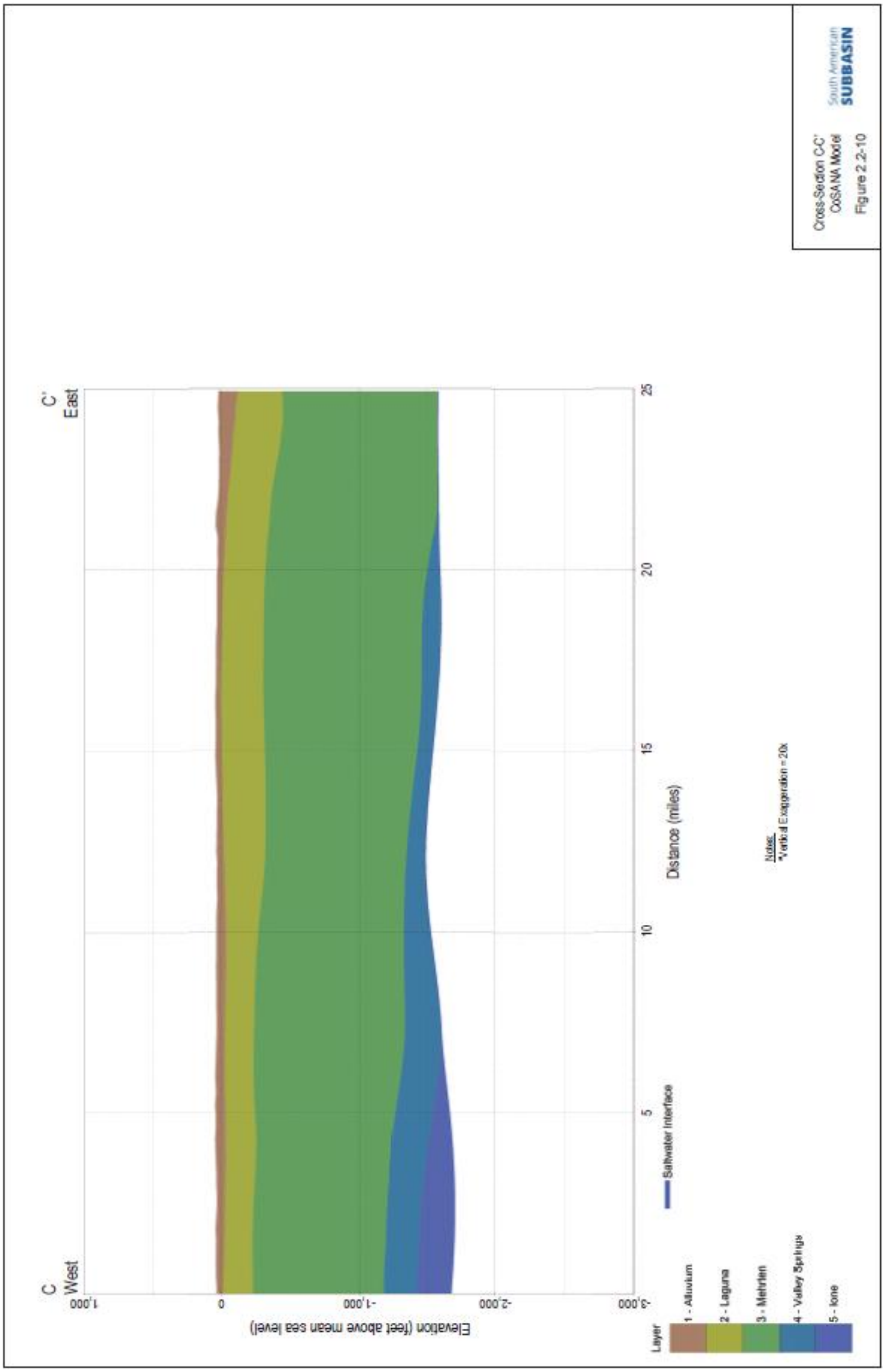


Figure 2-38: CoSANA Model Cross Section C-C

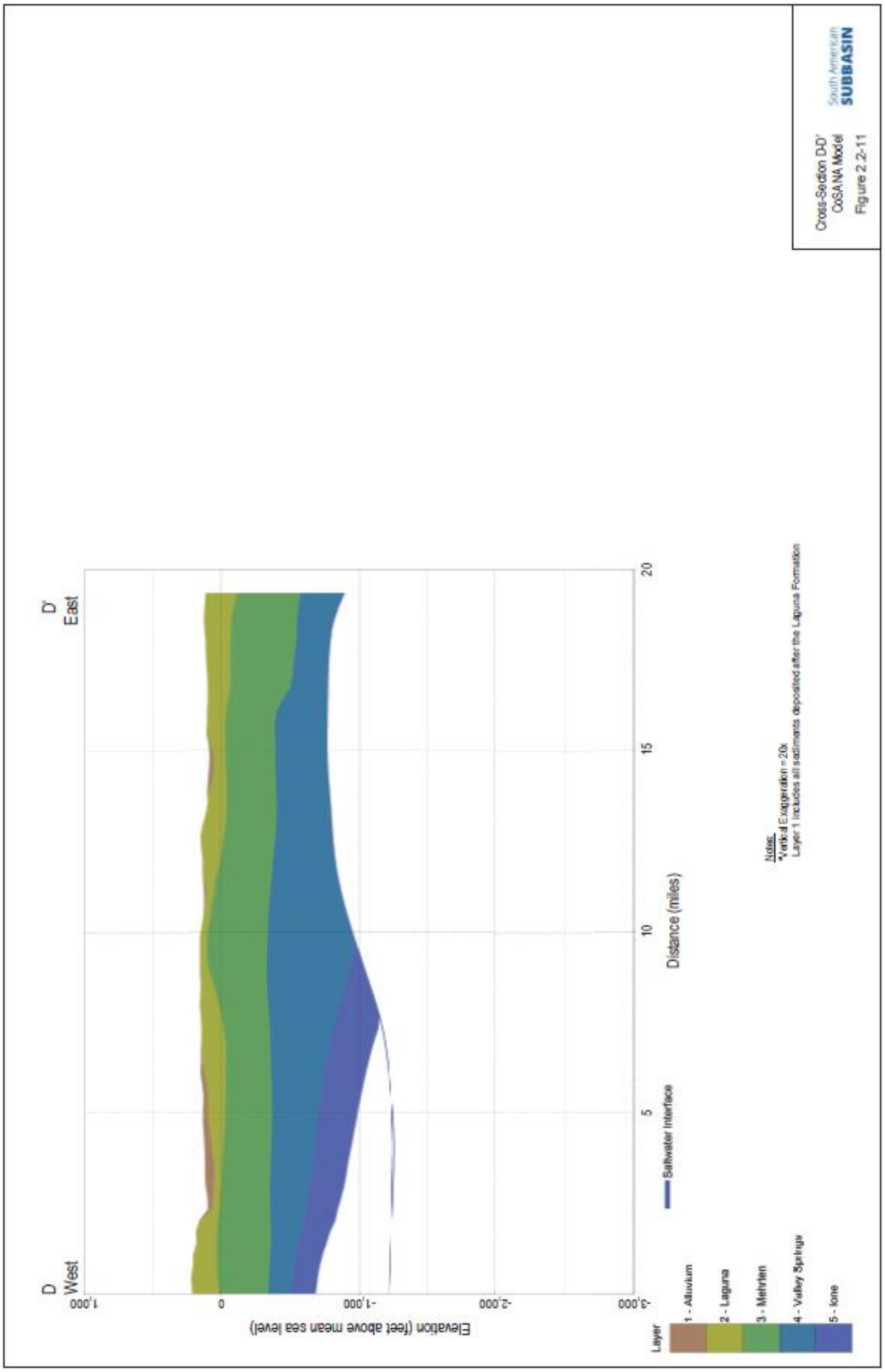


Figure 2-39: CoSANA Model Cross Section D-D

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 heterogenous 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 Ione 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.

Ione Formation

The Ione Formation is exposed in eastern Sacramento County from Carbondale Road north to Folsom. The middle Eocene-age Ione 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 Ione 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 Ione 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 Ione 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 Ione 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).

2.2.3.3 Airborne Electromagnetic Surveys

As part of DWR's Basin Characterization Program, Airborne Electromagnetic (AEM) surveys were completed in the SASb in April 2022. The purpose of the project was to collect electrical resistivity of the subsurface using geophysical tools in high and medium priority groundwater basins. This data is intended to support GSAs and assist them in making groundwater management decisions so groundwater sustainability can be achieved in basins. The SASb is part of AEM Survey Area 6. AEM survey data is publicly available online on the CA Natural Resources Agency website (https://data.cnra.ca.gov/dataset/aem).

The AEM surveys provide an electrical resistivity profile of the subsurface geological layers at depths of up to 300 meters (1,000 feet). Using the electrical resistivity profile, the distribution of coarse-grained and fine-grained materials can be inferred.

The resistivity models produced by the AEM survey will be a useful source of additional information to understand the SASb's hydrogeology. These models may assist in the identification of groundwater recharge areas for project and management actions, the identification of interconnected surface waters, and other elements of basin characterization. The SASb plans to incorporate the AEM data in the next update of the CoSANA model to improve and refine the understanding of the Subbasin's HCM. Furthermore, AEM data updates to the SASb HCM in the CoSANA model will be considered during the next periodic evaluation due in January 2032.

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 Ione 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 Ione 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 2.2-1 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

Layer	Minimum	Average	Maximum
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 – Ione	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 – Ione	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 – Ione	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 – Ione	0.000010	0.000050	0.000078

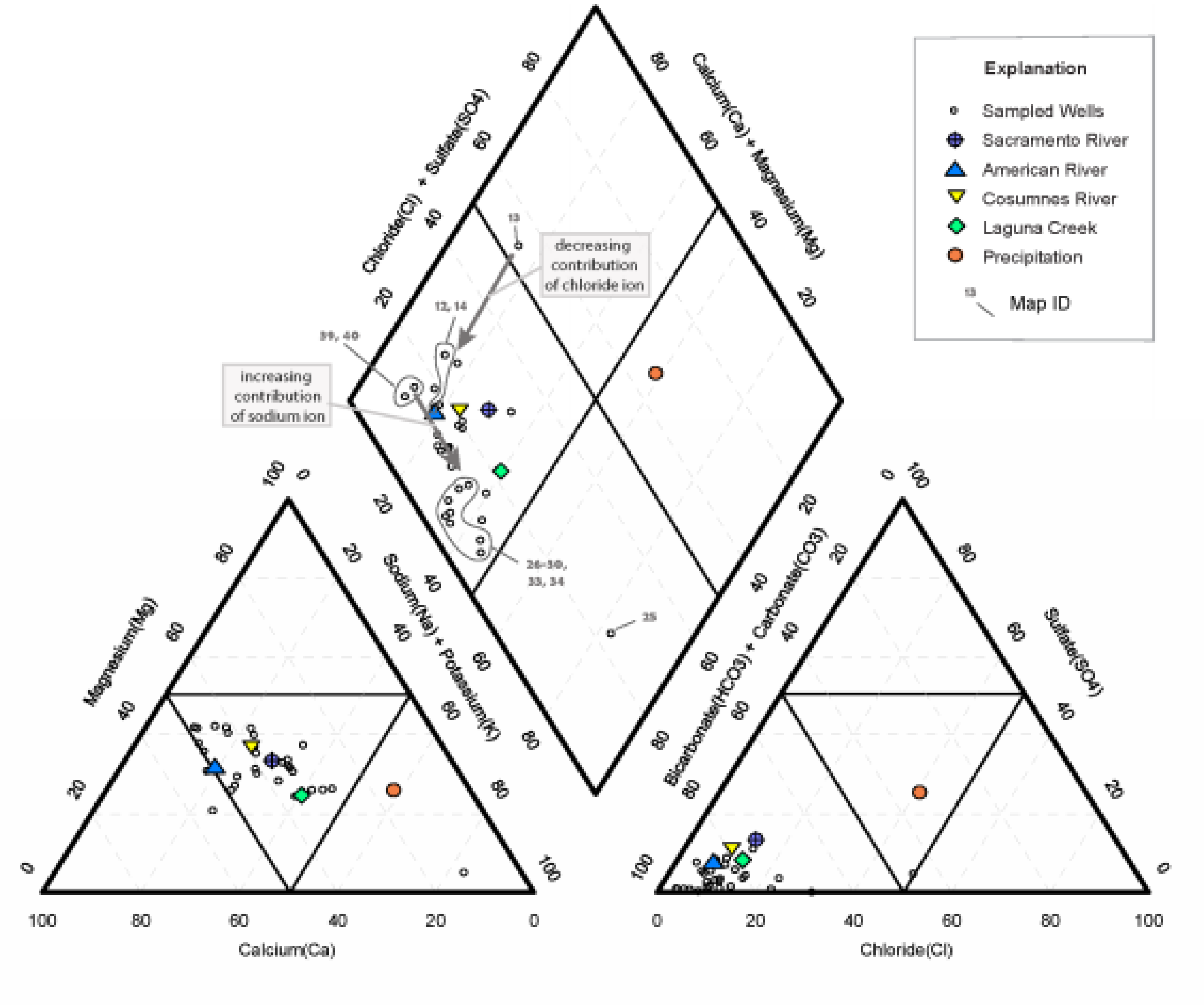
2.2.7 Natural Water Quality Characterization

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 (µg/L) to 16,000 µg/L, with the majority of wells having an average value of less than 200 µg/L. Manganese concentrations in the potable region of the lower zone of the aquifer range from less than 2 to 1,700 µg/L with the majority of wells having an average value of less than 50 µg/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 2-40: Piper Diagrams

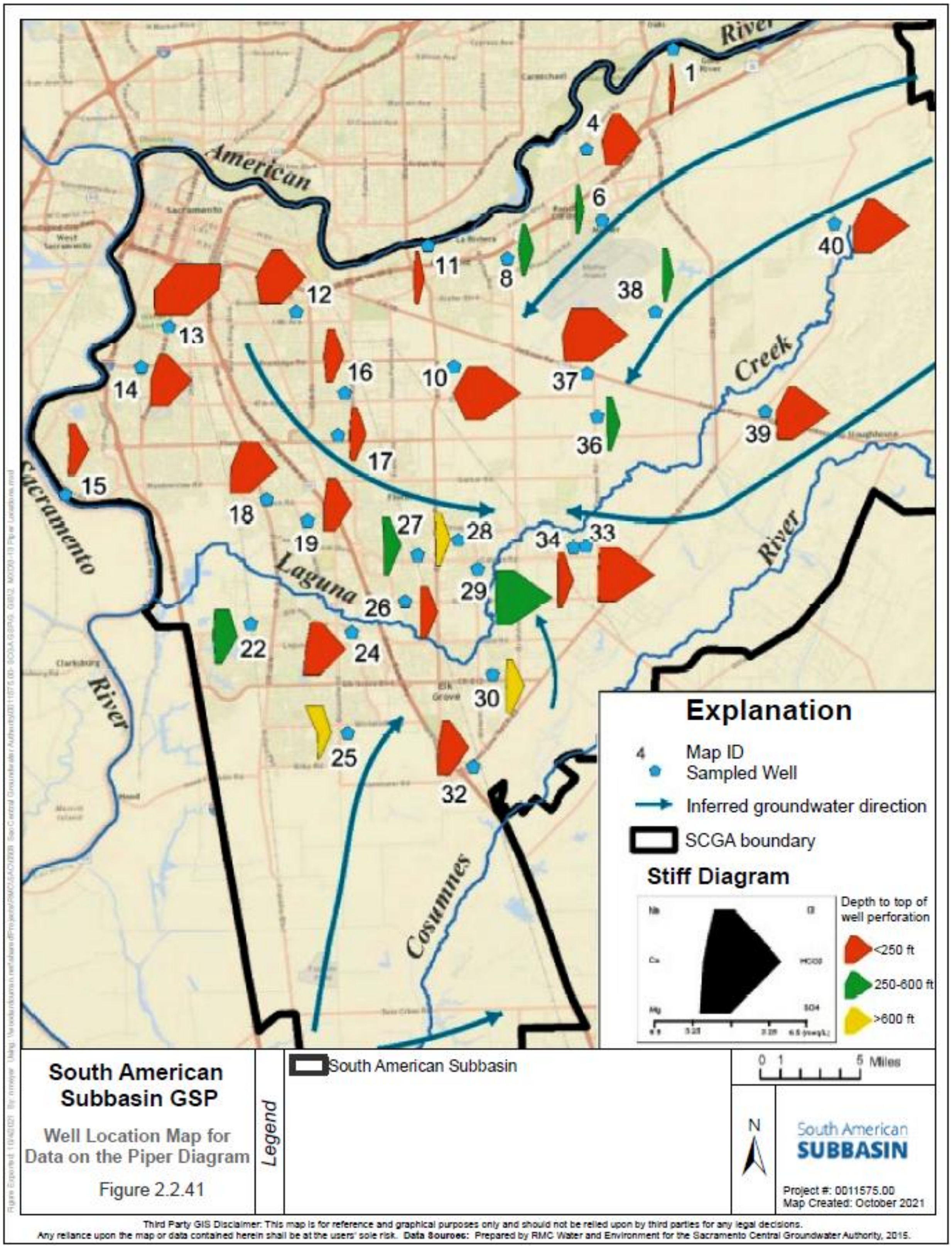


Figure 2-41: Well Location Map for Data on the Piper Diagram

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)

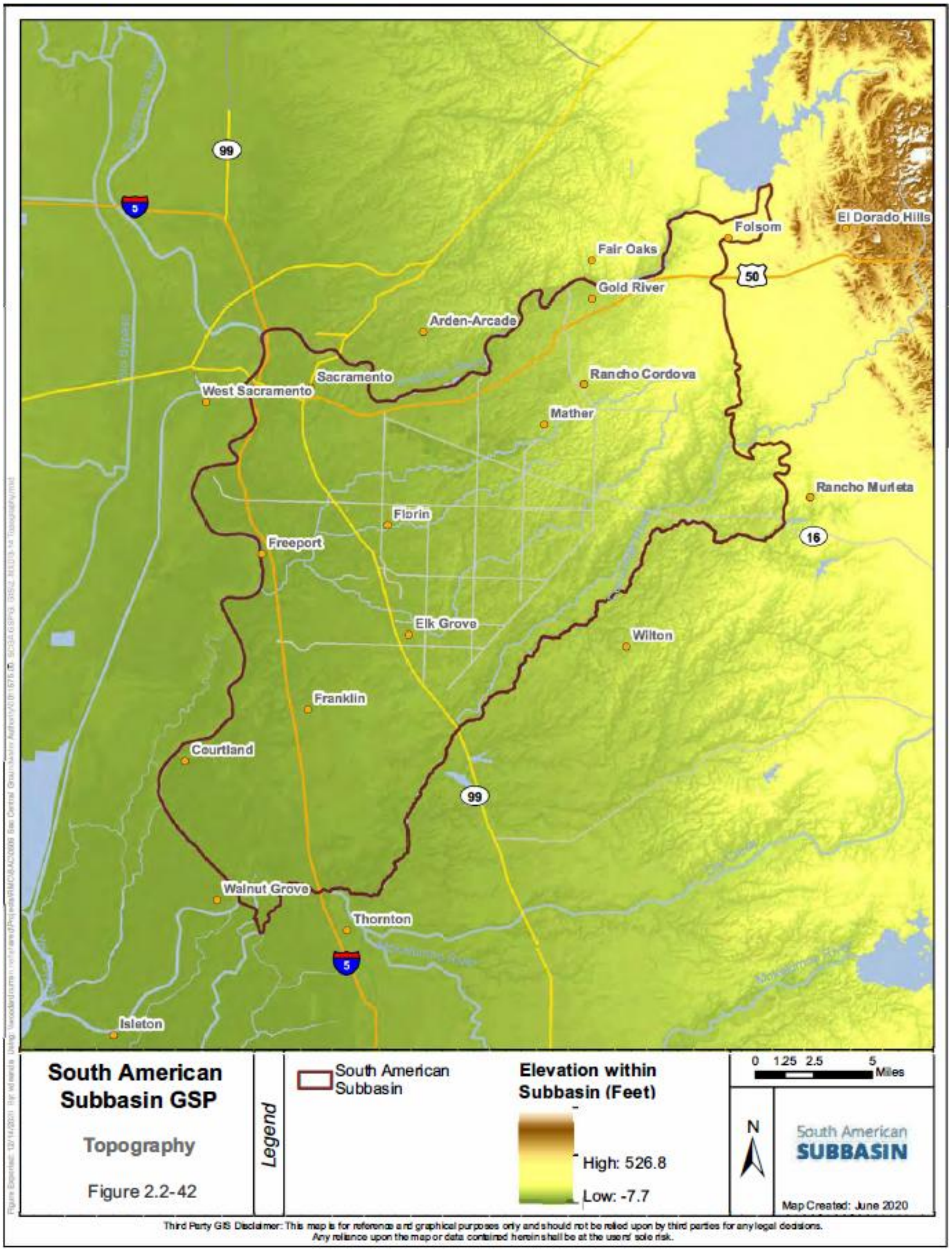


Figure 2-42: Topography

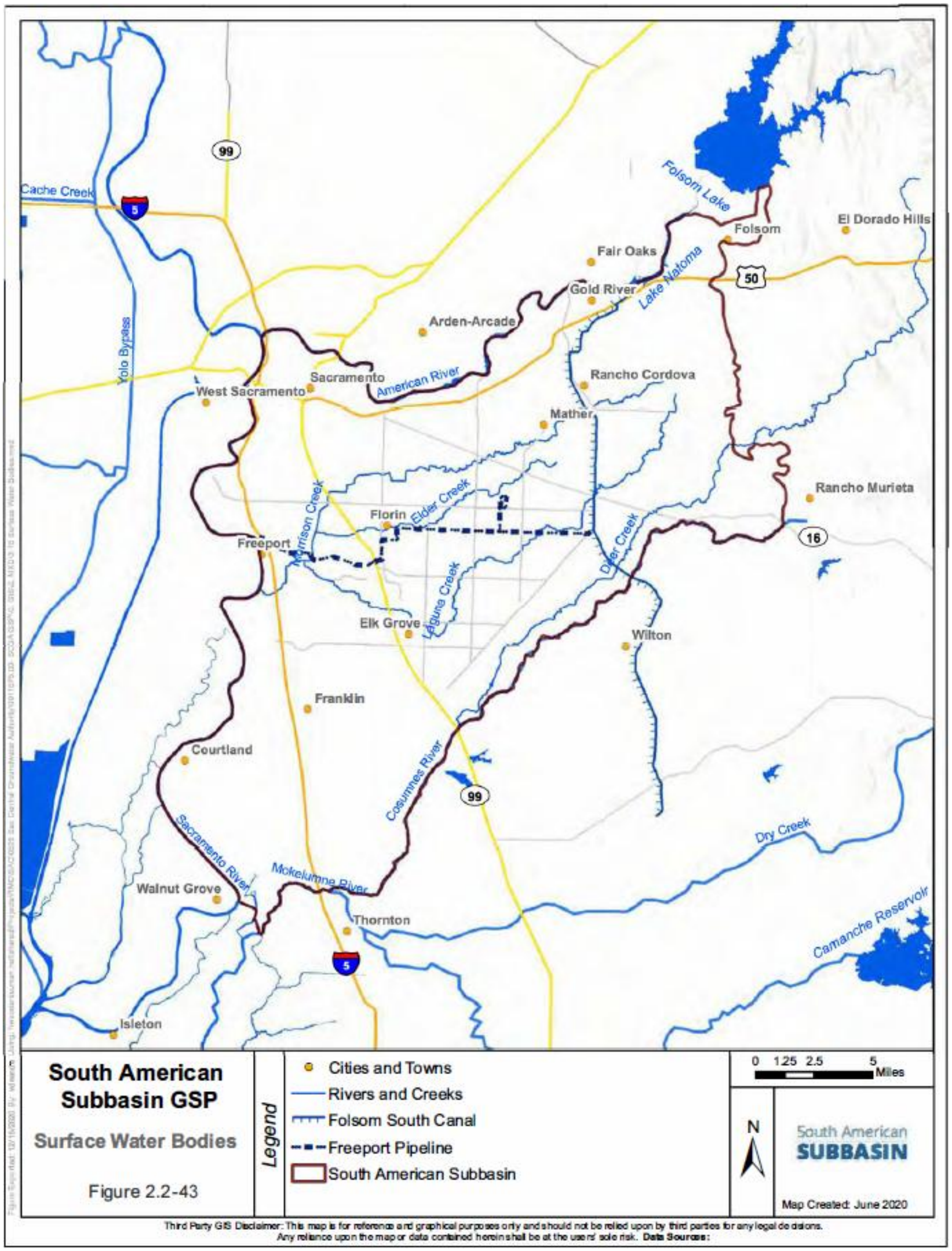


Figure 2-43: Surface Water Bodies

- **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.

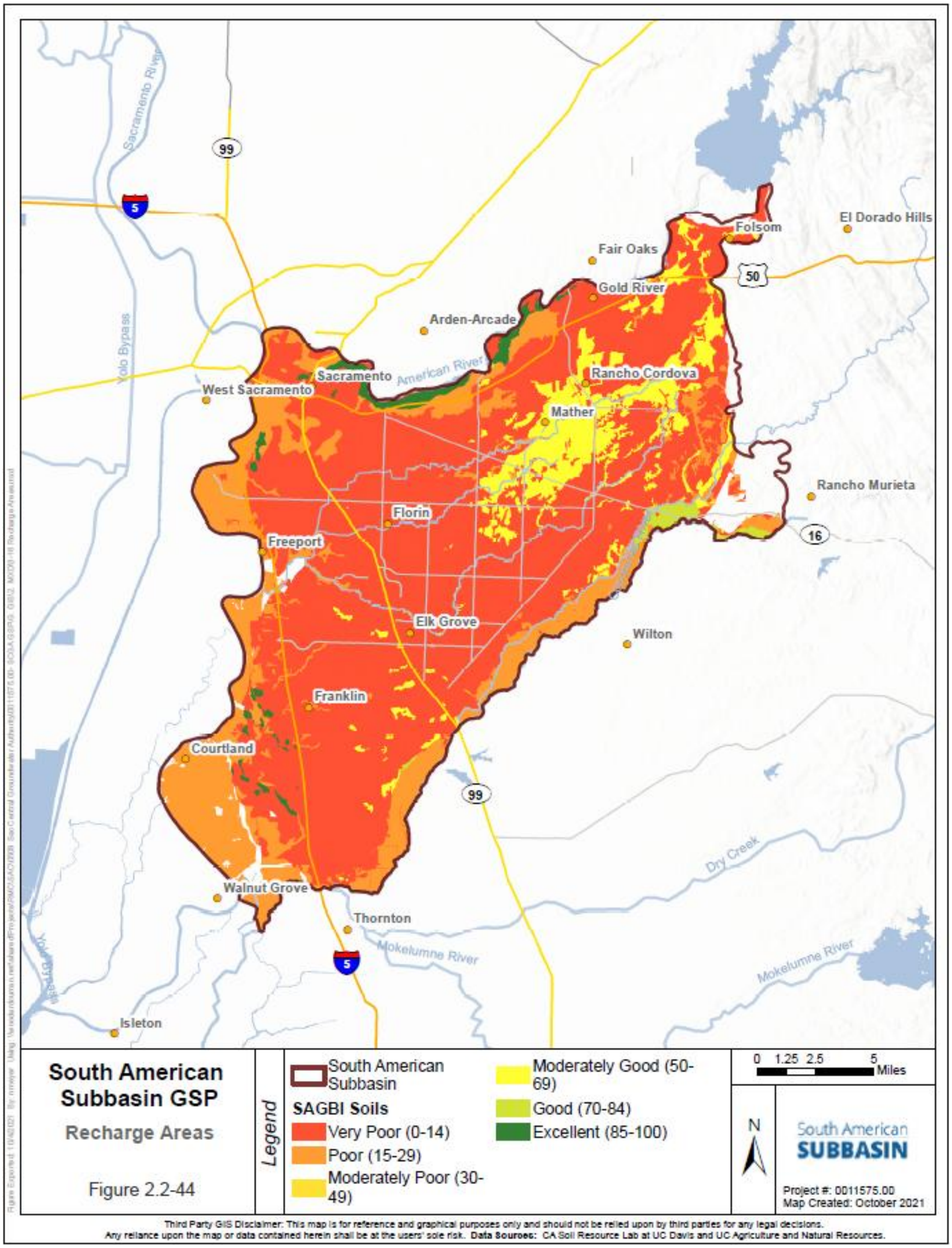
2.2.8.3 Surface Waters with Potential to Affect Groundwater Quality

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.



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.

Figure 2-44: Recharge Areas

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

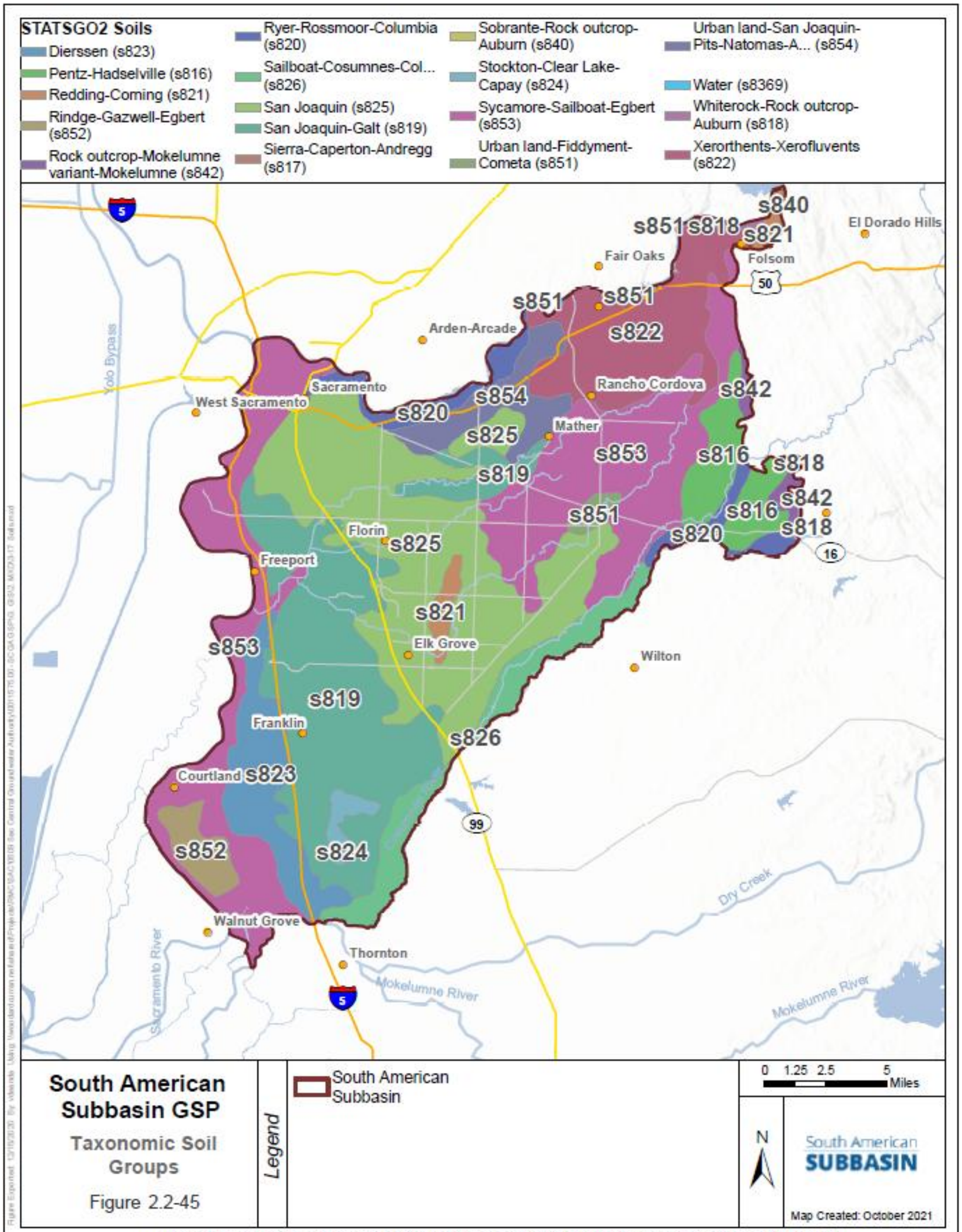
Significant data gaps were not identified for the SASb that would create uncertainty that would affect the ability of the GSP to achieve sustainability by 2042. However, all hydrogeologic conceptual models are uncertain to a limited extent and can be improved with additional data. Improved information in the areas below would support 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.



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:** Natural Resources Conservation Service Web Soil Survey STATSGO2.

Figure 2-45: Taxonomic Soil Groups

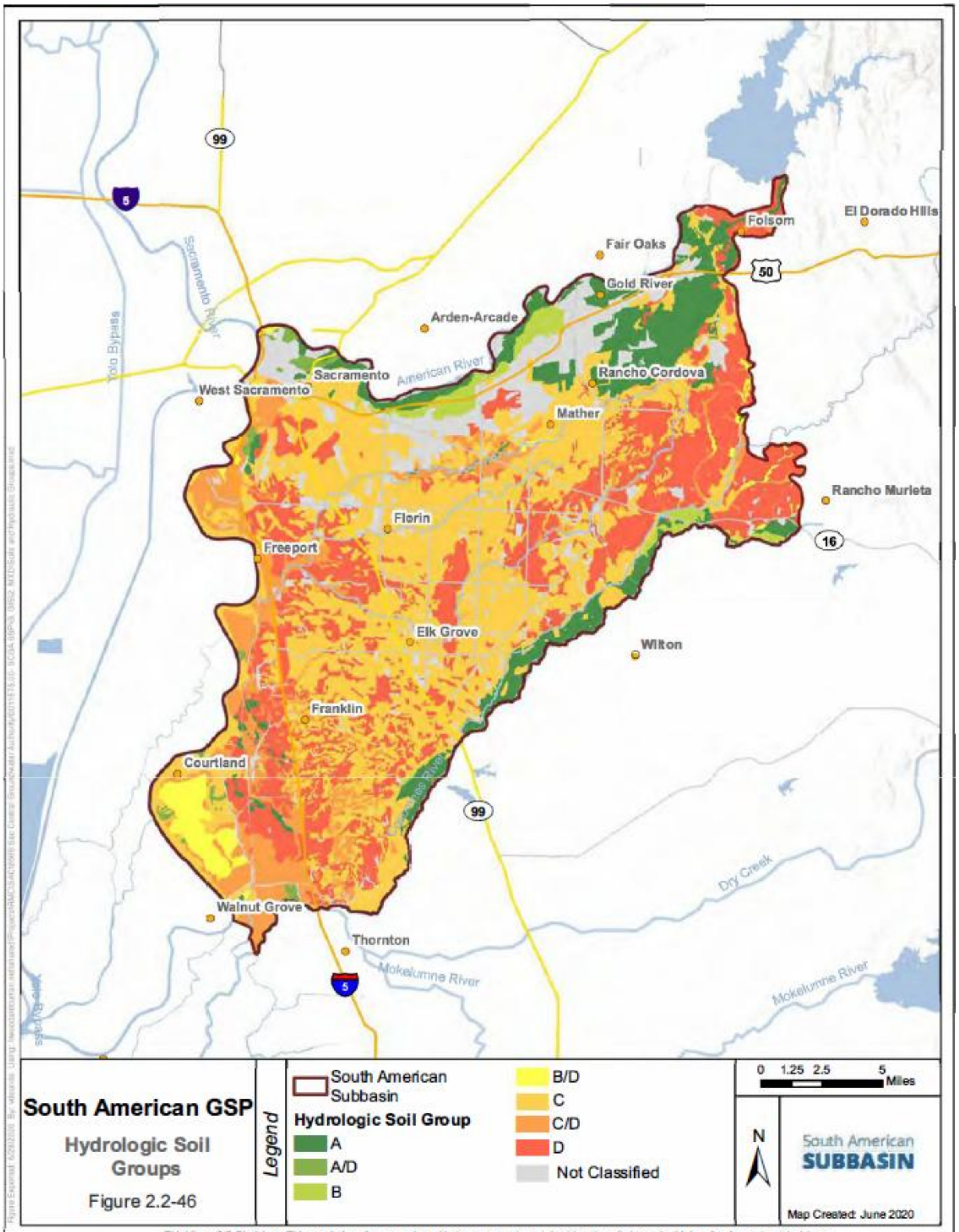


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Figure 2-46: Hydrologic Soil Groups

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-20th 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[8]. 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 2-47** through **Figure 2-48** 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 2-47 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.

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[8] 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.

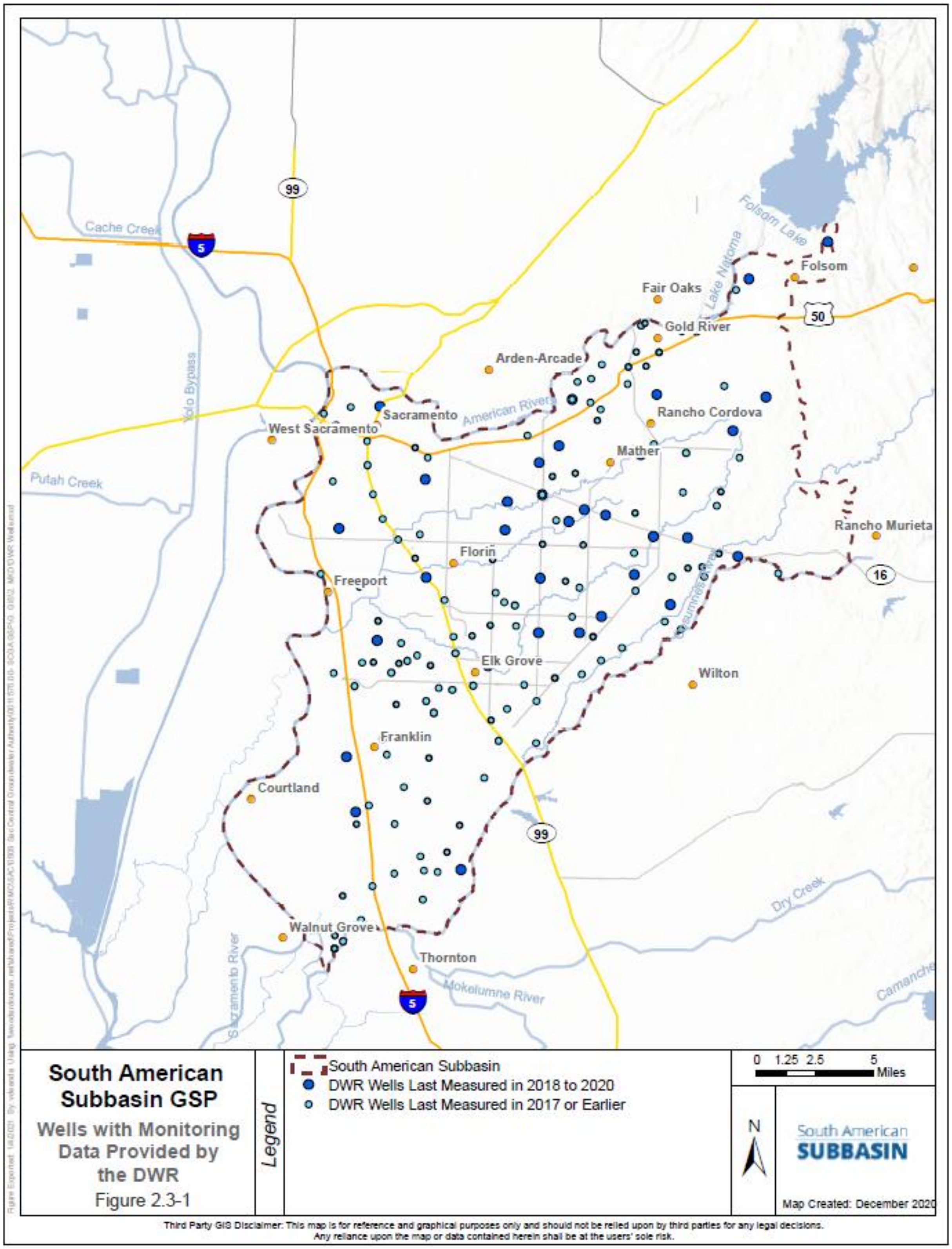

Figure 2-47: South American Subbasin Wells with Monitoring Data Provided by DWR

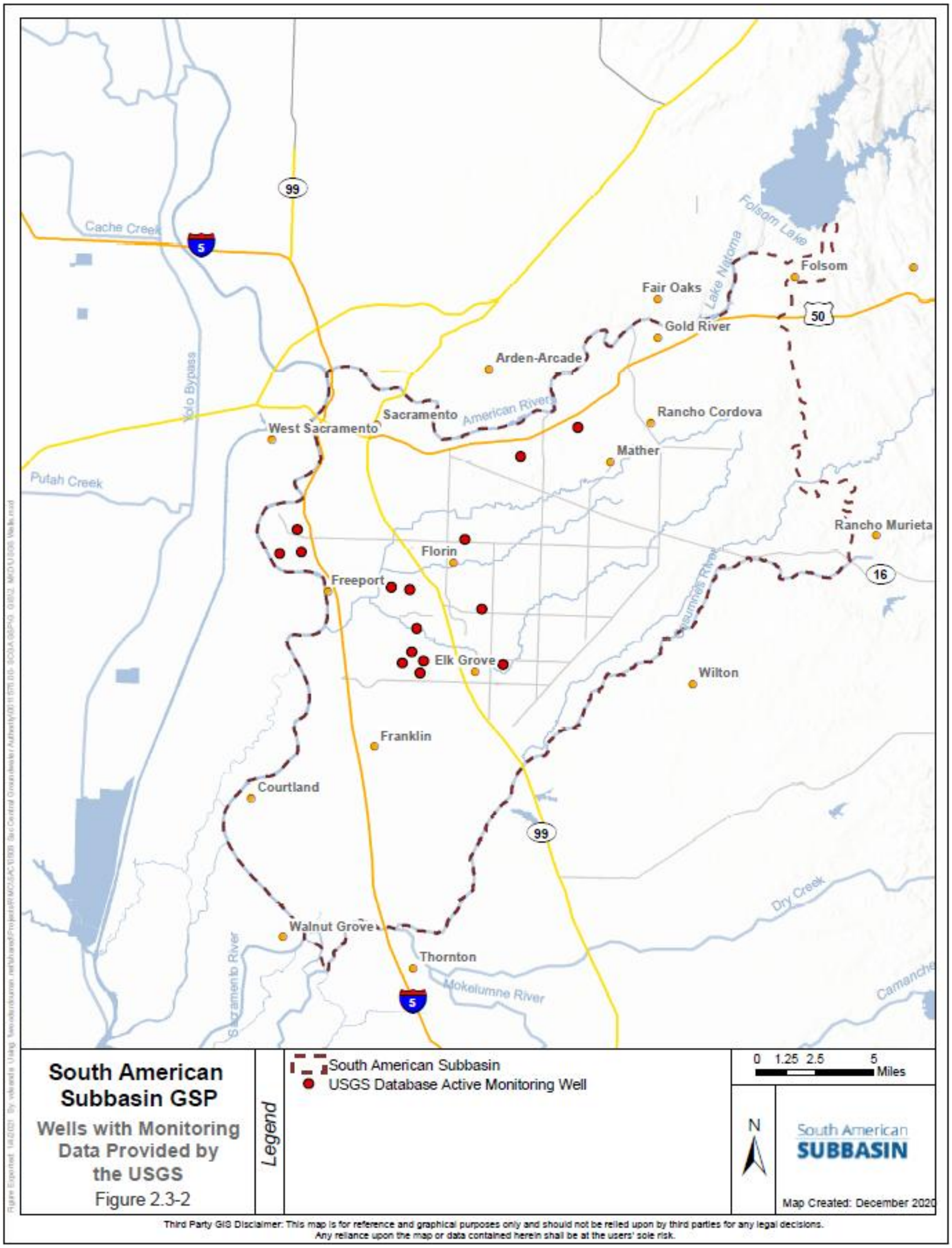

Figure 2-48: South American Subbasin Wells with Monitoring Data Provided by USGS

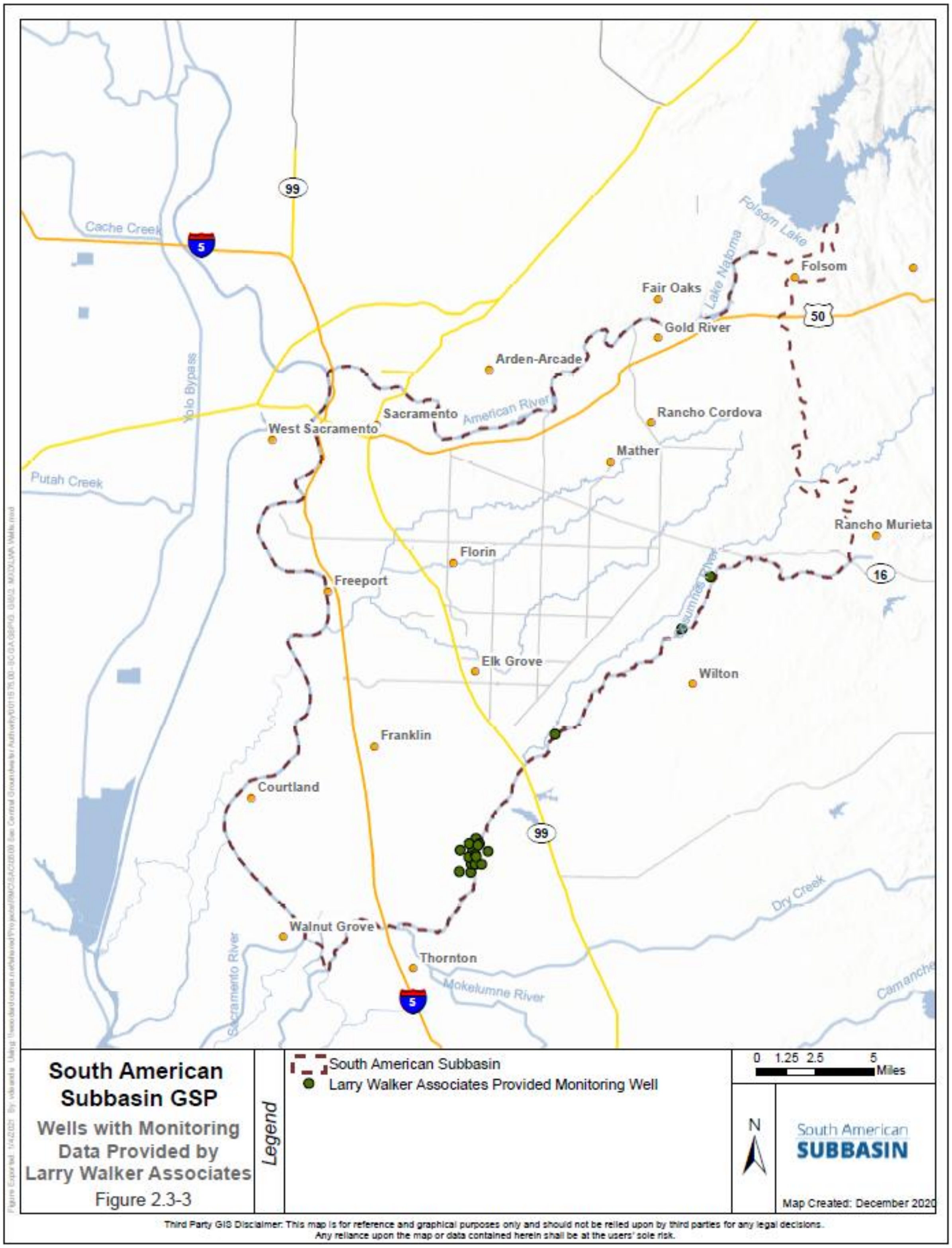

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Figure 2-49: South American Subbasin Wells with Monitoring Data Provided by LWA

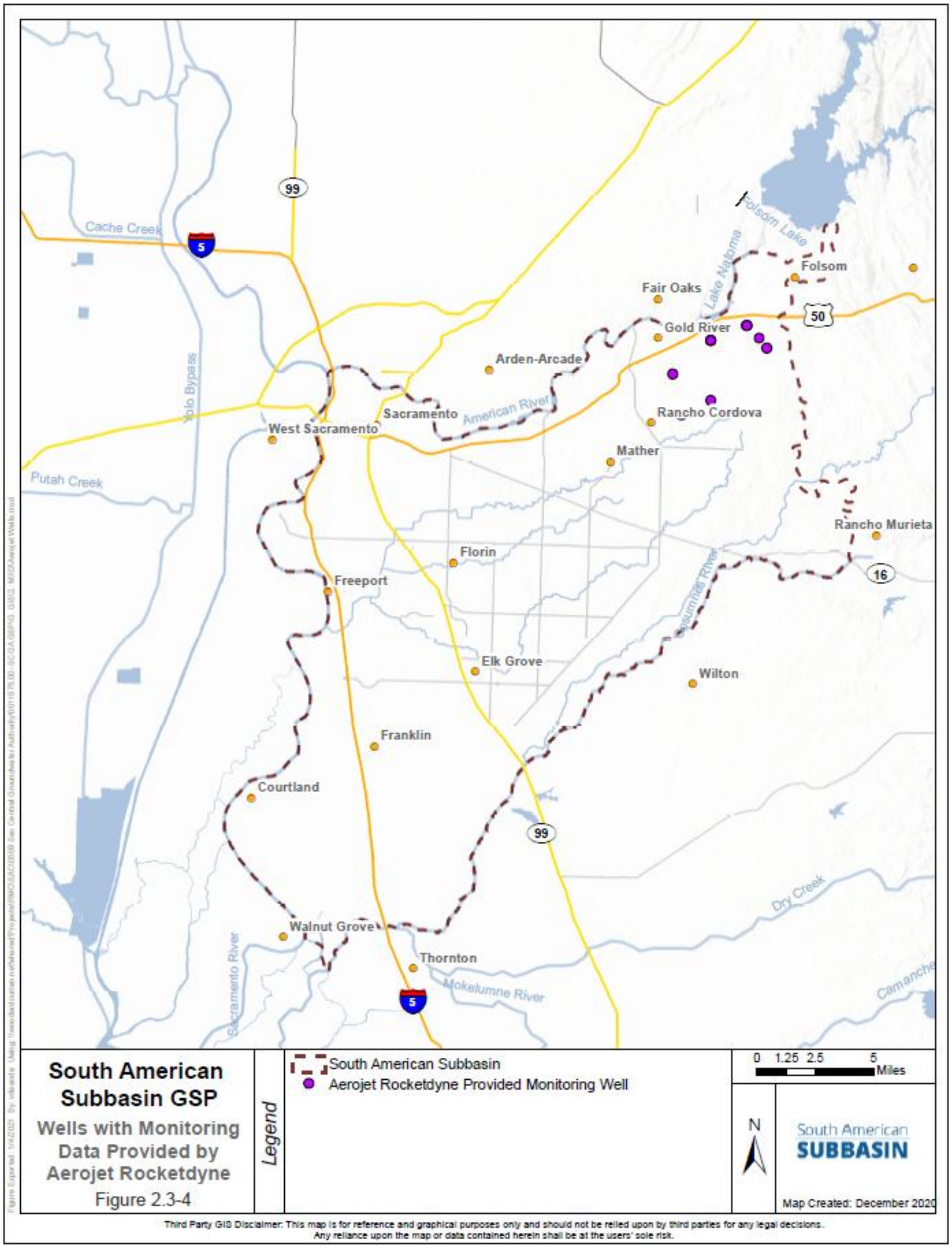


Figure 2-50: South American Subbasin Wells with Monitoring Data Provided by Aerojet Rocketdyne

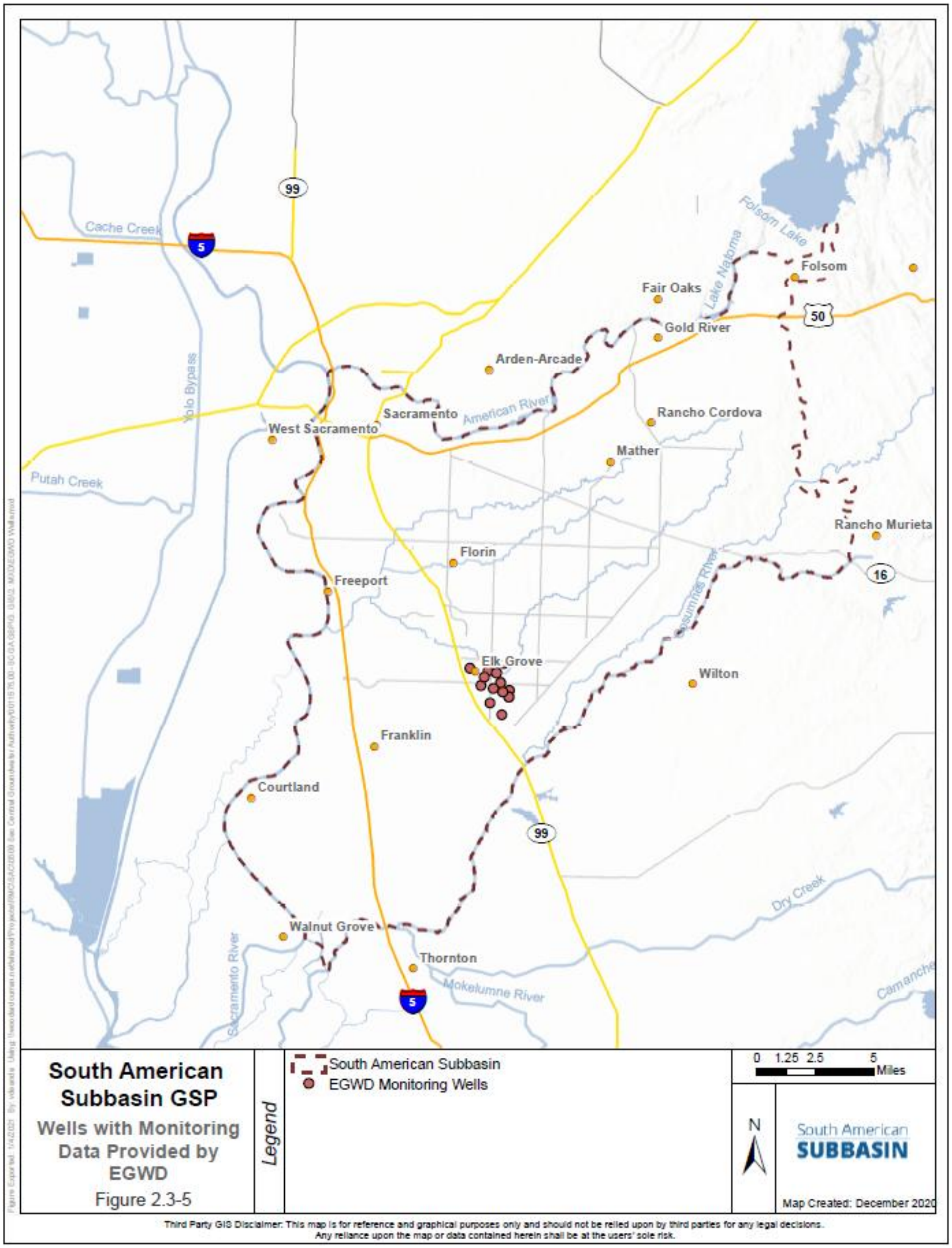


Figure 2-51: South American Subbasin Wells with Monitoring Data Provided by Elk Grove Water District

Figure 2-48 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 2-49 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 2-50 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 2-51 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.

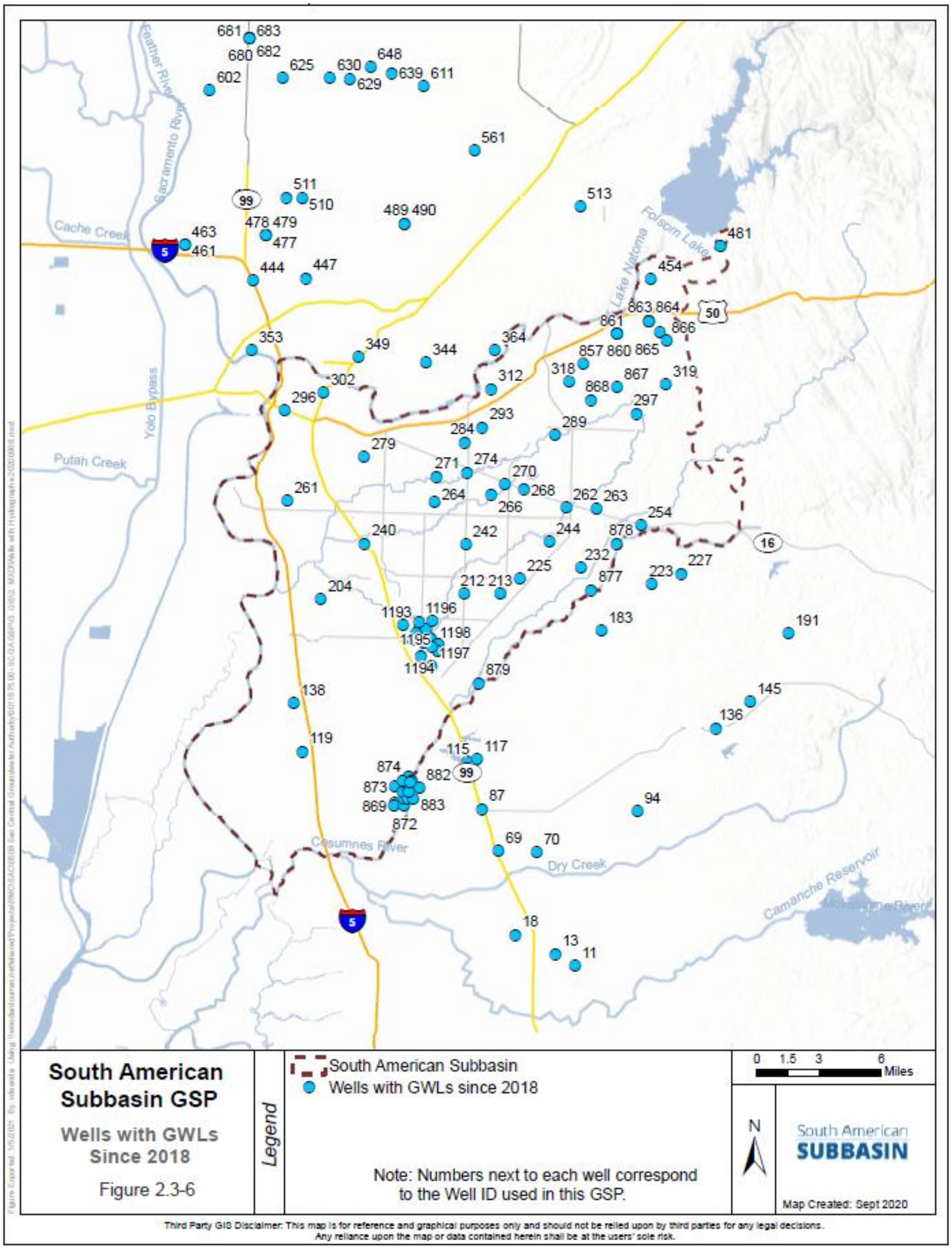


Figure 2-52**Figure 2-52** shows the location of wells with measured groundwater levels since 2018 within the Subbasin. **Figure 2-53** to **Figure 2-60** show hydrographs of groundwater levels from 1970 to 2020 in selected wells. These wells were selected because they broadly represent

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

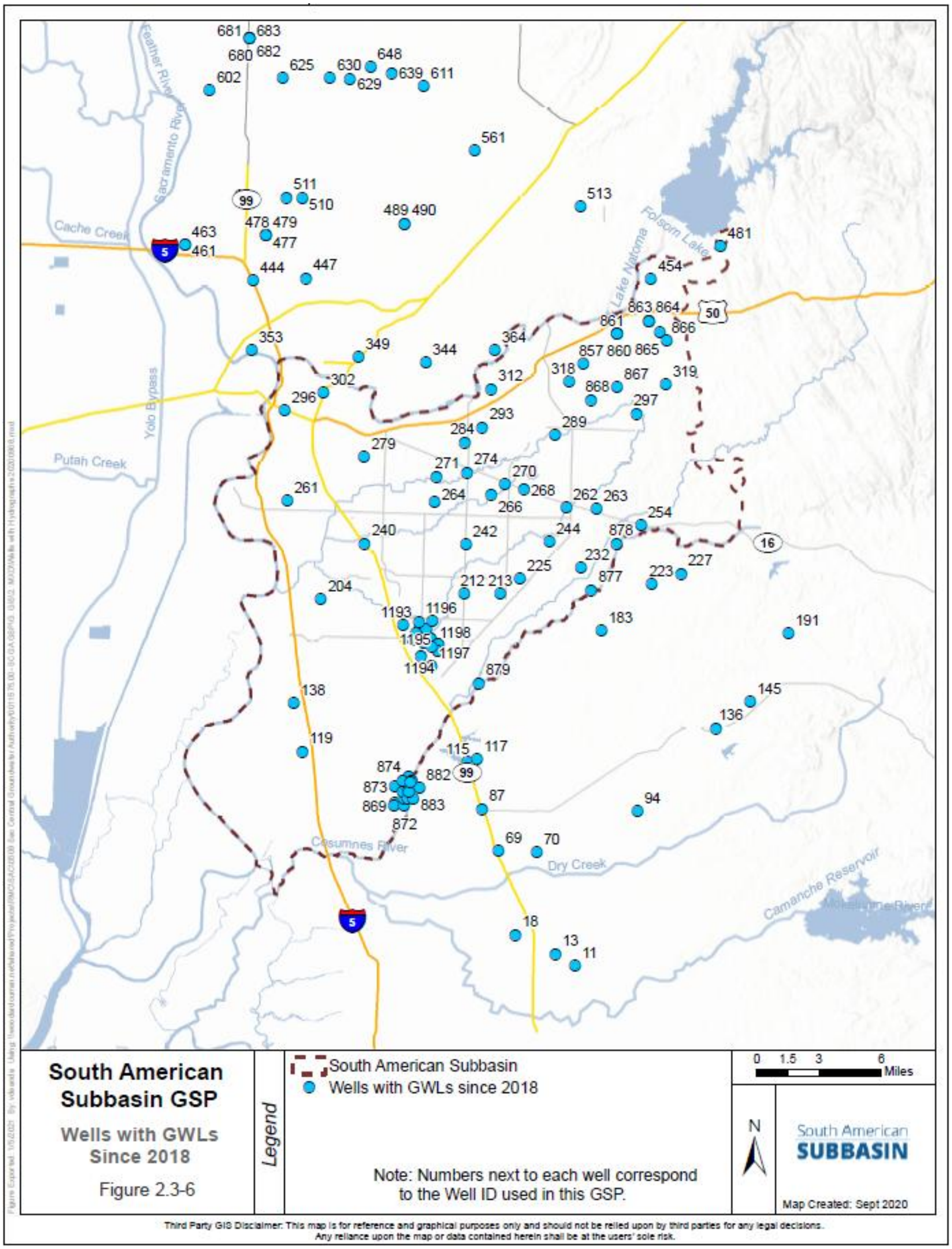


Figure 2-52: South American Subbasin Wells with Groundwater Level Measurements Since 2018

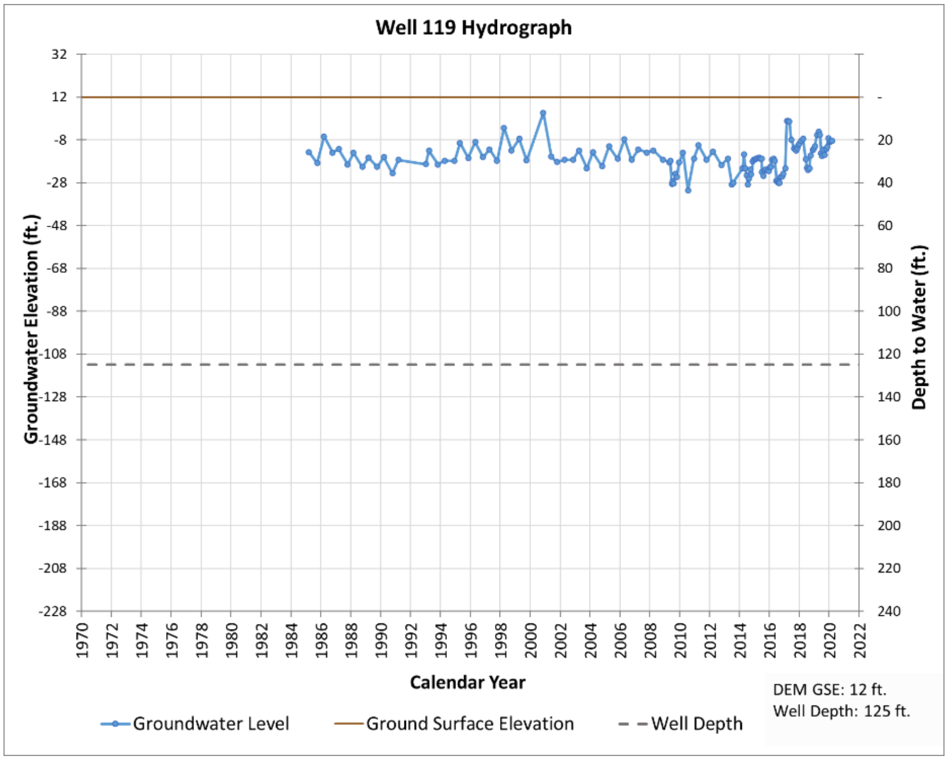


Figure 2-53: Well 119 Hydrograph

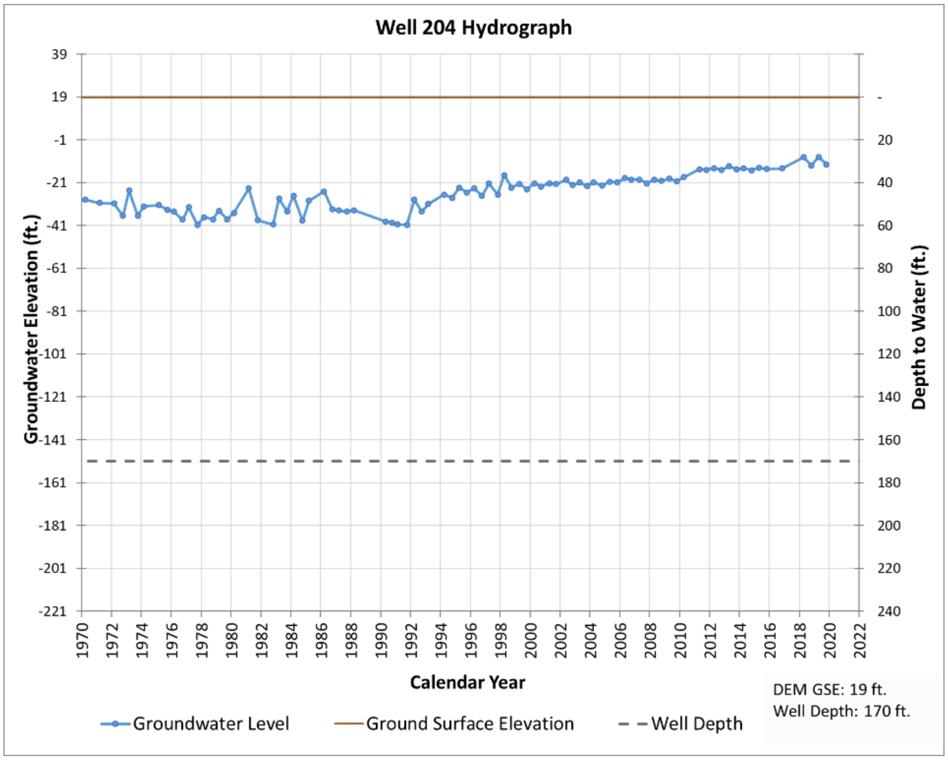


Figure 2-54: Well 204 Hydrograph

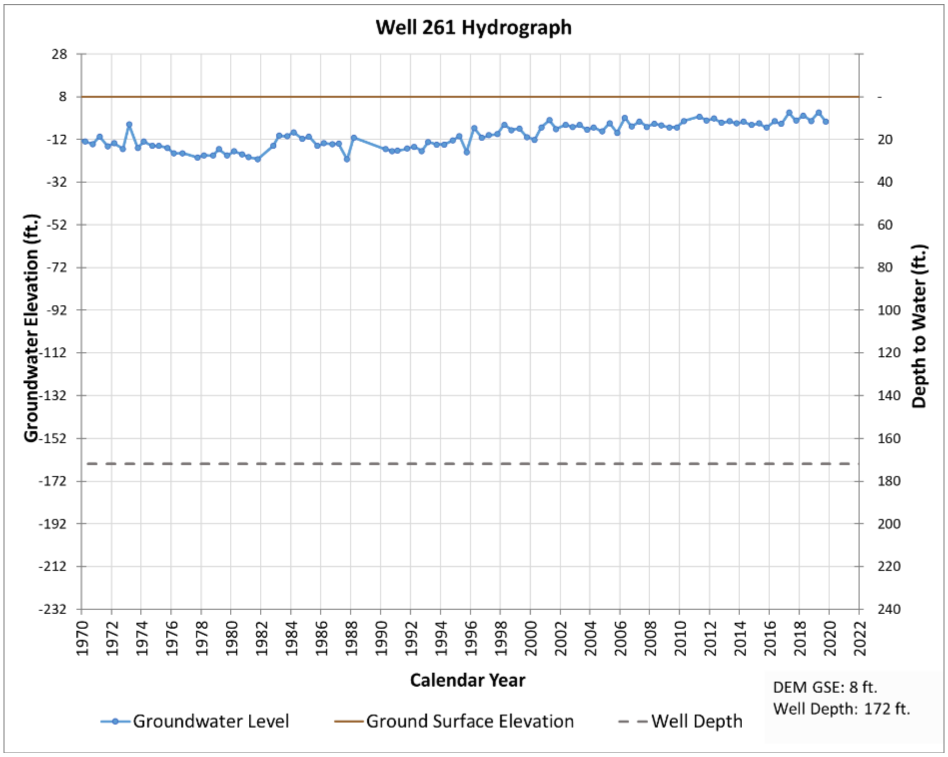


Figure 2-55: Well 261 Hydrograph

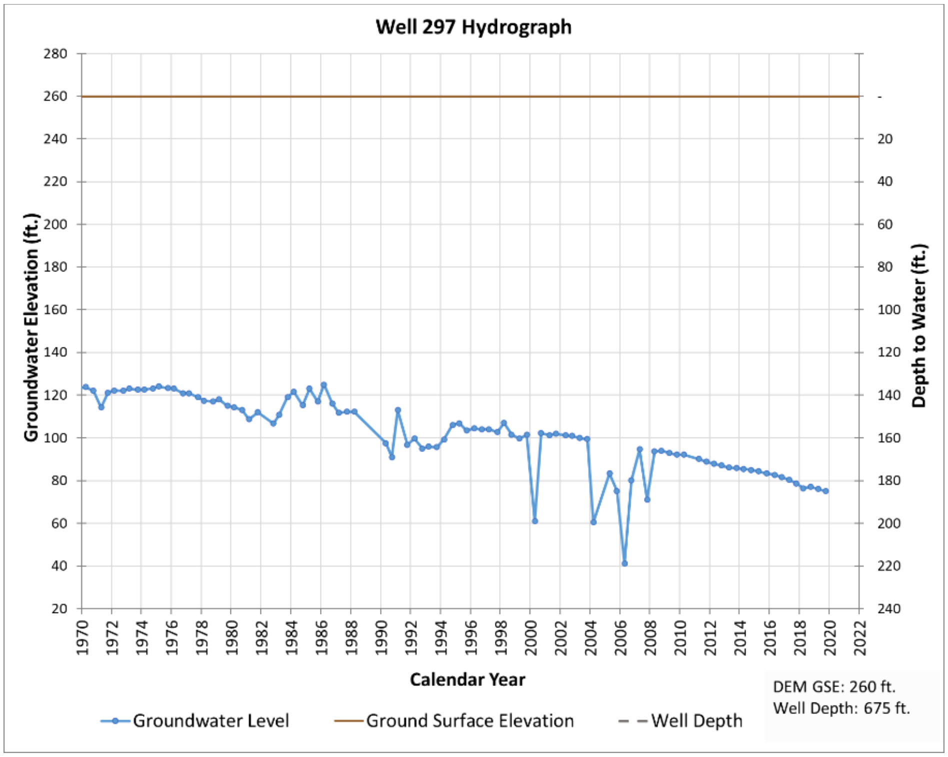


Figure 2-56: Well 297 Hydrograph

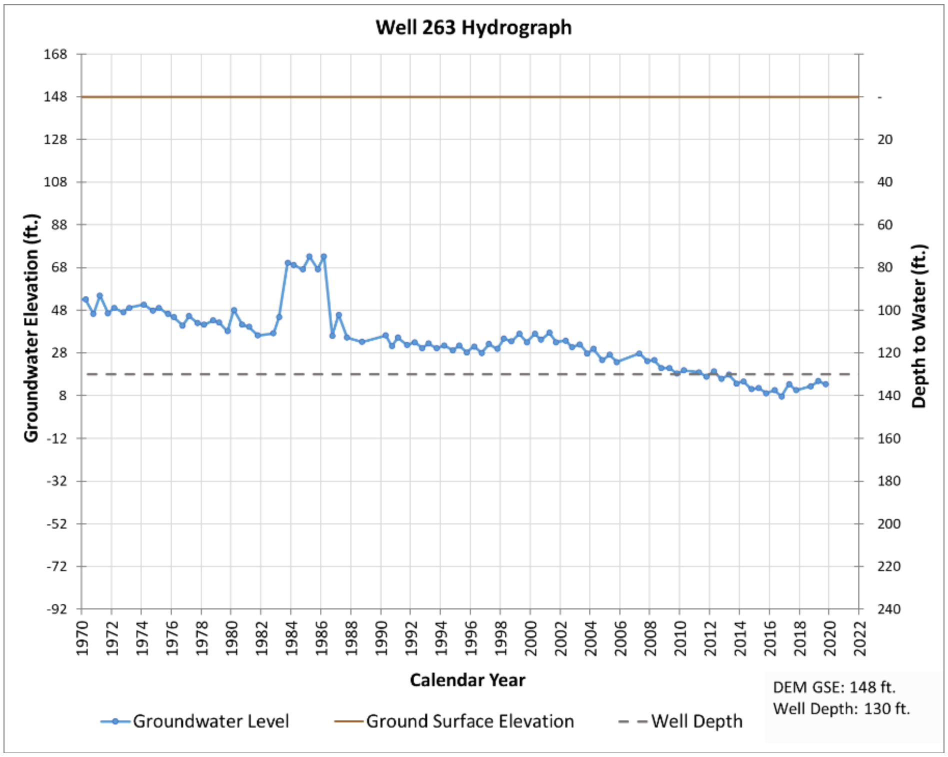


Figure 2-57: Well 263 Hydrograph

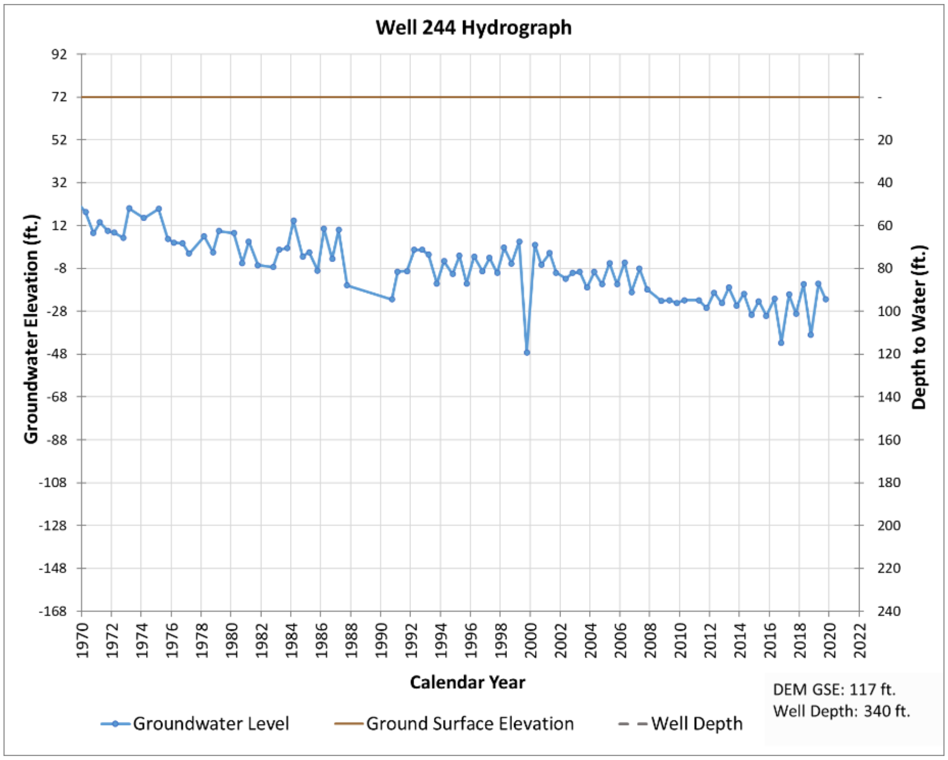


Figure 2-58: Well 244 Hydrograph

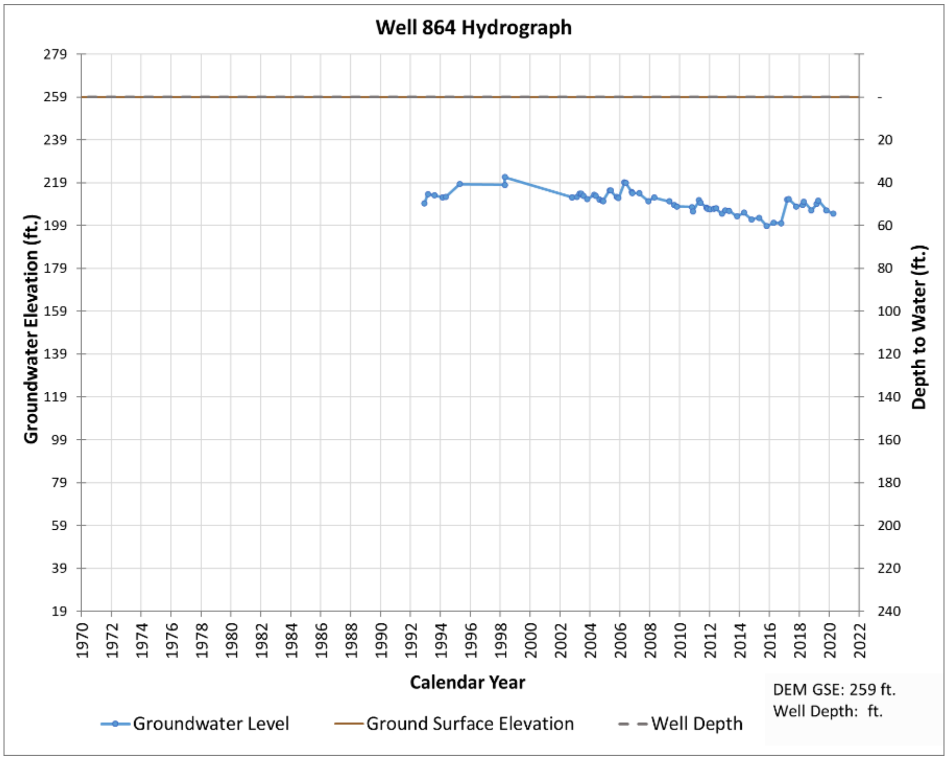


Figure 2-59: Well 864 Hydrograph

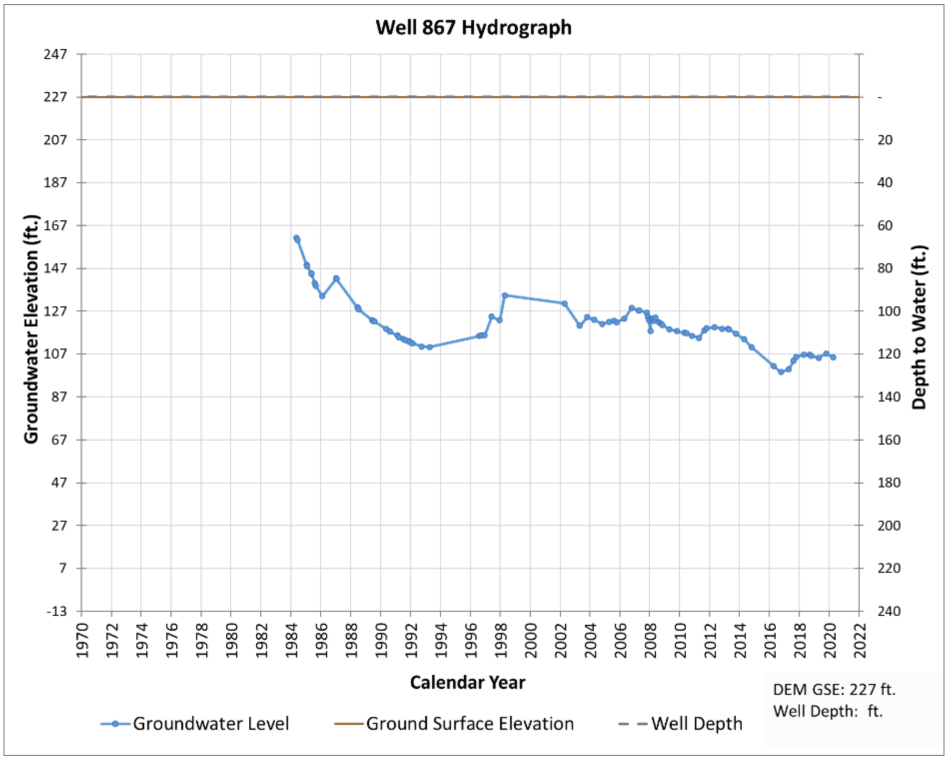


Figure 2-60: Well 867 Hydrograph

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.

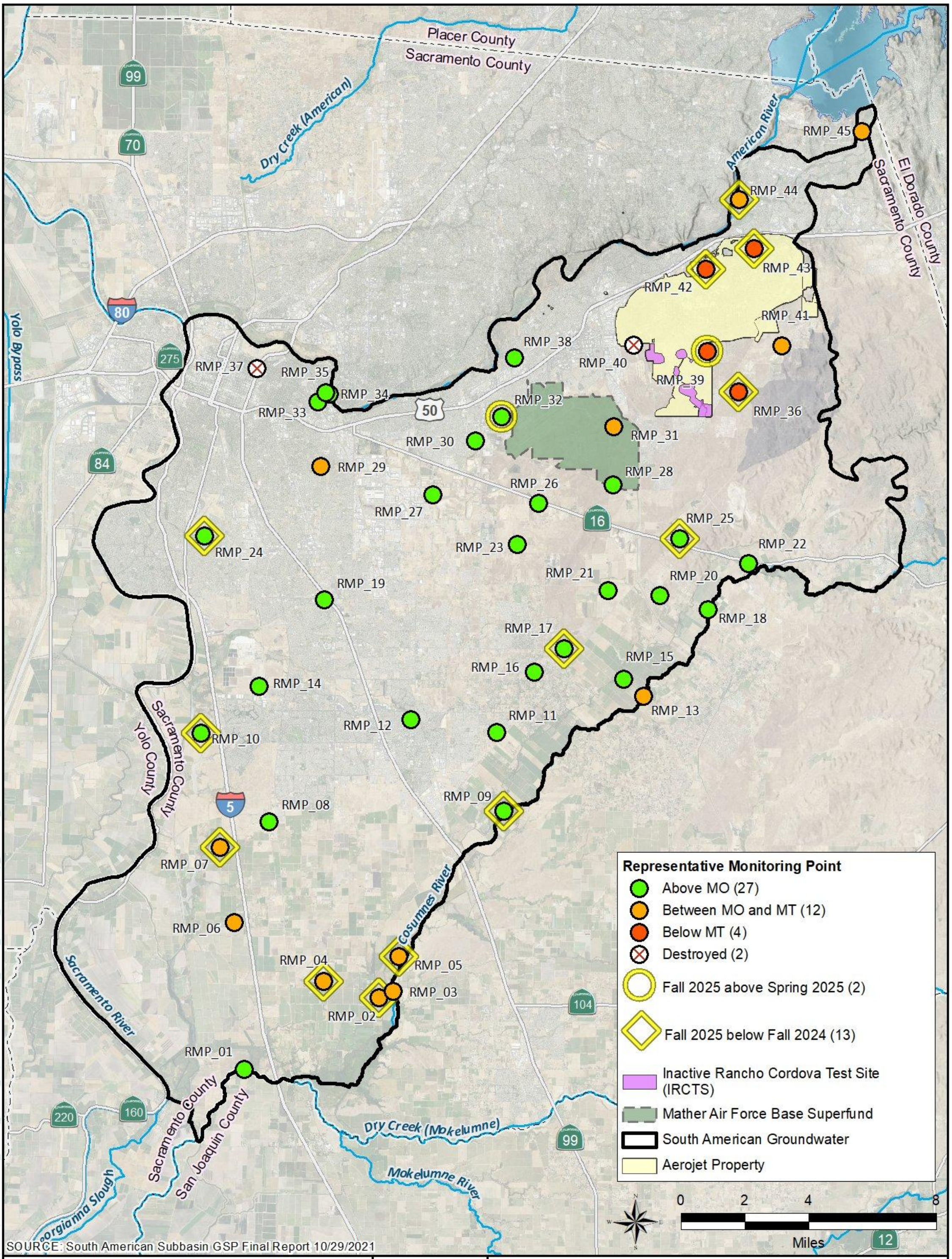
Groundwater conditions also vary across different parts of the Subbasin. For example, many of the rivers and streams that flow along the boundaries or within the Subbasin are sources of groundwater recharge. Other zones are utilized for pumping for both domestic and agricultural uses, while some areas 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 2-53** to **Figure 2-55** 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 2-56** to **Figure 2-58**) 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 2-59** and **Figure 2-60**), 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.

Since 2020, declines have continued to be observed in some eastern portions of the Subbasin, while western areas have experienced slight increases or generally stable conditions. Continued implementation of the Harvest Water Project is expected to further increase groundwater levels in the western portion of the Subbasin. **Figure 2-61** shows groundwater levels at RMPs for Fall 2025. Overall, 27 out of 35 wells located outside of Superfund-affected areas are above their measurable objectives (MOs). Some of the remaining wells are between the measurable objectives and minimum thresholds (MTs). Several of these wells are located near the Harvest Water Project area, where ongoing and planned activities are expected to improve groundwater conditions over time.



2027 GSP
Sacramento, CA

South American
SUBBASIN

Representative Monitoring Points
Fall 2025 Measurement Summary

Sacramento Central Groundwater Authority

DEC 2025

Figure 2-61: RMPs Fall 2025 Measurements

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 Ione 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 2-62**, were analyzed for vertical gradients. These wells are located in the central or eastern portion of the Subbasin.

Figure 2-63 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 2-64 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 2-66 shows the combined hydrograph for all the wells for which data was provided by EGWD. As shown in **Figure 2-51**, 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.

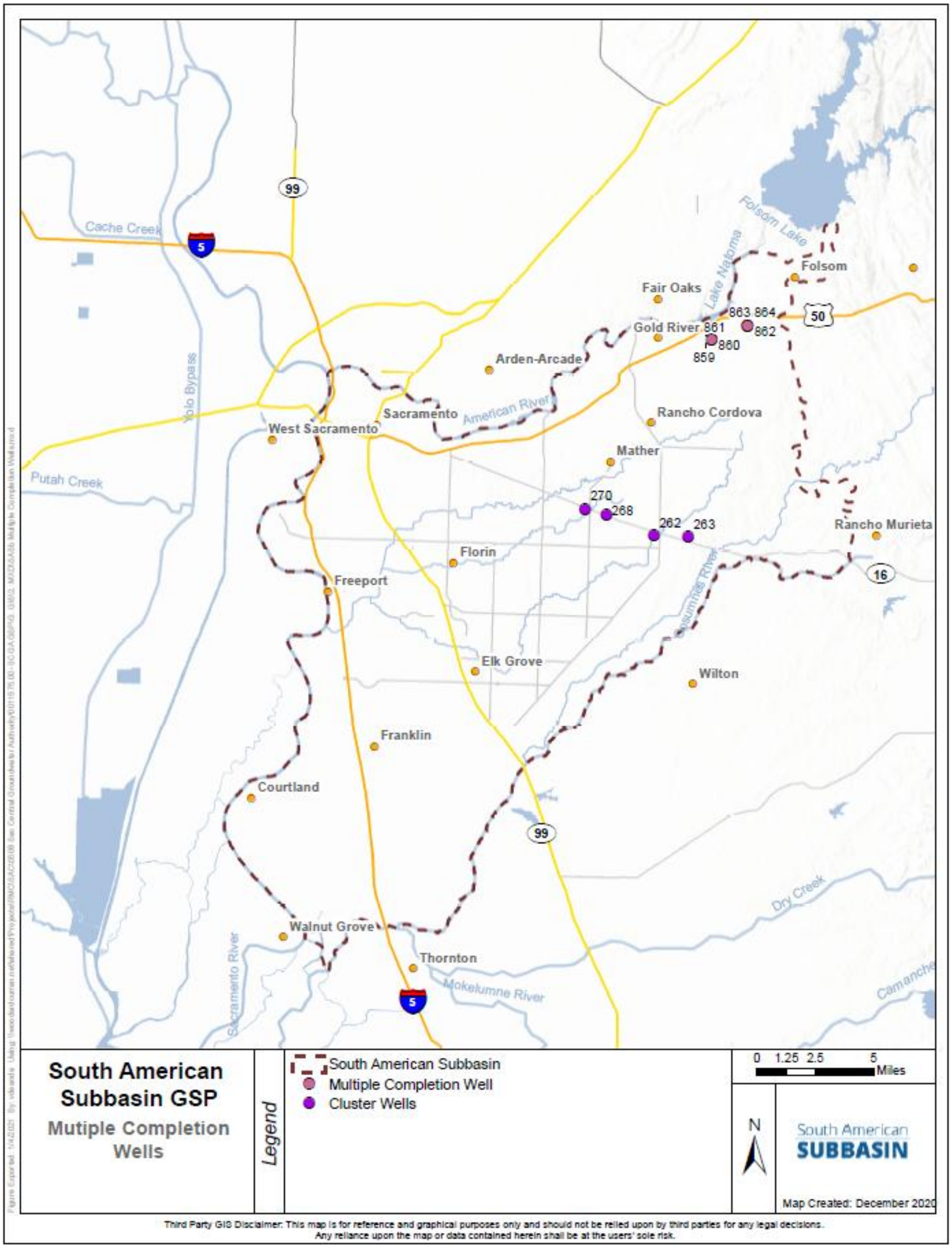


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Figure 2-62: South American Subbasin Multiple Completion and Cluster Wells

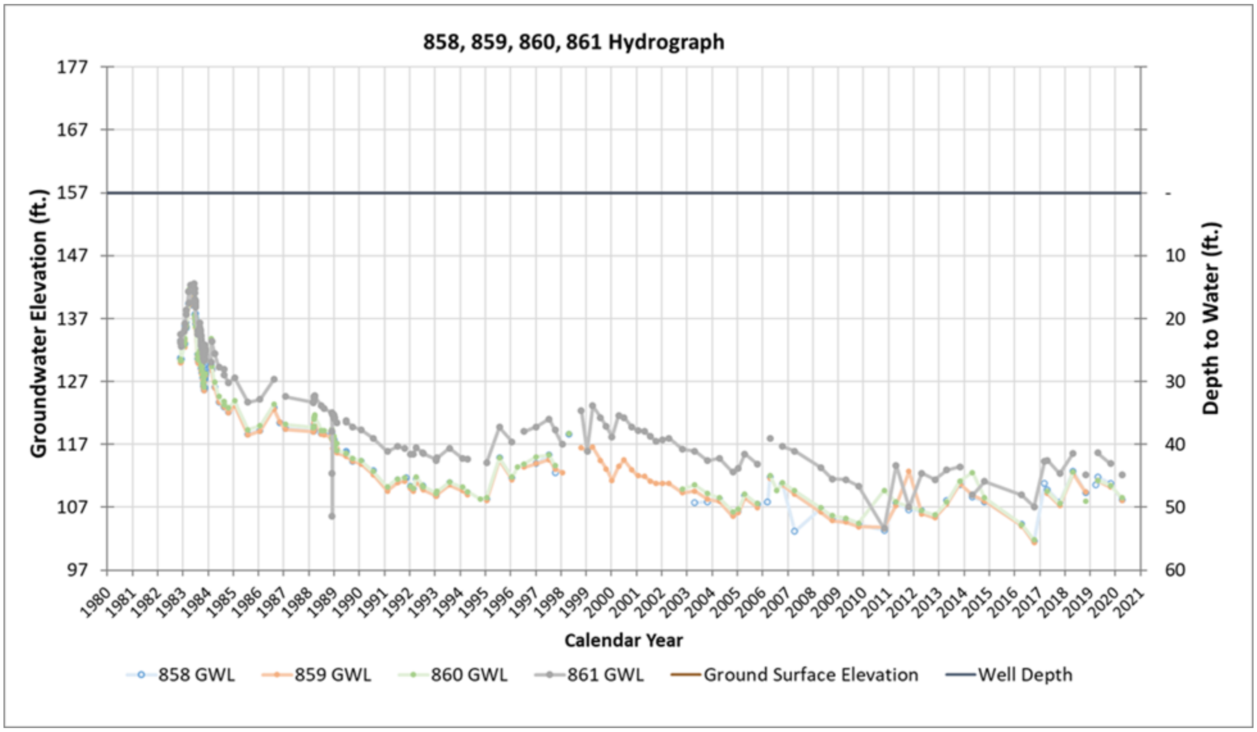


Figure 2-63: Wells 858, 859, 860 and 861 Hydrograph

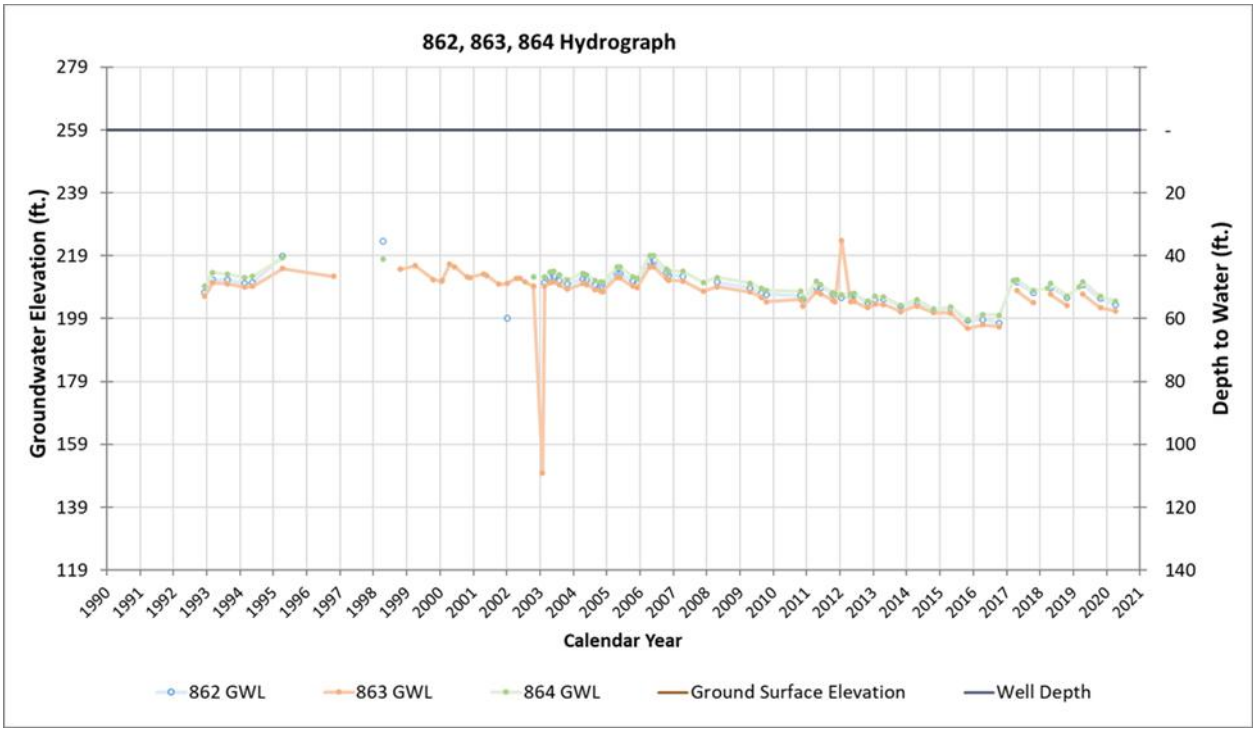


Figure 2-64: Wells 862, 863 and 864 Hydrograph

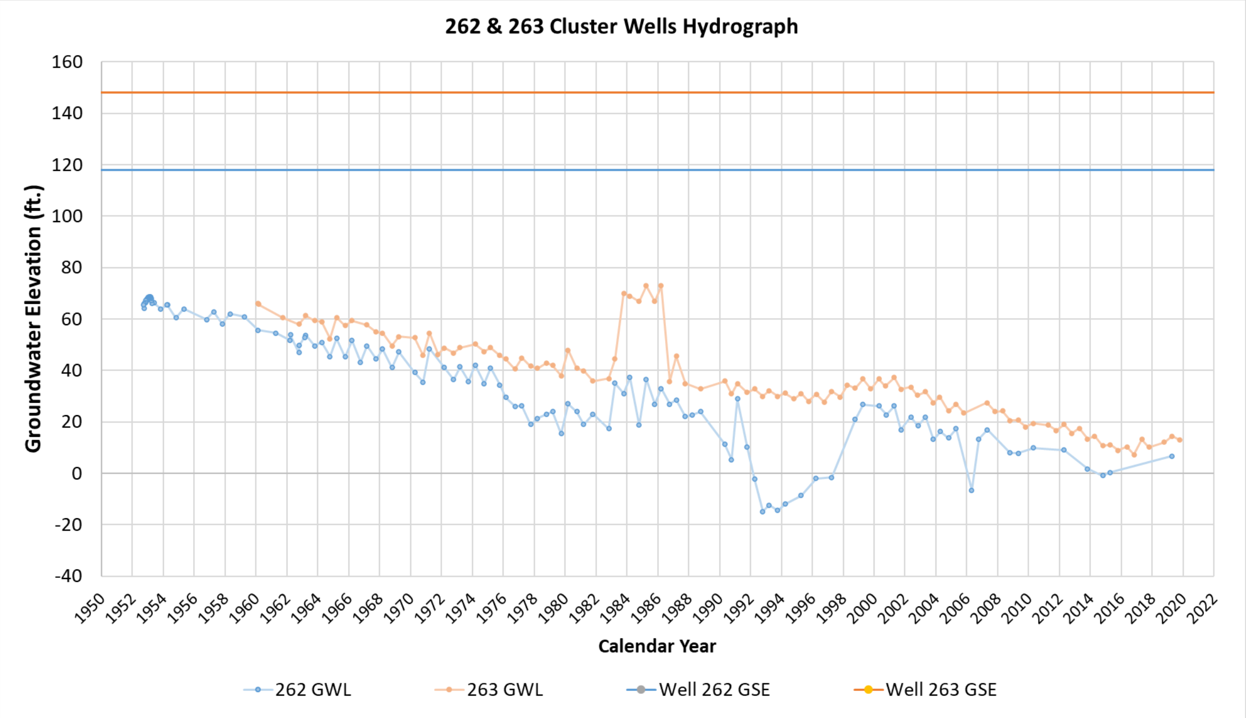


Figure 2-65: **EGWD Cluster Wells Hydrograph**

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.

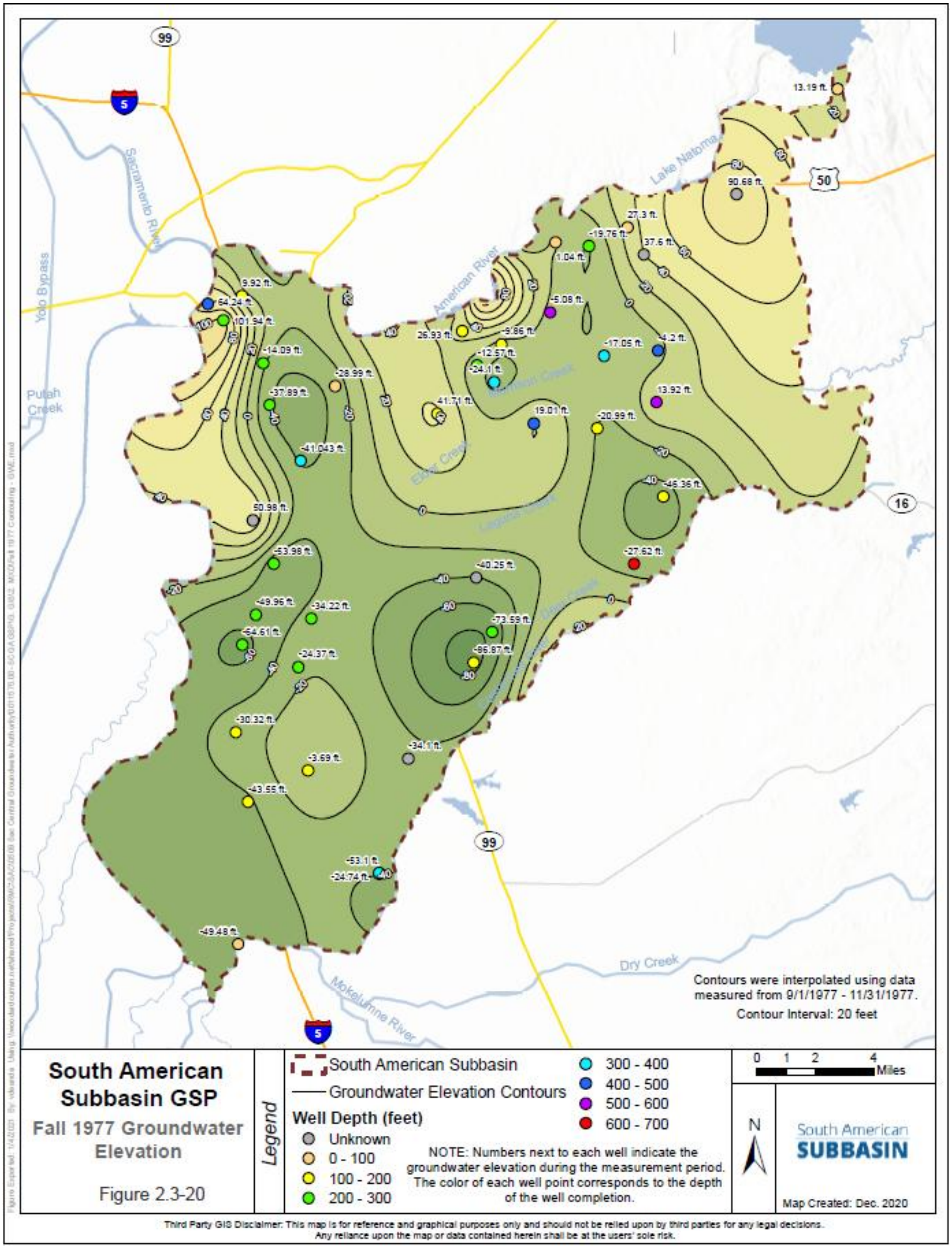
Figure 2-66 Figure 2-65 shows groundwater elevation contours for Fall 1977, which represents conditions at the end of one of the worst droughts recorded in California's history. The index (0.84) for WY 1977 is the second lowest in the 120-year WY record. The groundwater flow direction in the Subbasin 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 2-67 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 2-68 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 wester 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 2-69 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.

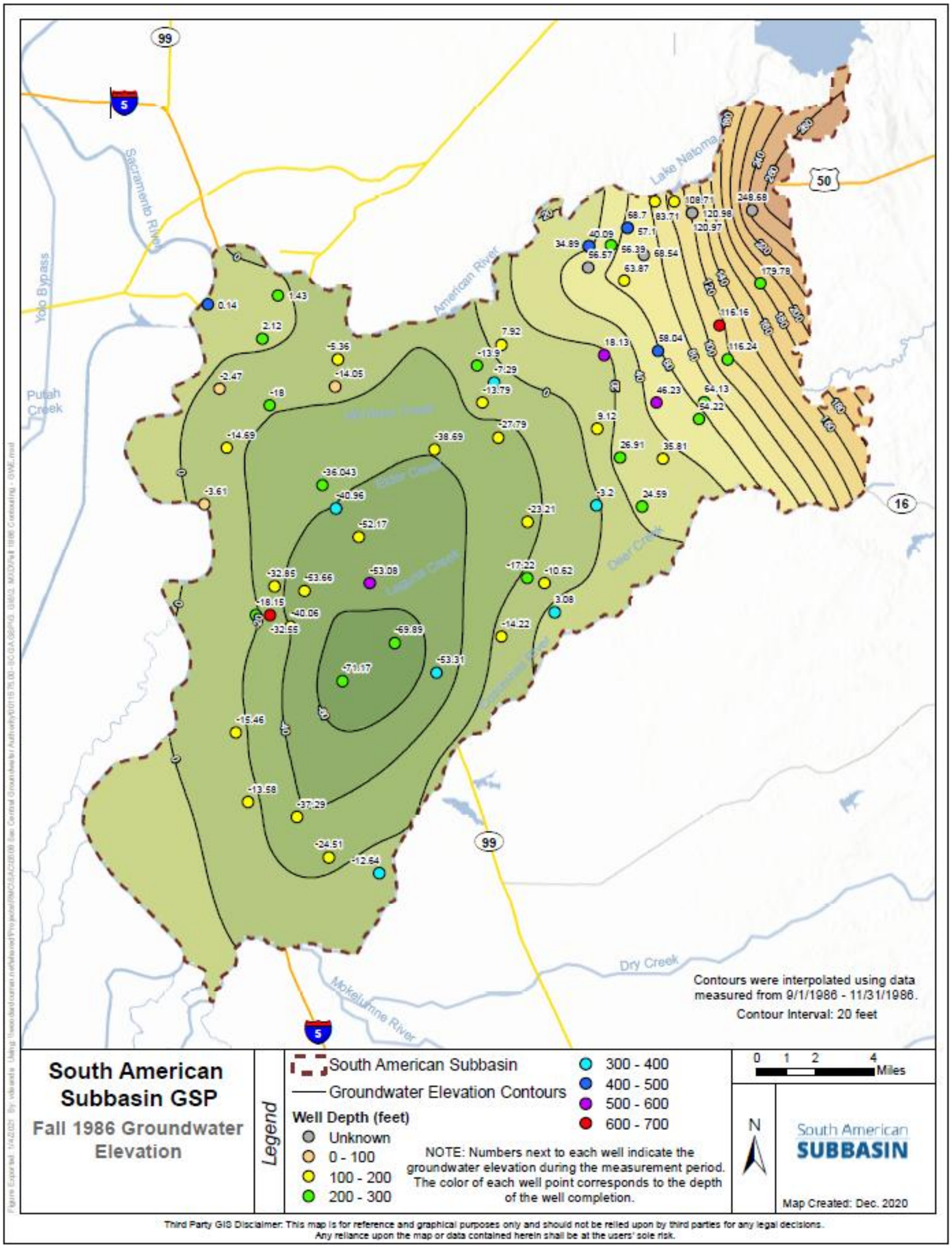
Note that the indicated reduction in this pumping depression may be impacted by a monitoring network that has more shallow wells than deep wells, and observed benefits accruing in the shallow zone may not necessarily be accruing in the deeper zone. The focused monitoring in the shallow zone is due to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

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.

Figure 2-66: Fall 1977 Groundwater Level Contours



Contours were interpolated using data measured from 9/1/1986 - 11/31/1986.

Contour Interval: 20 feet

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.

Figure 2-67: Fall 1986 Groundwater Level Contours

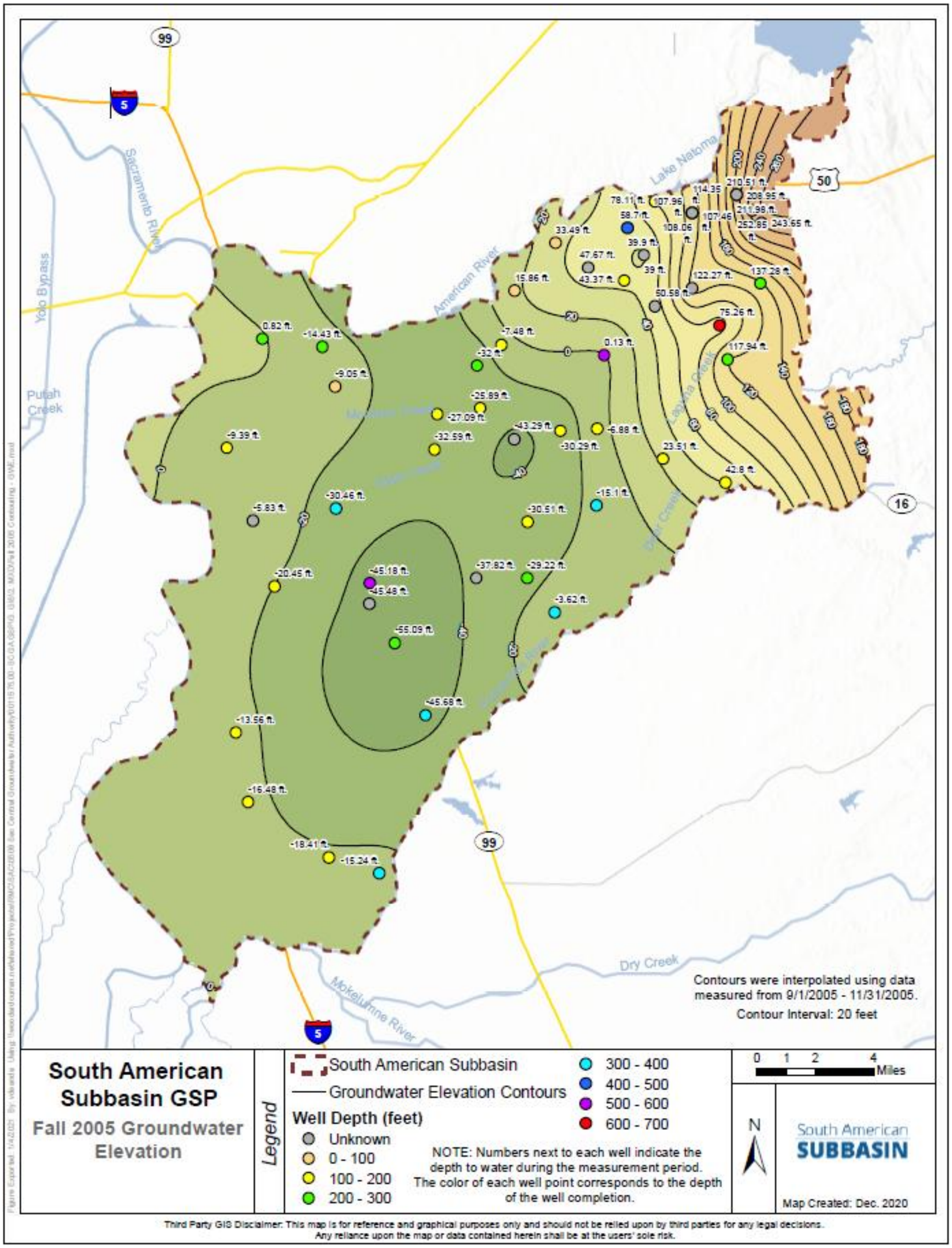


Figure 2-68: Fall 2005 Groundwater Level Contours

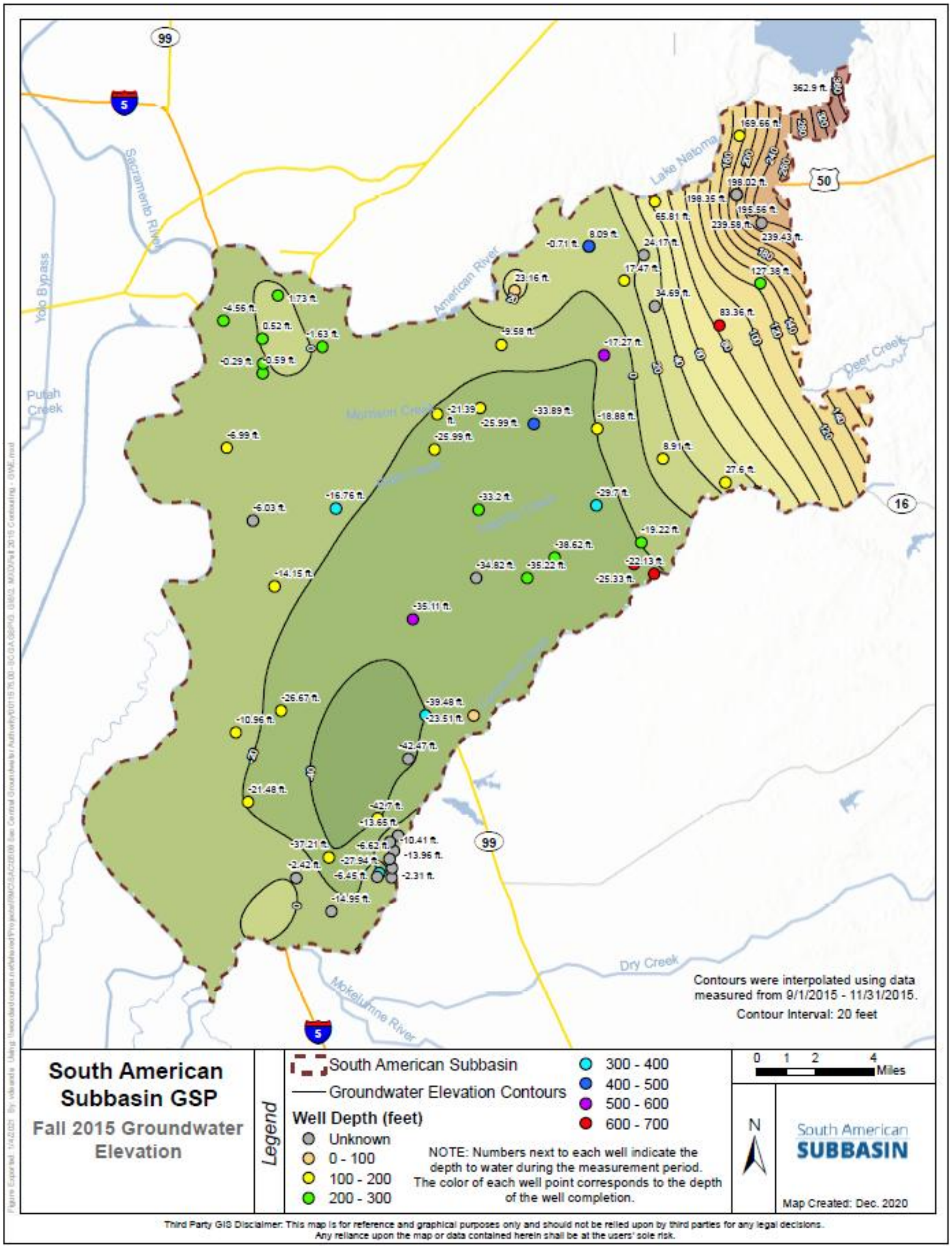


Figure 2-69: Fall 2015 Groundwater Level Contours

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 2-70** through **Figure 2-73**.

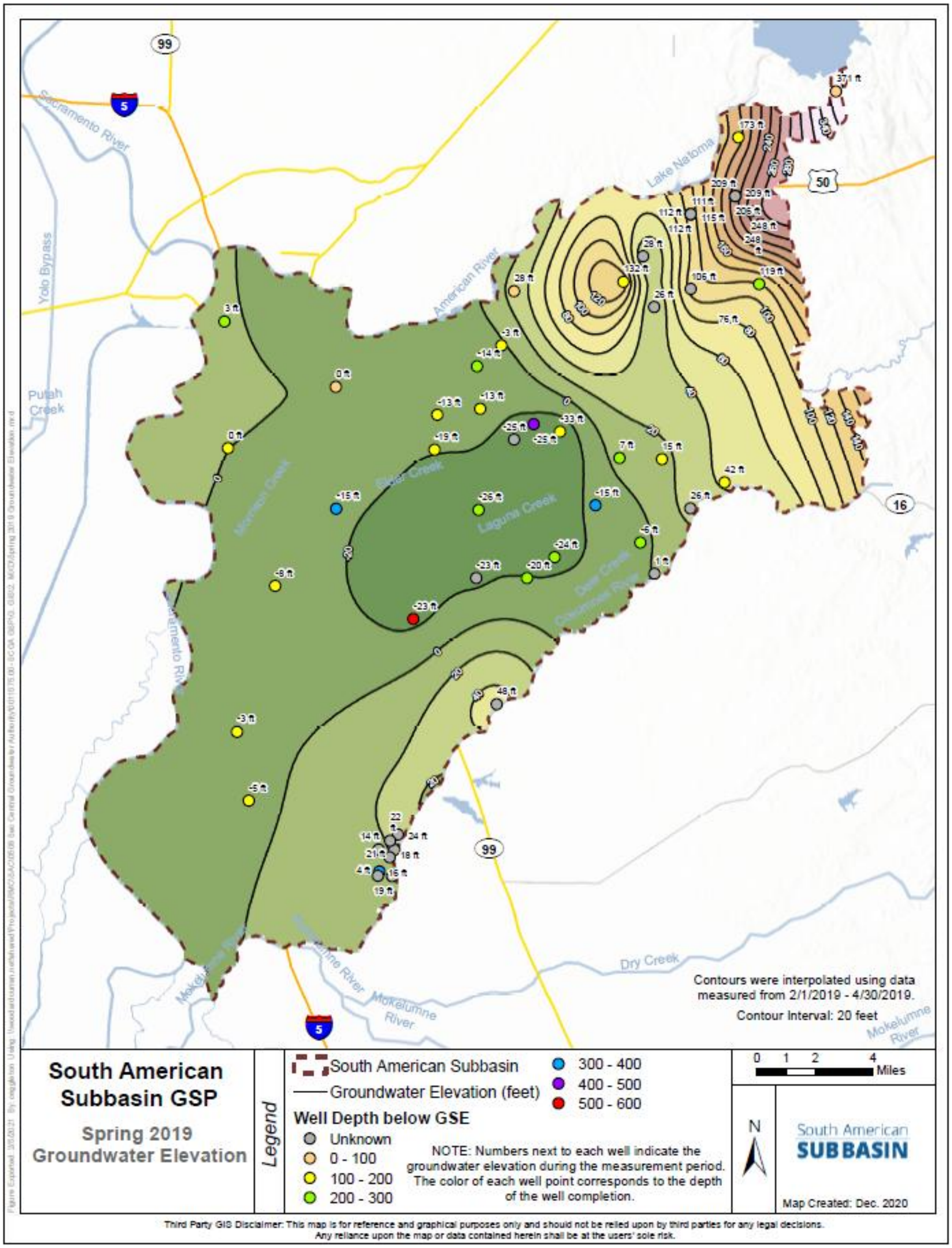
Data included to develop these contours were from April through May for Spring 2019, and September through November for Fall 2019. If multiple measurements for a well were available during this time, the measurement closest to the middle of the season (mid-April for Spring and mid-October for Fall) were used.

Figure 2-70 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 2-71 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 2-72 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 2-73 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

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.

Figure 2-70: **Spring 2019 Groundwater Elevation**

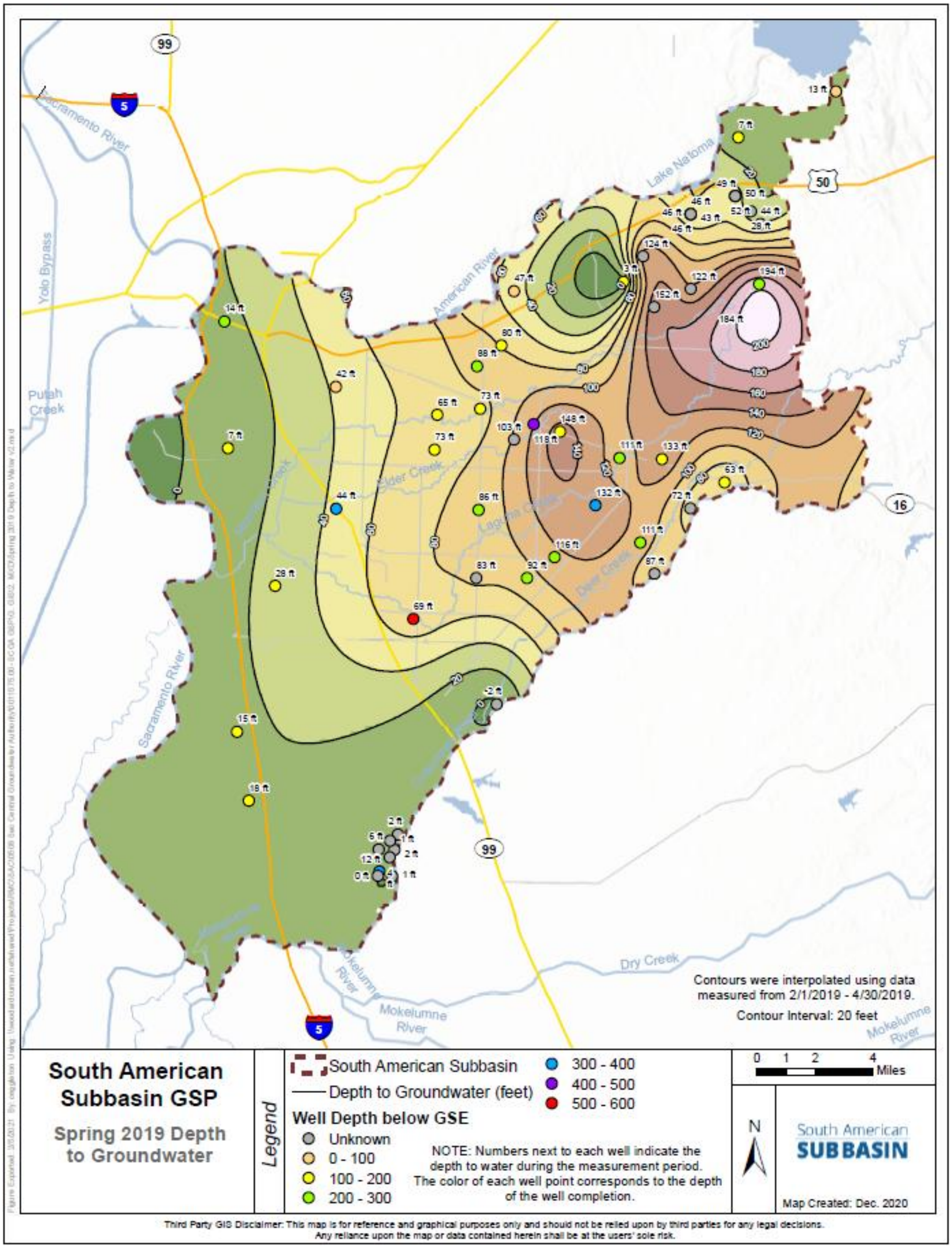


Figure 2-71: Spring 2019 Depth to Groundwater

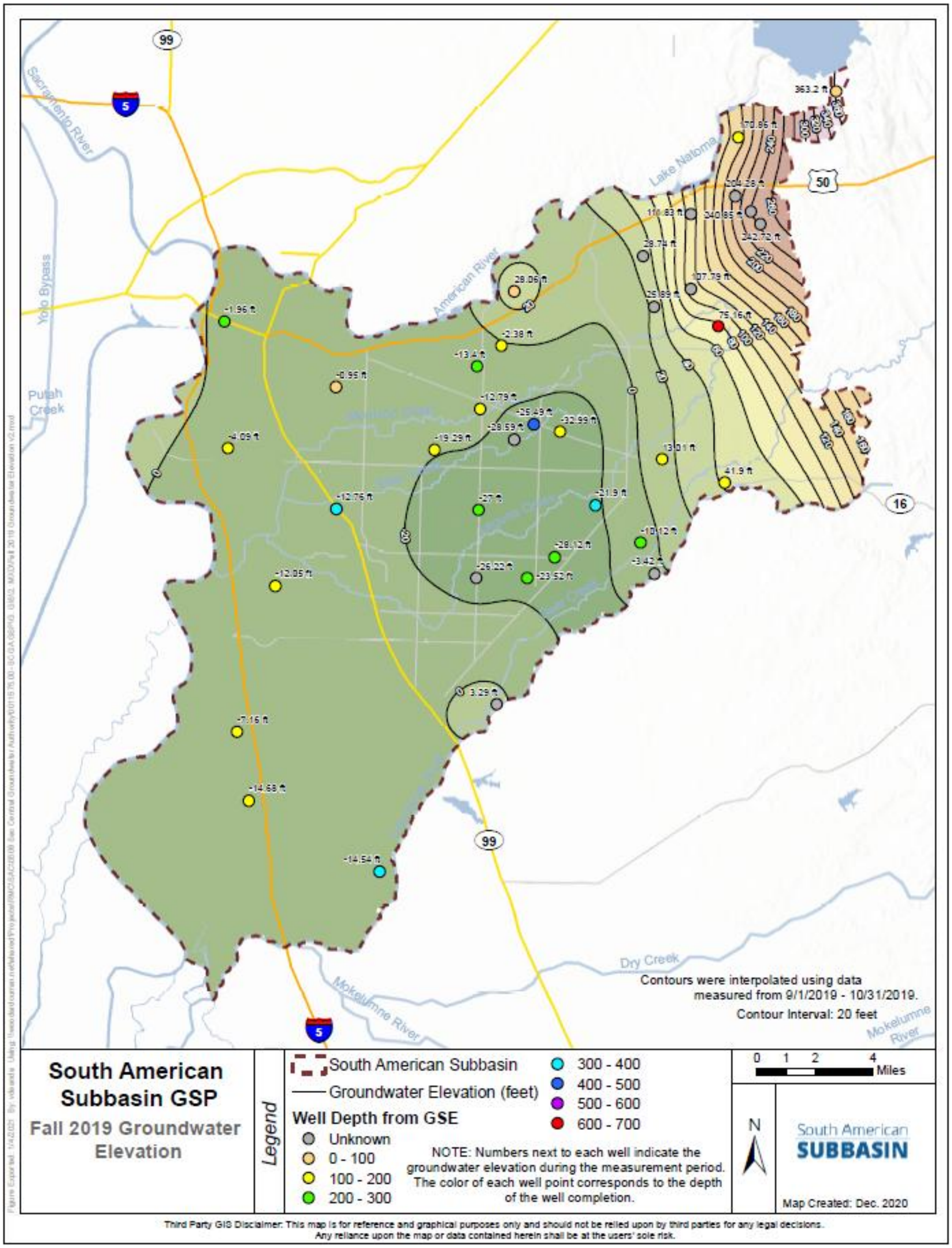
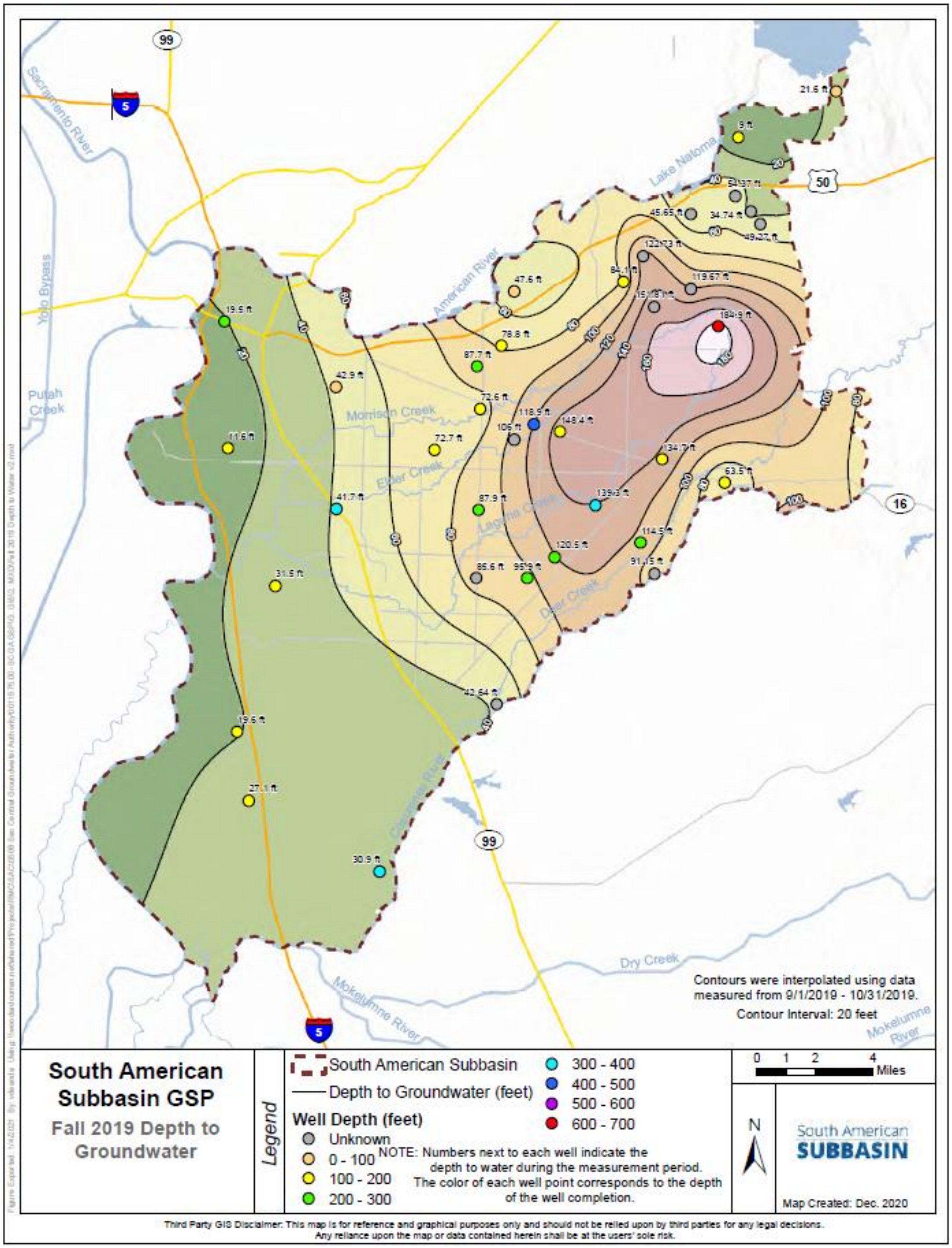


Figure 2-72: Fall 2019 Groundwater Elevation



Contours were interpolated using data measured from 9/1/2019 - 10/31/2019.

Contour Interval: 20 feet

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.

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 2-73: Fall 2019 Depth to Groundwater

2.3.2 Change in Groundwater Storage

The CoSANA model was used to estimate historical changes in storage of SASb from 1995-2025. **Figure 2-74** shows annual total storage for the SASb as well as the cumulative change in storage, and water year type. The CoSANA model water budget for the Subbasin calculated an estimated increase in SASb storage of about 7,000 AF during WY 2025. During the 31-year period from 1995-2025, there has been an estimated cumulative increase in groundwater storage of 139,400 AF.

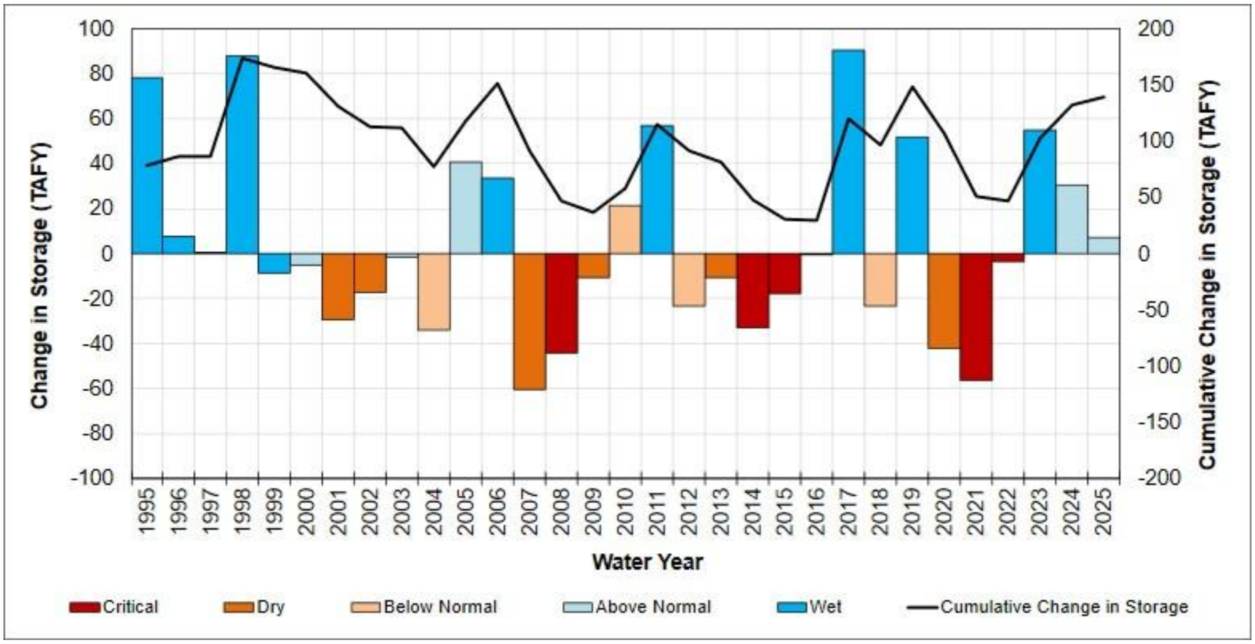


Figure 2-74: **Groundwater Storage by Year, Water Year Type, and Cumulative Volume**

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[9] 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.

Groundwater Quality Trends According to Available Historical Data

The combined database from GAMA and GEI Consultants was evaluated for nitrate, TDS, and arsenic. Specific conductance data was also evaluated (data solely from the GAMA database). Data solely from the GAMA database was evaluated for hexavalent chromium, and the larger

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[9] http://geotracker.waterboards.ca.gov/gama/datadownload

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, specific conductance, arsenic, hexavalent chromium, and PFAS. Variations of nitrate, TDS, and specific conductance 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 2-75** illustrates variation in nitrate for eight 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 2-78** and the deep zone in **Figure 2-79**. 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 2-78 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 2-79** 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 2-76** illustrates variation in TDS for eight 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 2025; however, these elevated concentrations are still deemed acceptable.

TDS data are plotted spatially for the shallow zone in **Figure 2-80** and the deep zone in **Figure 2-81.** 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 2-80** 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 2-81** shows that all TDS data for deep wells were less than the upper SMCL value of 1000 mg/L.

Specific Conductance

Specific Conductance (SC) data in the SASb are extensive, spanning from 1955 to present. **Figure 2-77** illustrates variation in SC for eight time intervals. The recommended secondary SMCL is displayed as a dashed red line (900 µmhos/cm), while the upper SMCL is shown as 1,600 µmhos/cm. As shown, SC concentrations in both the shallow and deep aquifer zones were generally consistent throughout the period of evaluation. SC concentrations in the shallow zone exhibited greater variability and slightly higher concentrations relative to the deep zone, particularly after 2000. However, the observed variation does not indicate a consistent increasing trend over time. SC concentrations in the deep zone remained relatively stable throughout the period of analysis and generally remained below 50 percent of the recommended SMCL. While several shallow wells exceeded the recommended SMCL, only a limited number of wells approached or exceeded the upper SMCL during the period of record.

SC data are plotted spatially for the shallow zone in **Figure 2-82** and the deep zone in **Figure 2-83**. The maps divide the wells into four categories: wells where all samples were below 50 percent of the recommended SMCL (indicated as a green point), wells where at least one sample was above 50 percent of the recommended SMCL (indicated as a yellow point), wells where at least one sample exceeded the recommended SMCL of 900 µmhos/cm (indicated as an orange point), and wells where at least one sample exceeded the upper SMCL of 1,600 µmhos/cm (indicated as a red point)

SC concentrations in the shallow zone are below 50 percent of the recommended SMCL in the majority of wells in the eastern and northeastern portions of the Subbasin, while wells exceeding 50 percent of the recommended SMCL are present in the central and western portions of the Subbasin. A limited number of shallow wells exceeded the recommended SMCL and only a few isolated wells exceeded the upper SMCL. SC concentrations in the deep zone are lower and less variable than in the shallow zone, with the majority of wells remaining below 50 percent of the recommended SMCL. Only three wells exceeded 50 percent of the recommended SMCL, and two wells exceeded the recommended SMCL.

Analysis of concurrent TDS and SC measurements in the Subbasin demonstrates a strong linear relationship between the two analytes, with SC predicted from TDS using a scaling factor of 1.546 and an R^2 value of 0.967. The spatial distribution of SC is also consistent with TDS, indicating that the two constituents exhibit similar groundwater quality patterns throughout the Subbasin.

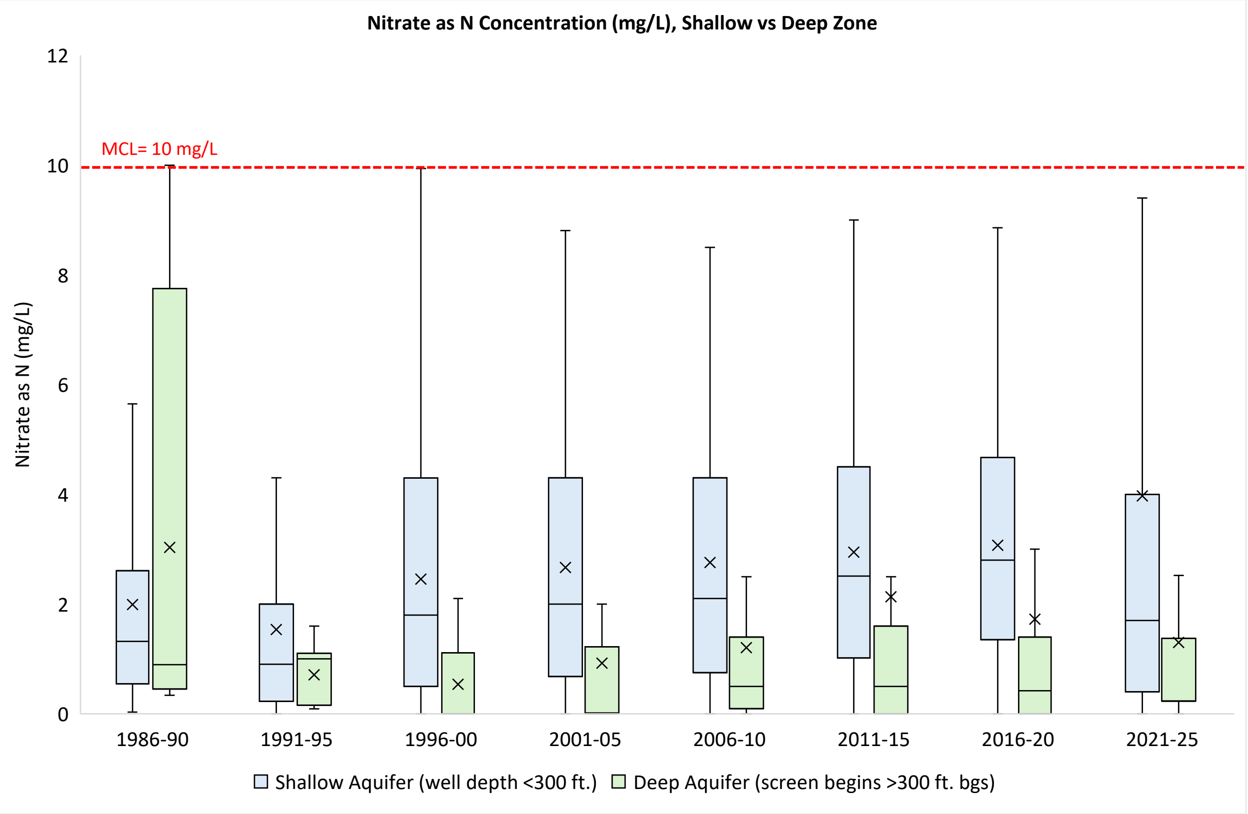

Figure 2-75: Historical Range of Nitrate Concentrations

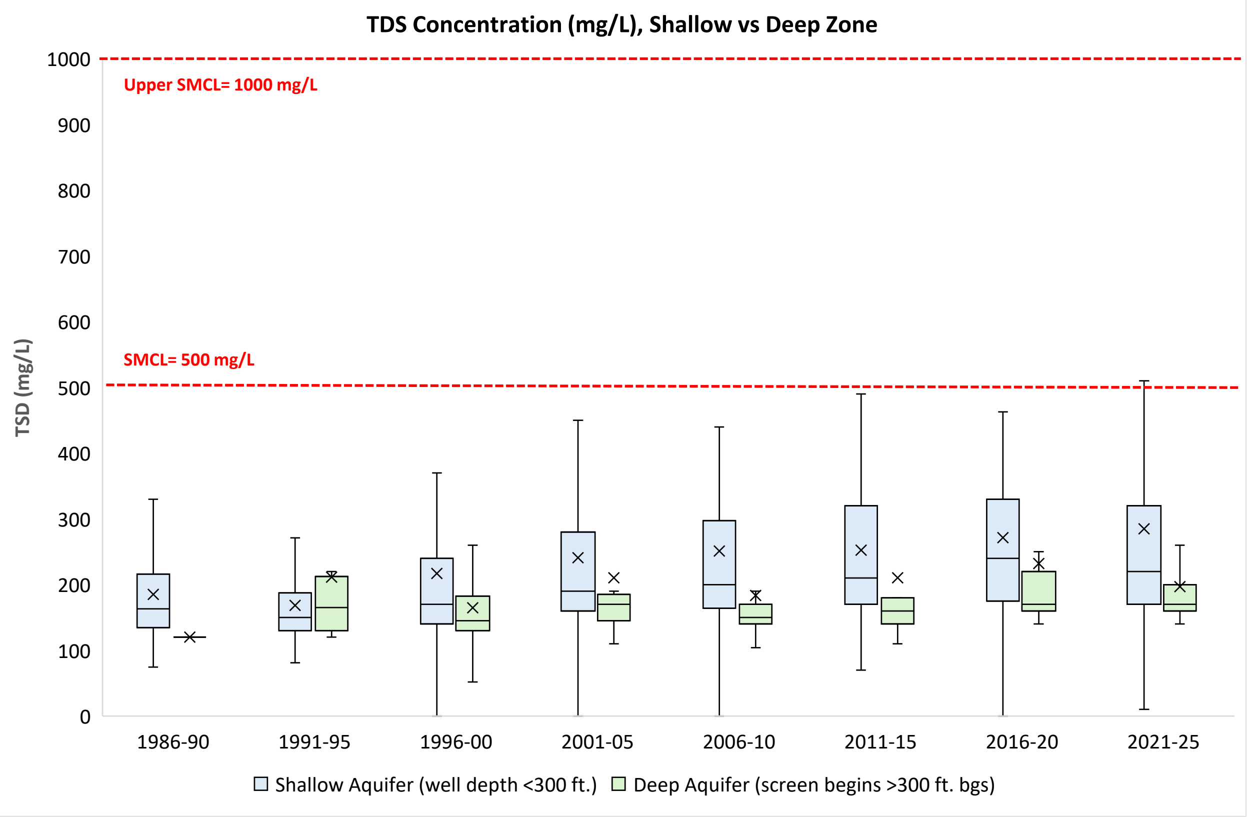

Figure 2-76: Historical Range of TDS Concentrations

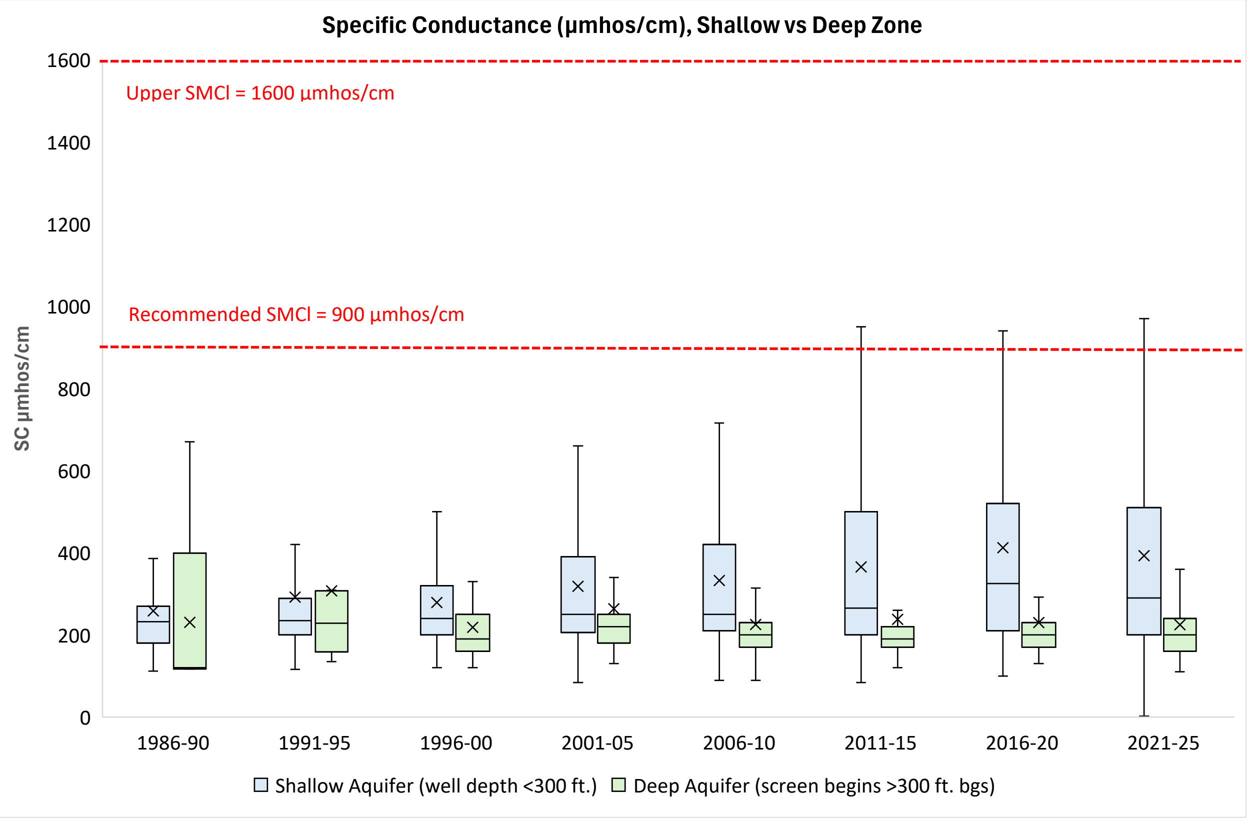

Figure 2-77: **Historical Range of Specific Conductance**

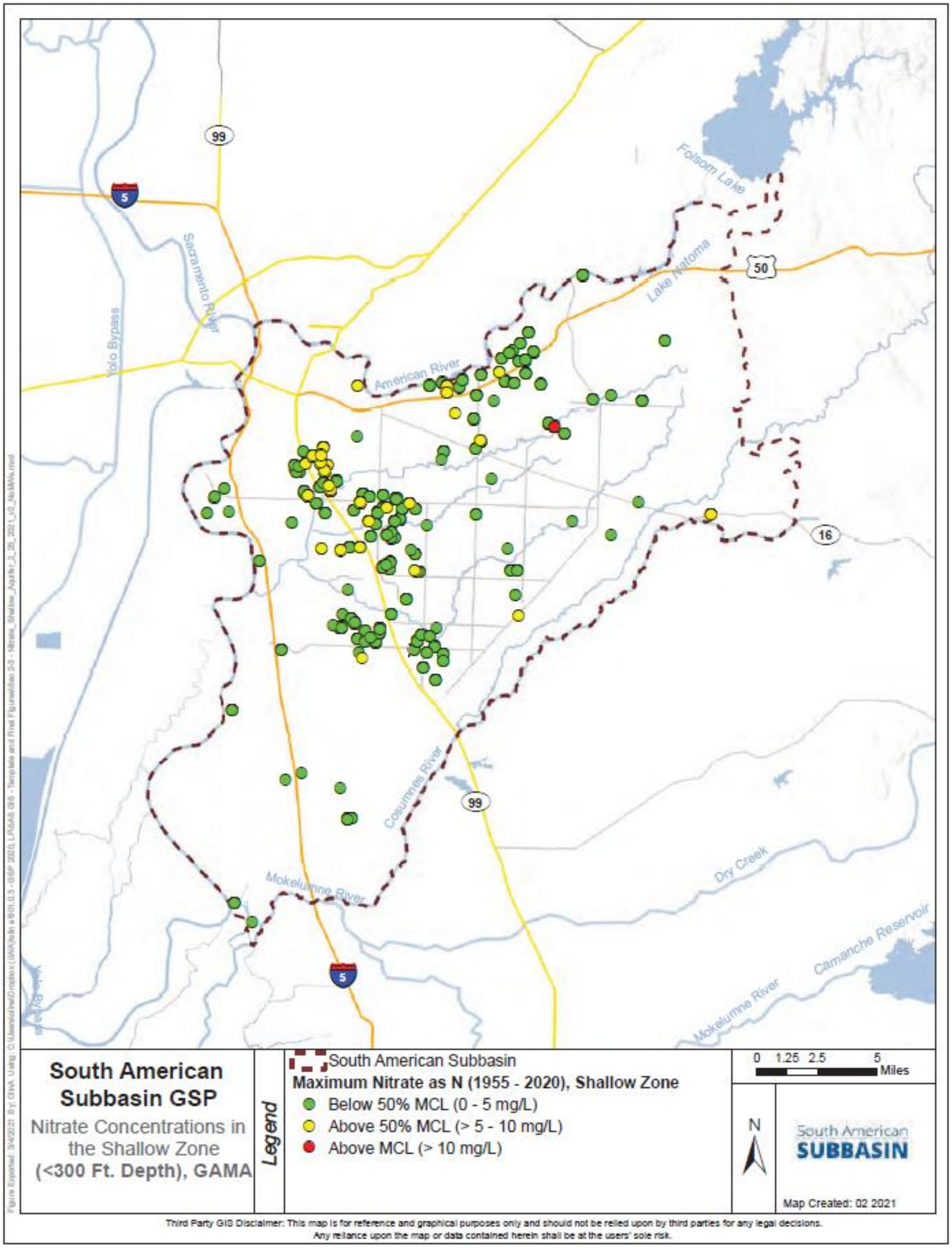

Figure 2-78: **Nitrate Concentrations in the Shallow Zone**

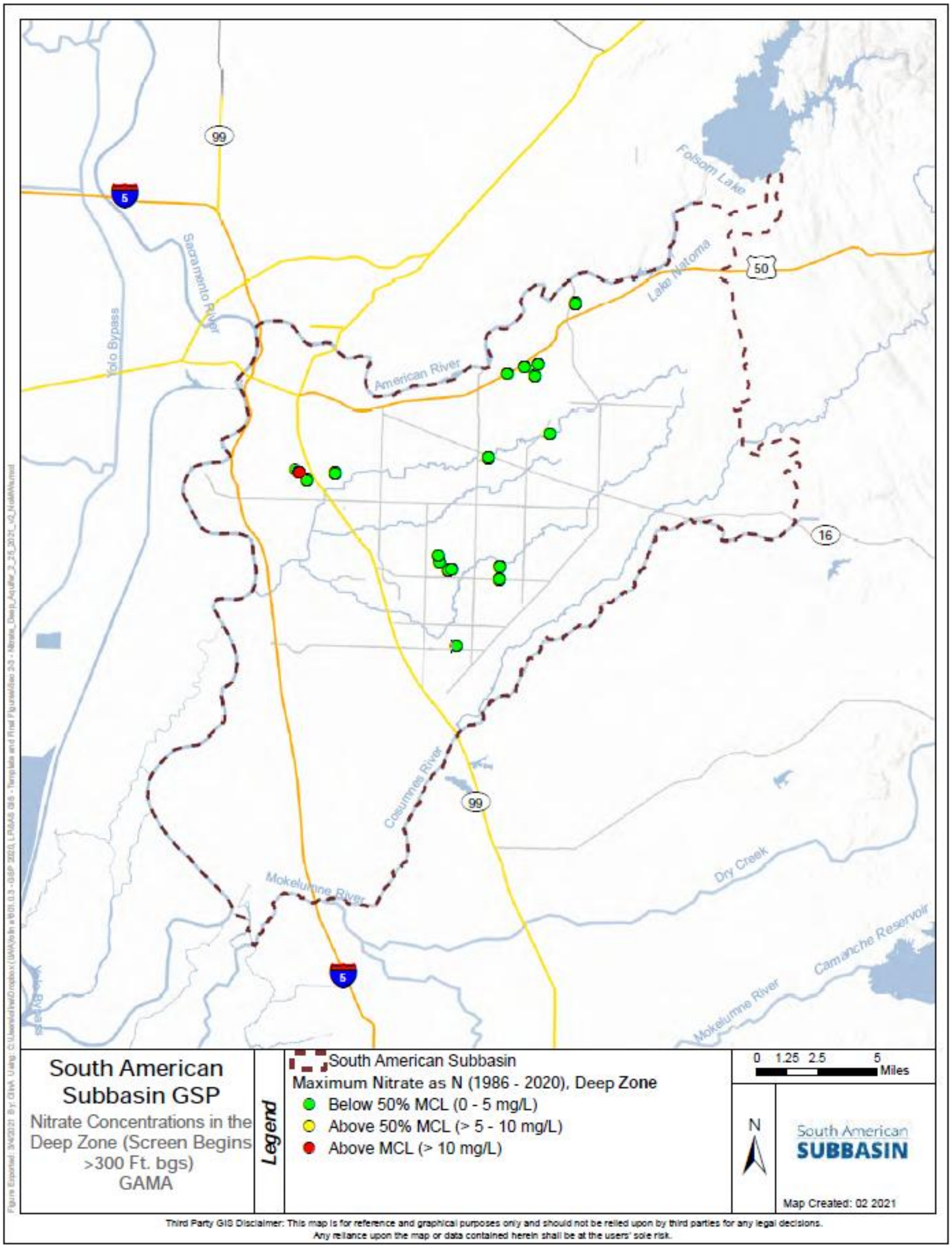

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Figure 2-79: Nitrate Concentrations in the Deep Zone

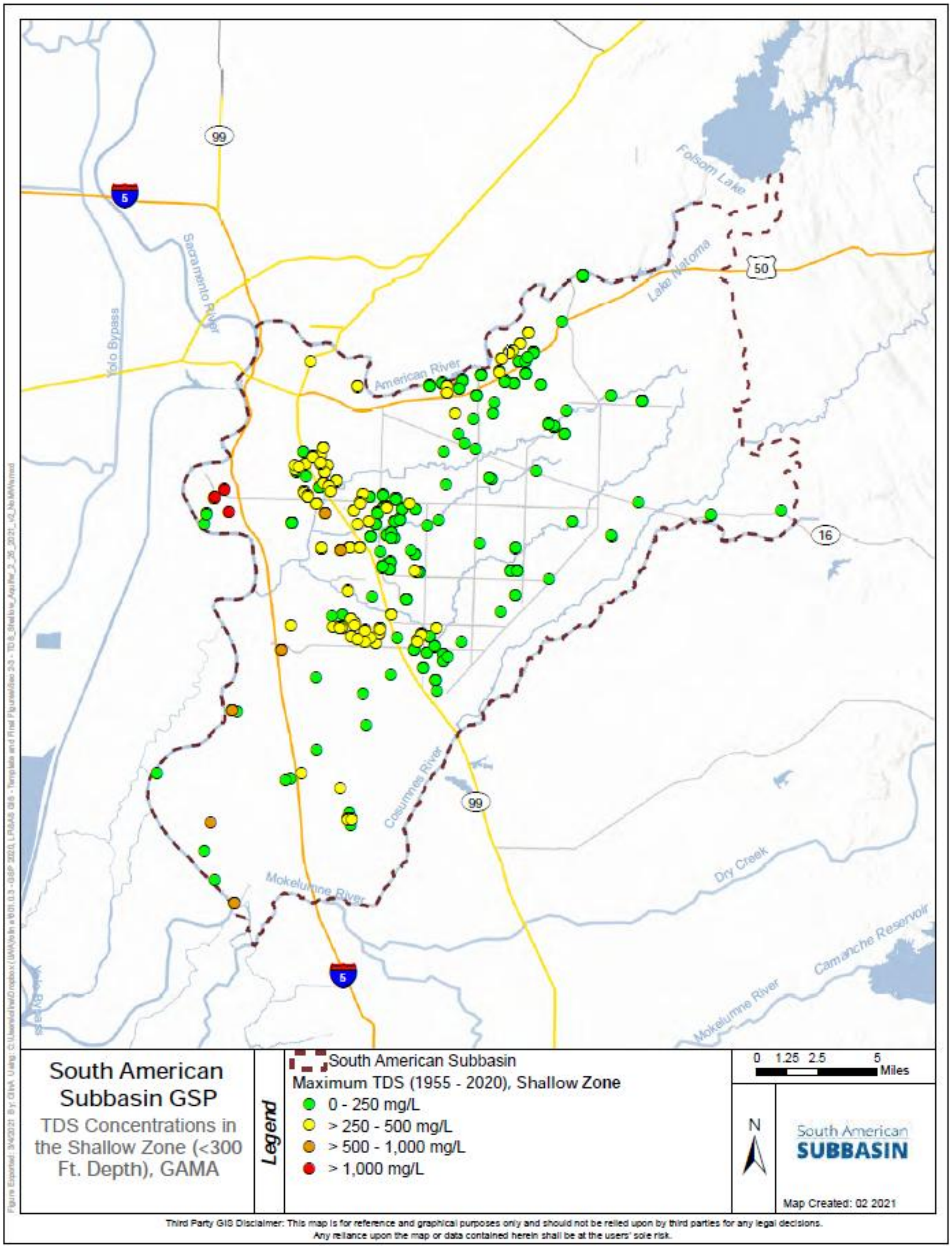


Figure 2-80: TDS Concentrations in the Shallow Zone

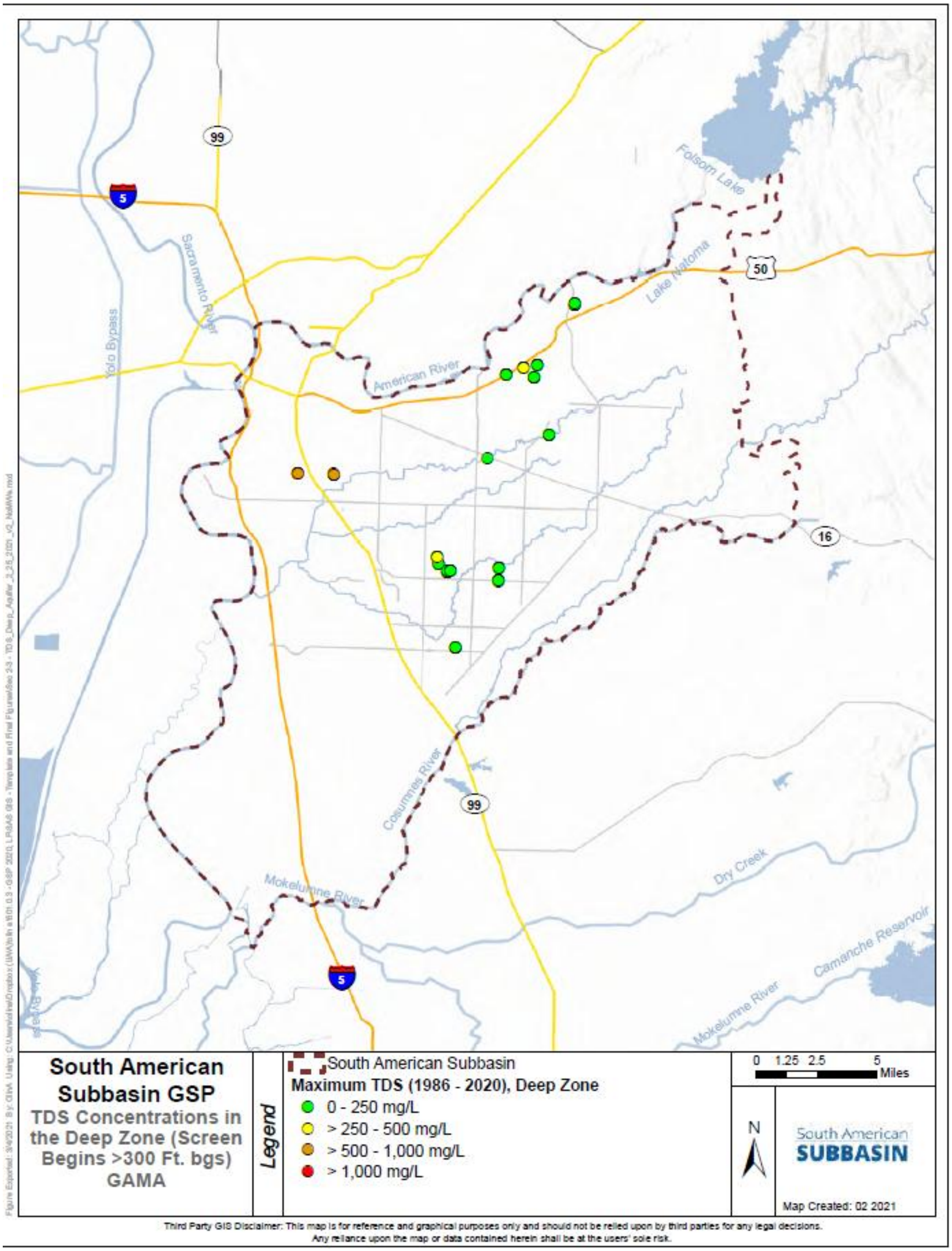
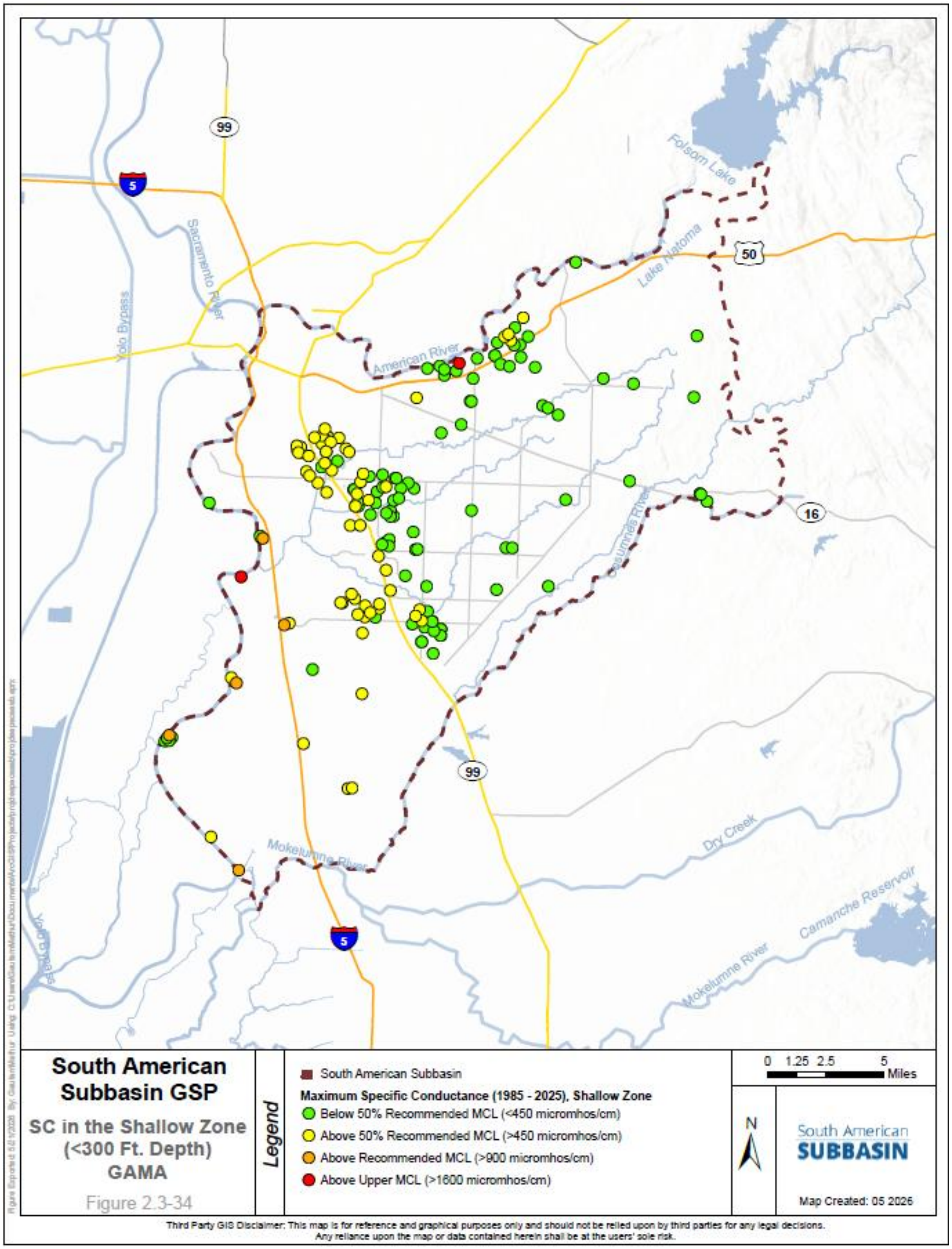
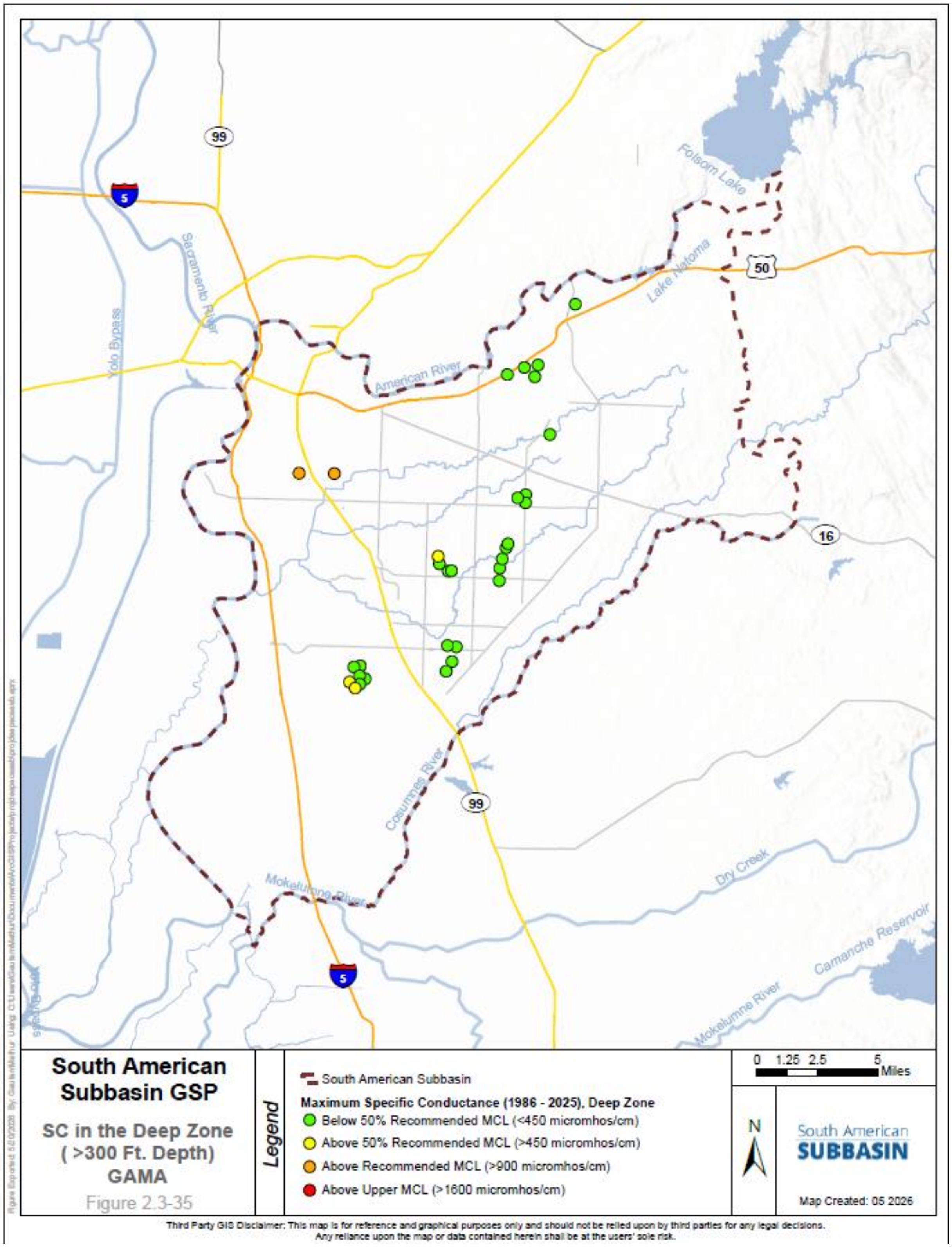


Figure 2-81: TDS Concentrations in the Deep Zone



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 2-82: Specific Conductance in the Shallow Zone



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 2-83: Specific Conductance in the Deep Zone

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 2-85** and the deep zone in **Figure 2-86**. 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 2-85 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 2-86** 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.

To verify there are not significant increases in arsenic concentrations a trend analysis was completed for wells with at least five measurements in the period of 2005-2025. A Mann-Kendall test was used to evaluate whether a trend was present; pre-whitening was applied to remove autocorrelation from the time series data.

The results show that for wells with at least one sample above 5 µg/L, 4 of 89 wells indicate an increasing concentration trend, and for wells with all samples below 5 µg/L, 1 of 123 wells indicate an increasing concentration trend (**Table 2.3-2**). Of all wells evaluated, the low number of wells with increasing trends (2.4%) suggests that arsenic concentrations are generally stable in the Subbasin. This indicates that Subbasin management, e.g., groundwater pumping, is not degrading water quality with respect to arsenic. Additionally, 4 out of 5 of the wells with increasing trends occur where arsenic concentrations were previously elevated, which is likely due to natural occurrence rather than Subbasin management.

Table 2.3-2: Summary of Mann-Kendall Trend Analysis Results for Arsenic (1958 - 2025 and 2005 - 2025)

Period	Wells with Decreasing Trend	Wells with No trend	Wells with Increasing Trend	Total Wells
1958 - 2025	27	189	5	221
2005 - 2025	27	180	5	212

The spatial distribution of wells with an increasing trend shows the wells are in the western portion of the Subbasin and are not limited to a restricted region (**Figure 2-84**). Additionally, the wells with increasing trends are co-located with wells that show no trend or decreasing trend, which suggests that overall the Subbasin does not have increasing arsenic concentrations.

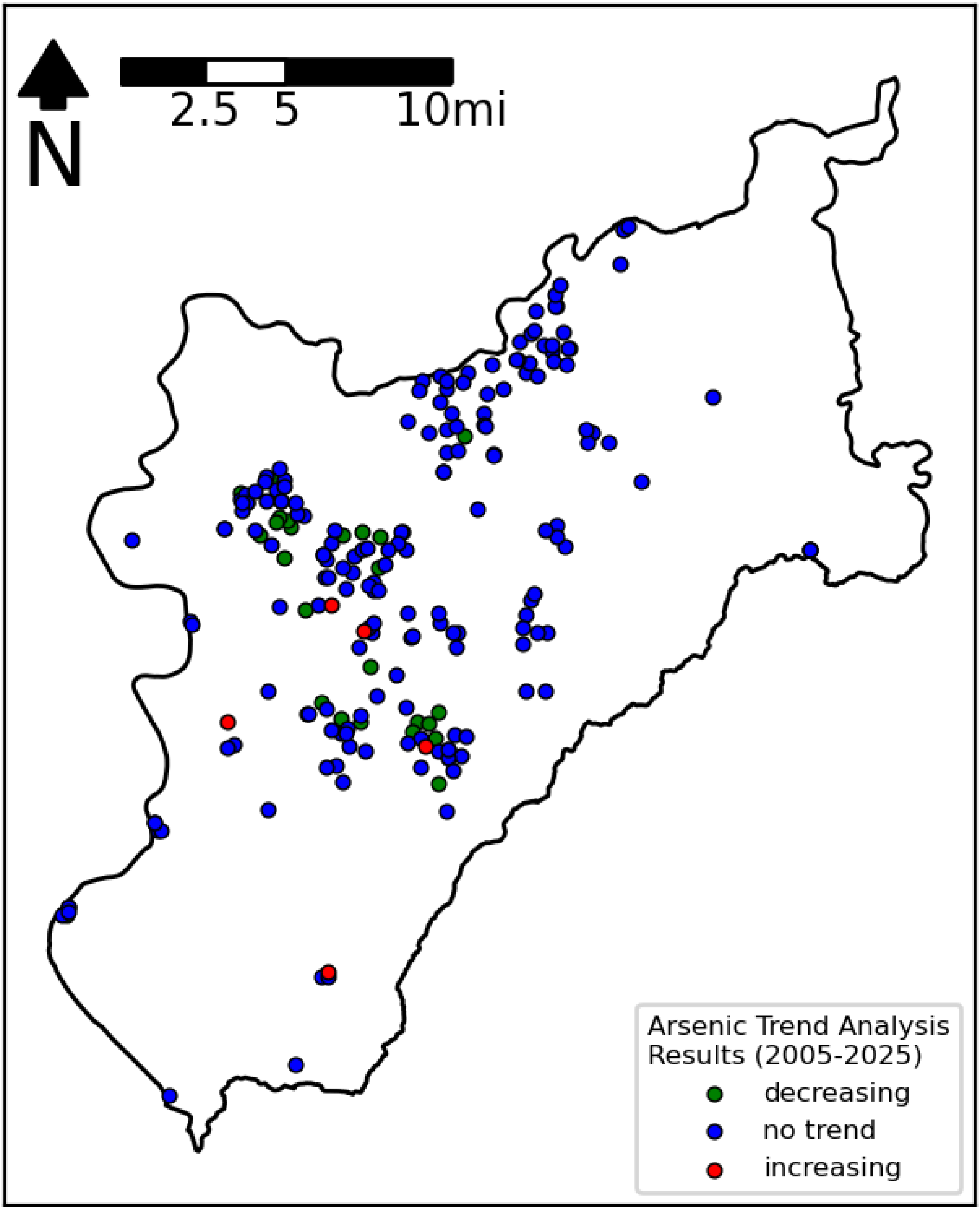


Figure 2-84: Map of Mann-Kendall Trend Analysis Results for Arsenic from 2005-2025 for Wells with at least 5 Samples

Hexavalent Chromium

Hexavalent chromium data span from 2001 to present and are plotted spatially for the shallow zone in **Figure 2-87**, and the deep zone in **Figure 2-88**. 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 2-89**, 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.

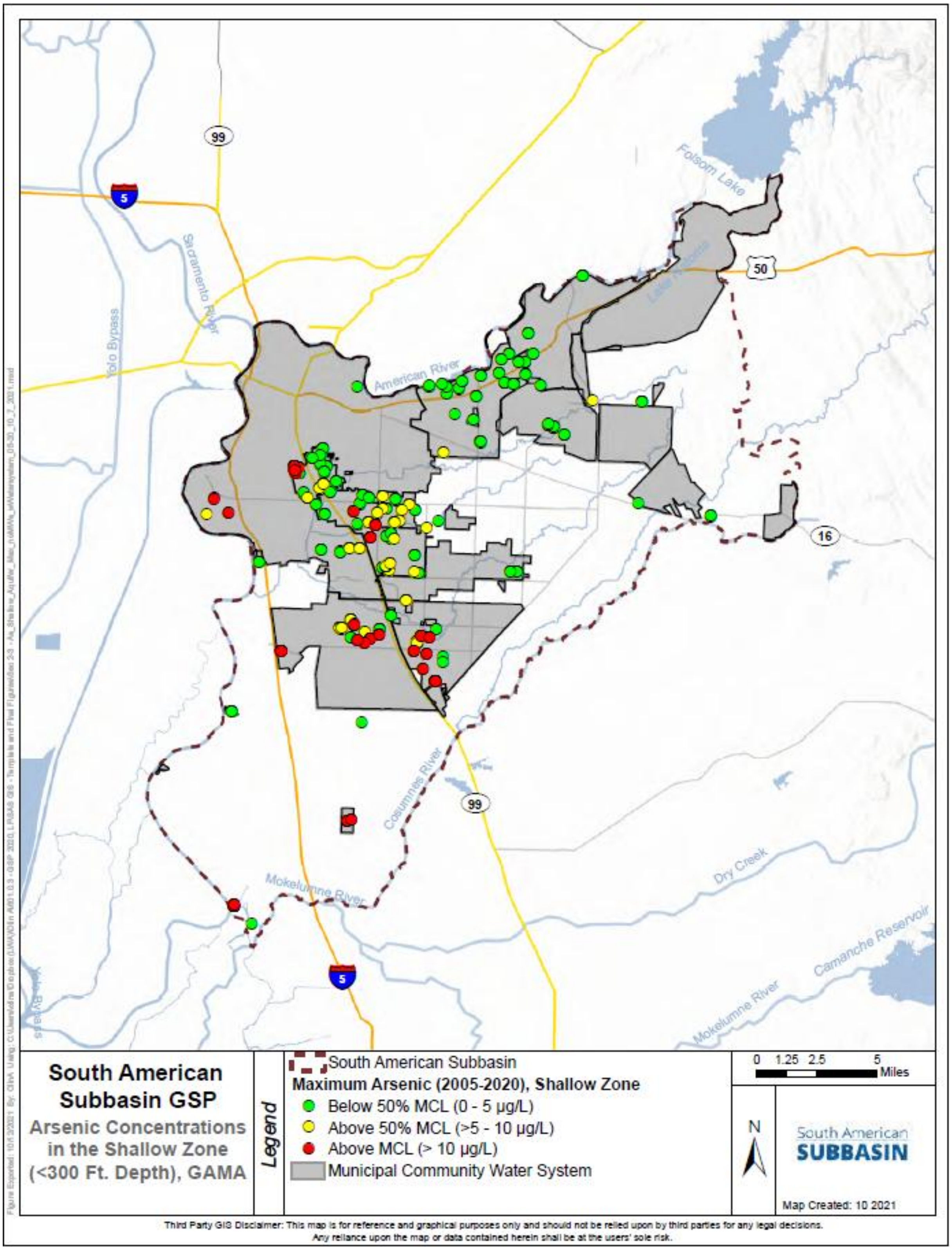


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Figure 2-85: Arsenic Concentrations in the Shallow Zone

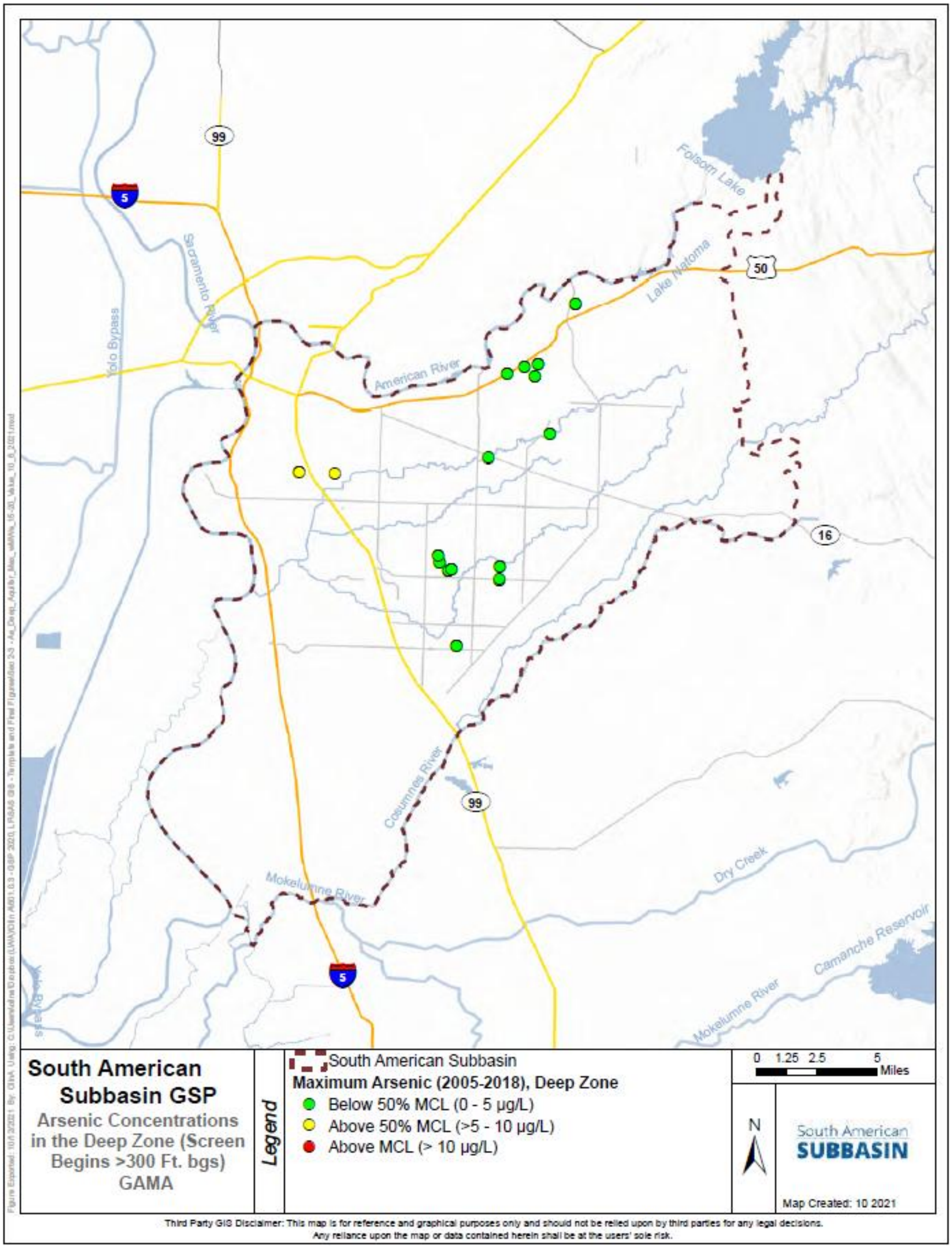

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Figure 2-86: Arsenic Concentrations in the Deep Zone

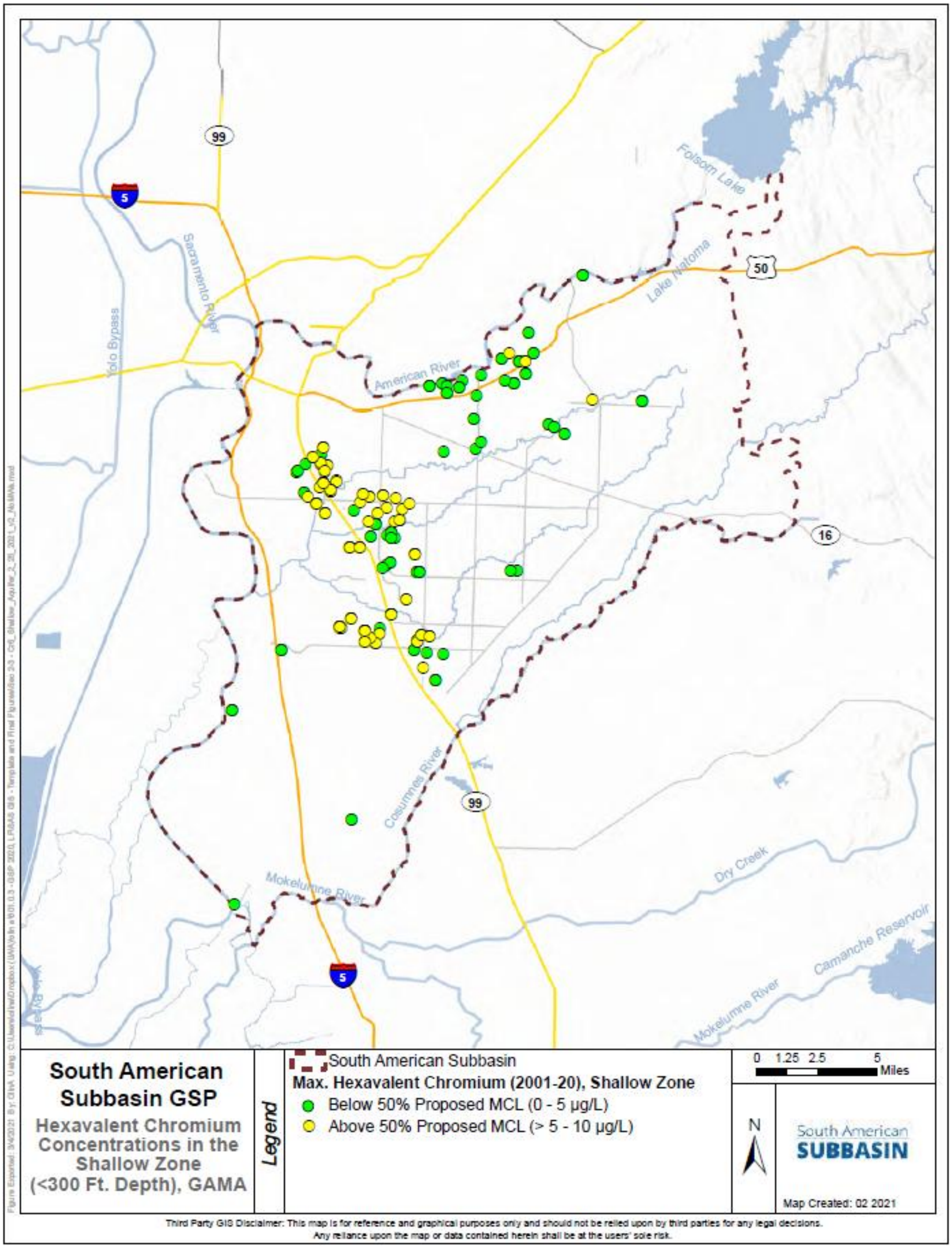

Figure 2-87: **Hexavalent Chromium Concentrations in the Shallow Zone**

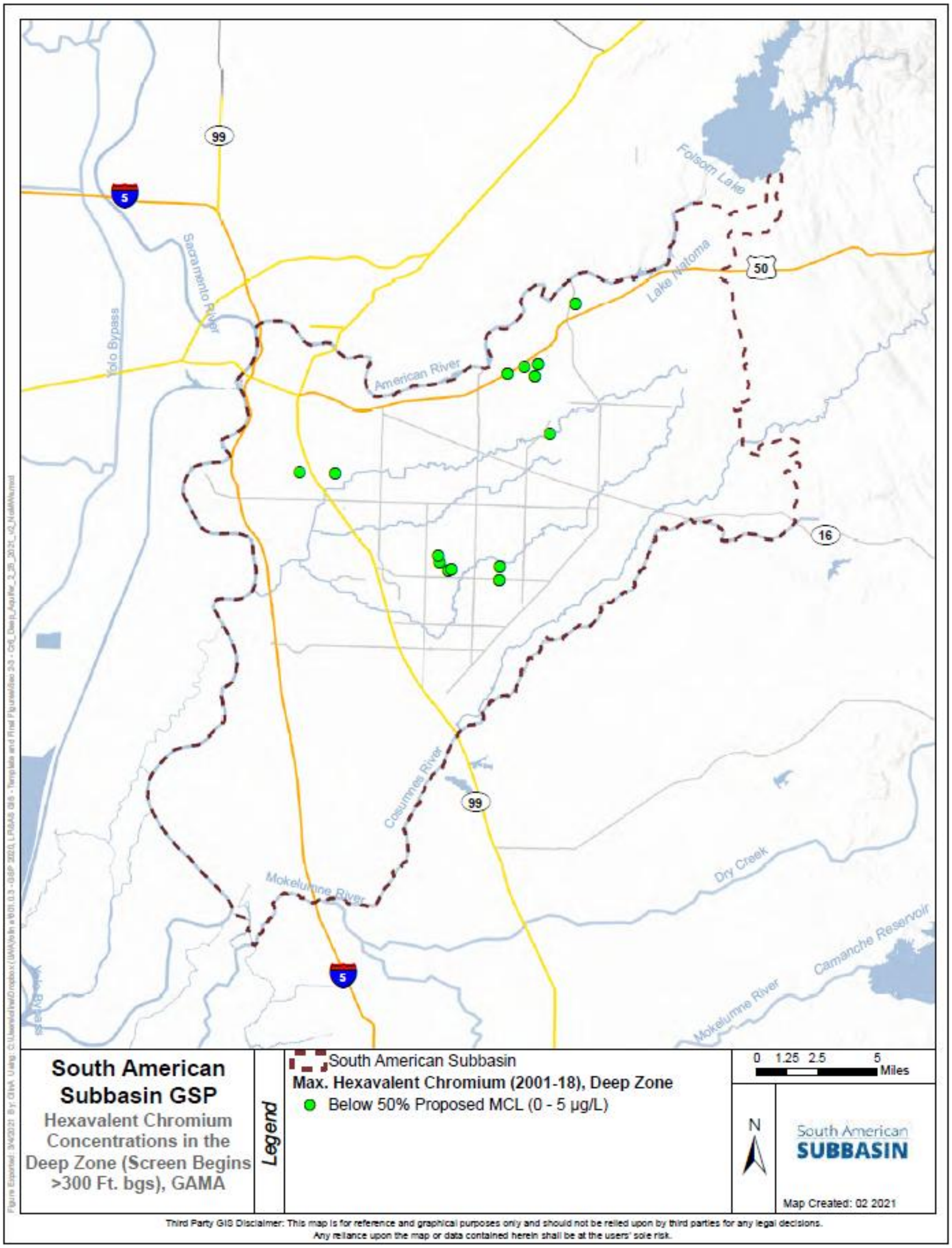

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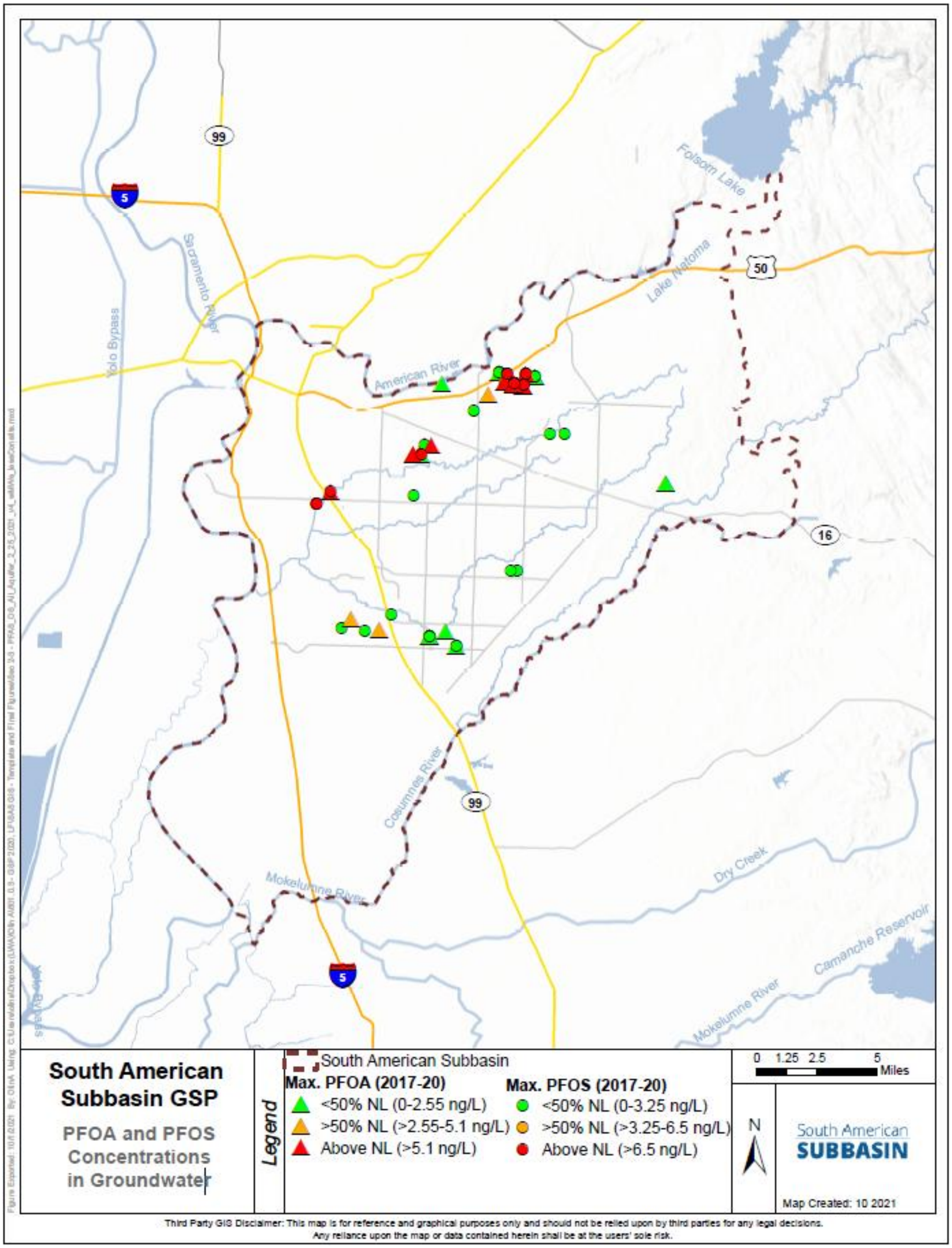
Figure 2-88: Hexavalent Chromium Concentrations in the Deep Zone



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 2-89: PFOA and PFOS Concentrations in Groundwater

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. These programs have all been discontinued.

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 the present. **Figure 2-90** shows total vertical displacement between June 2015 and April 2026. The maximum total displacement is between -0.5 and -1.0 feet and is located in the southwest area of SASb near the Sacramento River. The figure shows values between -0.25 and 0.25 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 2-91** is a time series plot of the elevation data, beginning in October 2005 through May 2024. The trend line suggest minimal land subsidence has occurred at the station since October 2005, equating 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[10].

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[10] https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence

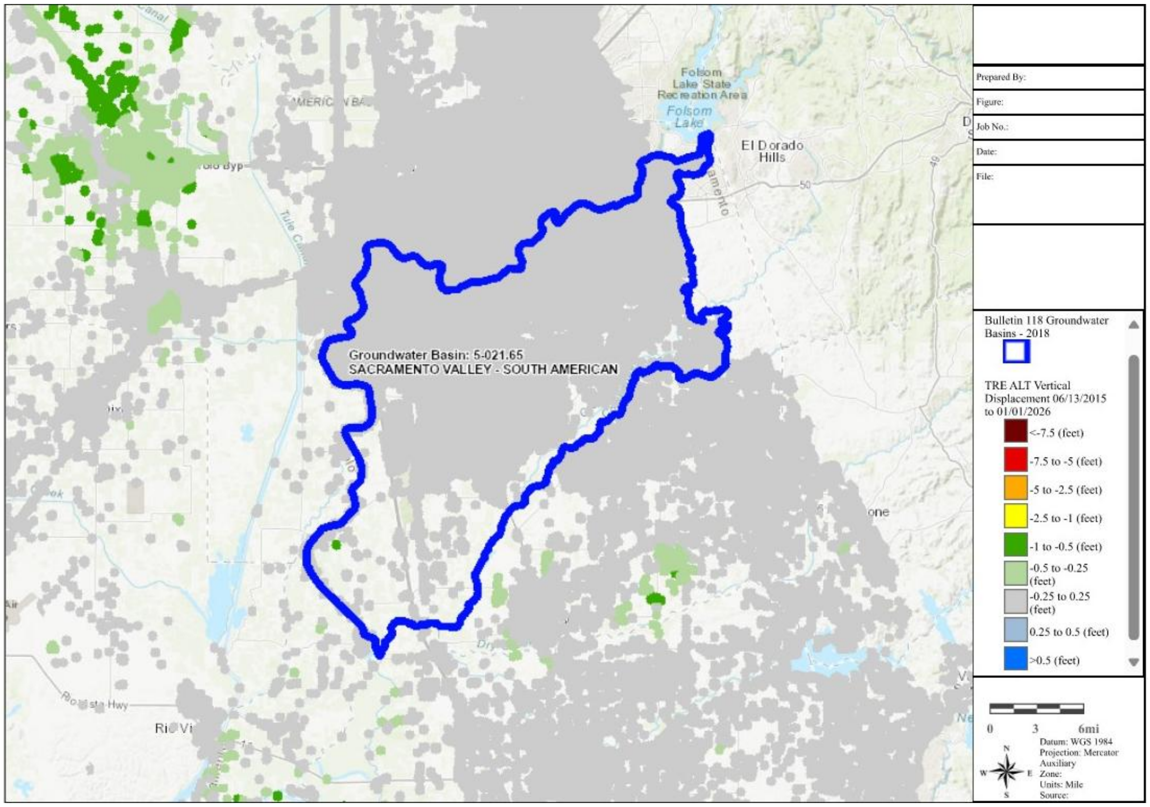
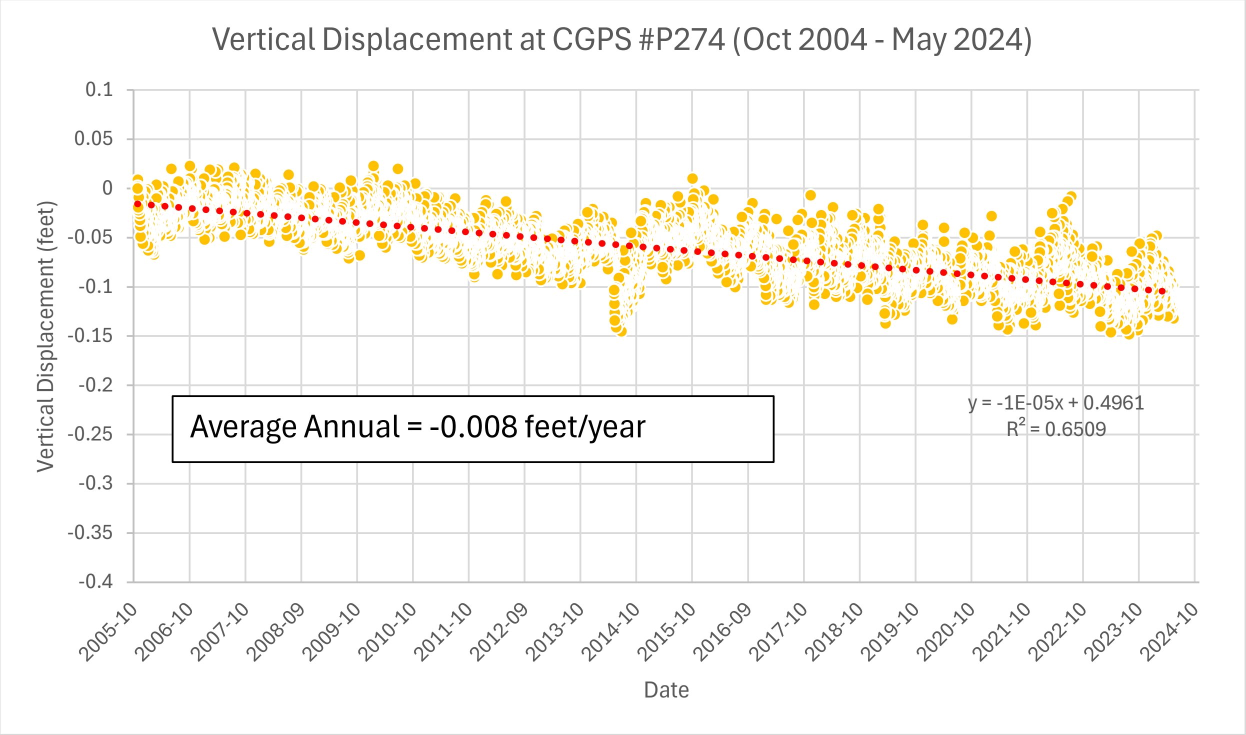


Figure 2-90: South American Subbasin InSAR Subsidence, June 2015 – April 2026



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 2-91: South American Subbasin CGPS Station (UNAVCO #P274) Subsidence, October 2005 – May 2024[1]

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 krige groundwater elevation surfaces at spring and fall seasons between 2005 and 2018. Next, the best available streambed elevation[11] 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, otherwise, it is considered disconnected (**Figure 2-92**). The surface waters considered in this

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[11] 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.

analysis included only major surface water systems represented in the CoSANA model (**Figure 2-93**), which are subdivided in 21 reaches (**Figure 2-94**).

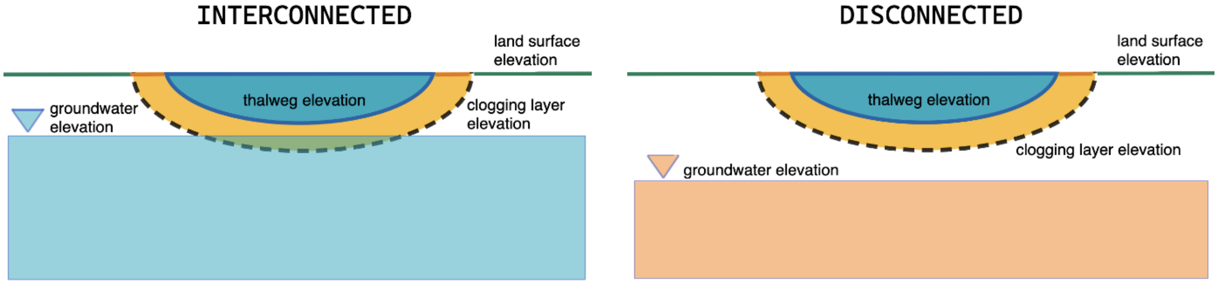


Figure 2-92: **Classification of Interconnected Surface Water (ISW) and Disconnected stream nodes depends on a comparison of the clogging layer elevation beneath the streambed and the groundwater elevation.**

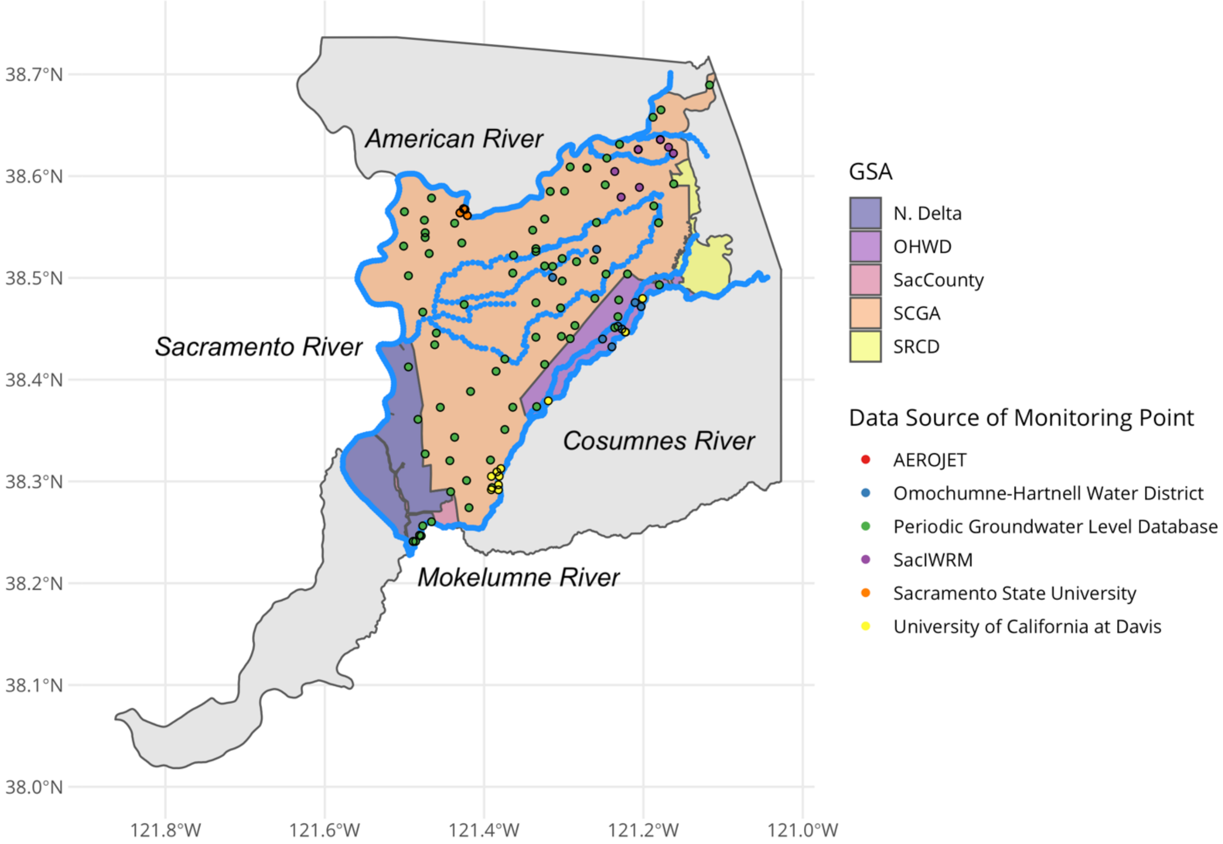


Figure 2-93: **South American Subbasin surface water nodes in the CoSANA model, GSAs, and locations of groundwater level monitoring locations and sources used for seasonal groundwater level interpolation.**

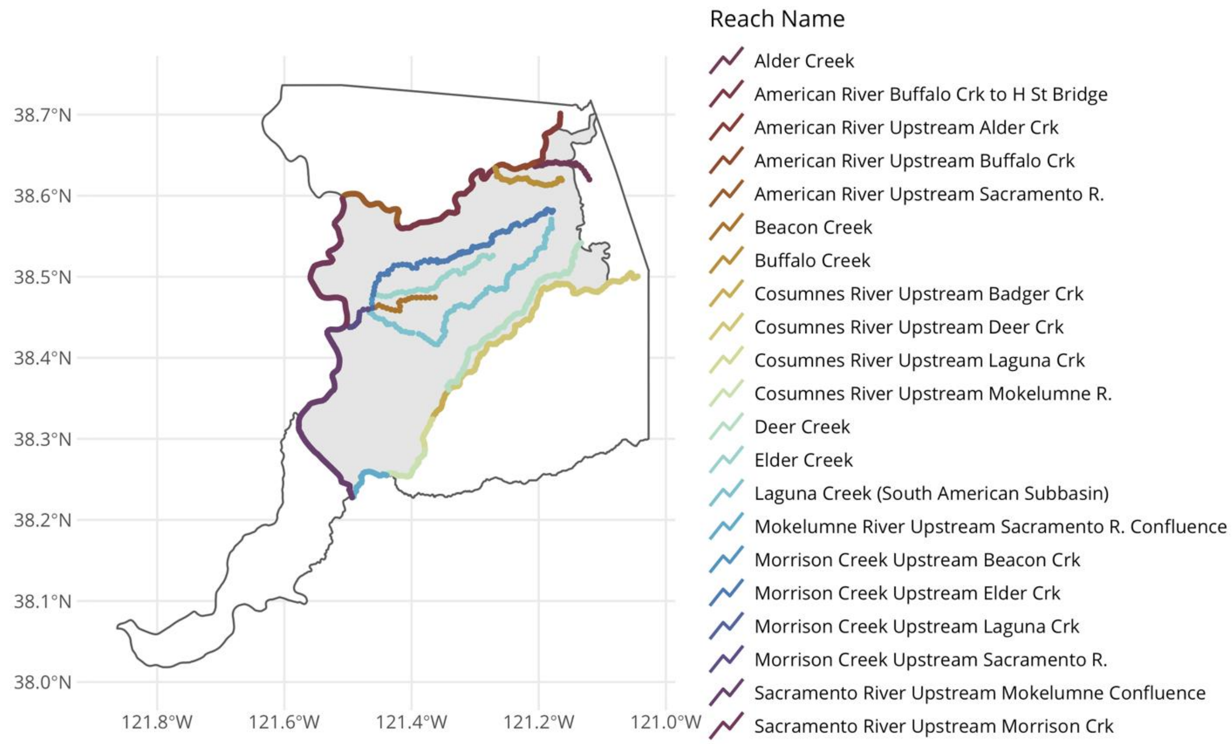


Figure 2-94: Major surface waters in the South American Subbasin divided into 21 reaches, based on CoSANA surface node representation.

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. Error! Reference source not found.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.

Updated evaluation of interconnected surface water conditions

An updated evaluation of interconnected surface water conditions was also conducted using recent model results to further refine the understanding of groundwater-surface water connectivity. This analysis evaluated the percentage of model timesteps during which groundwater levels exceeded stream invert elevations at individual stream nodes over the period WYs 2015 through 2024 (**Figure 2-95**).

The updated analysis generally confirms the characterization developed in the 2022 GSP, indicating that portions of the major river systems, including portions of the Sacramento River, American River, Cosumnes River, and Mokelumne River, remain hydraulically interconnected with the groundwater system under recent conditions. Smaller tributary systems exhibited greater variability in interconnectedness, with some reaches remaining disconnected during most or all of the analysis period while others exhibited partial or intermittent hydraulic connectivity.

The use of a percentage-based metric provides additional insight into the degree and variability of connectivity over time. Results indicate that while many major river reaches are consistently interconnected, some reaches exhibit seasonal or intermittent connectivity. Given uncertainties associated with groundwater level data, stream invert elevations, and spatial variability, this analysis is intended to support continued refinement of interconnected surface water characterization as additional data become available. More accurate and potentially more focused data and information will be needed to have better and more accurate assessment of the connectivity conditions of each reach.

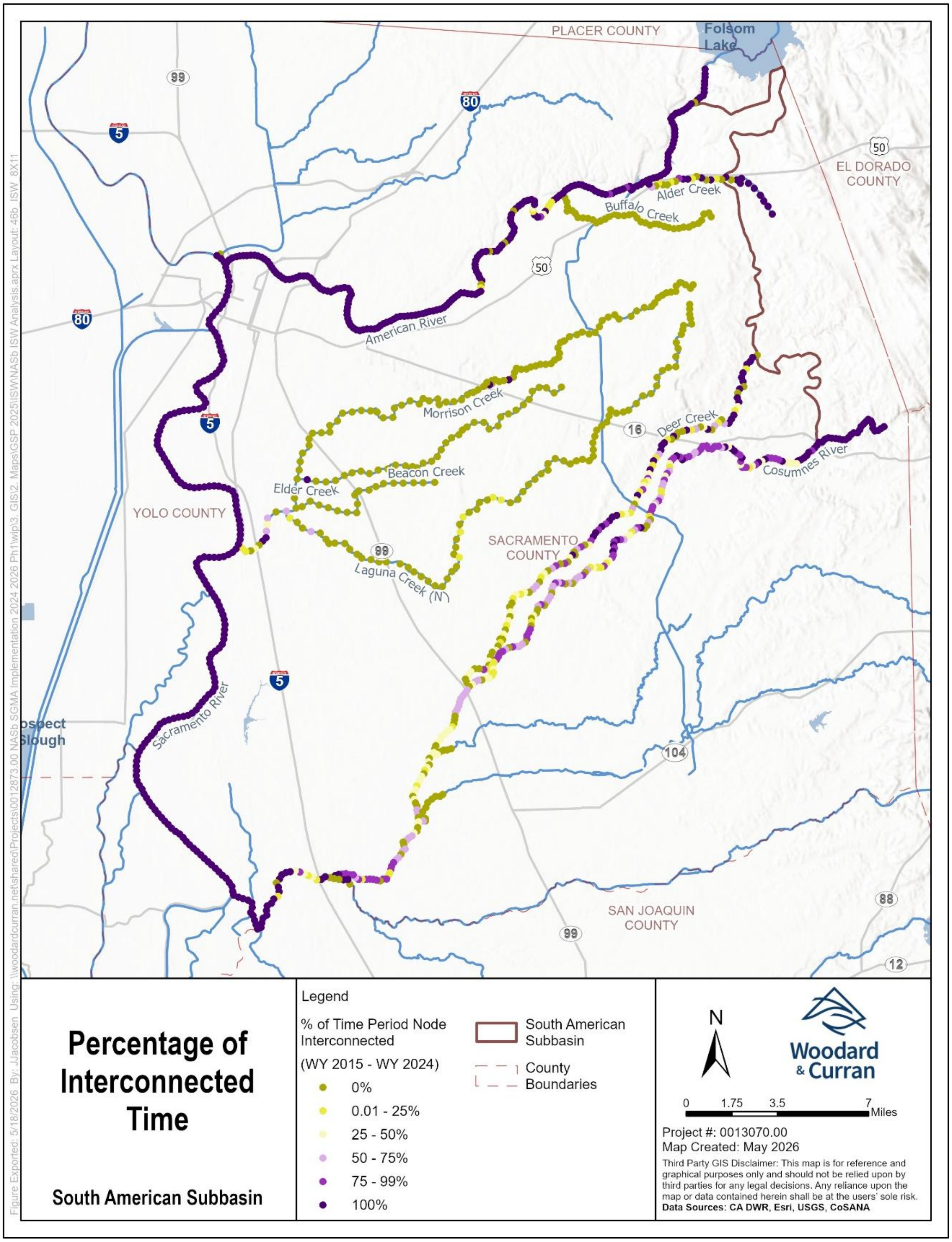
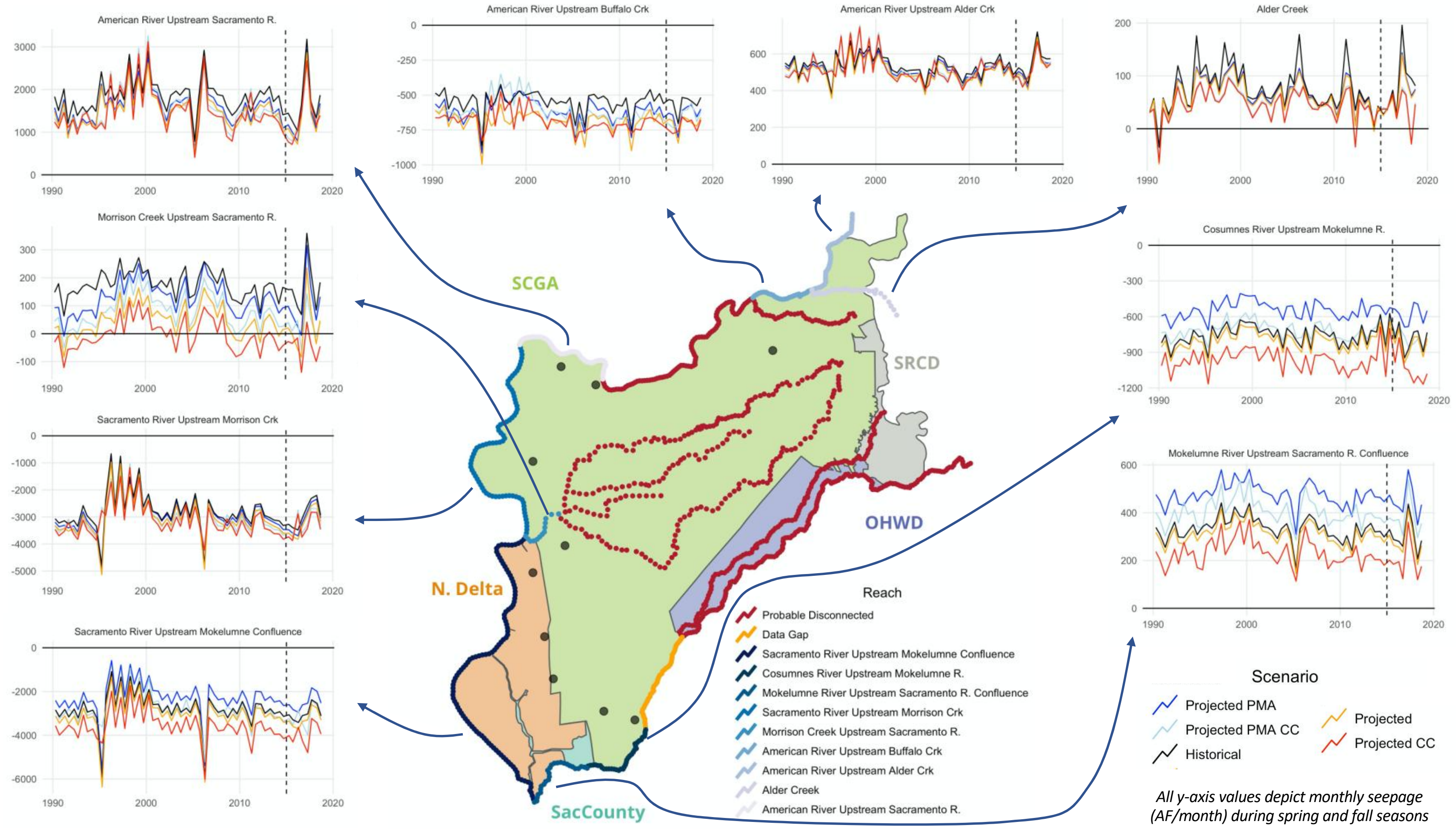


Figure 2-95: Percentage of Interconnected Time (WY 2015–2024)

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 2-96**). 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.



All y-axis values depict monthly seepage (AF/month) during spring and fall seasons

Figure 2-96: 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.

2.3.7 Groundwater Dependent Ecosystems

Vegetative groundwater dependent ecosystems (GDEs) are a beneficial user of groundwater that rely on a connection to saturated groundwater over some vertical displacement, 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 cataloged. Analysis of GDEs informed the creation of quantitative management criteria to identify the occurrence of significant and unreasonable changes to GDEs. These details are covered in **Appendix 3-D: Groundwater Dependent Ecosystems in the South American Subbasin**, and a brief summary of historical and present day GDE locations and characteristics are presented here.

Data assimilation and analysis

All available datasets were used to identify potential wetland and non-wetland GDEs, including:

- Natural Communities Commonly Associated with Groundwater Vegetation (NCCAG-V) developed by a working group comprised of California Department of Water Resources (DWR), California Department of Fish and Wildlife (CDFW), and The Nature Conservancy (TNC) and distributed by California DWR[12]
- South Sacramento Habitat Conservation Plan (SSHCP) landcover[13]
- CDFW Vegetation augmented with project-based mapping for a landscape management scenario analysis[14]
- National Wetlands Inventory (NWI) developed and distributed by US Fish & Wildlife[15]
- California Aquatic Resource Inventory (CARI) developed and distributed by the San Francisco Estuary Institute[16]

Datasets were analyzed to prevent overlap and double counting of potential GDEs, and a conservative rooting depth of 30 feet was assigned to each potential GDE polygon.

The maximum reported rooting depths of the plant species found in the SASb range from near-surface for grasses like creeping wildrye (3.8 feet) to deep-rooted trees like the Valley Oak (24.3 feet). Rooting depths of species within the SASb were evaluated, and the Valley Oak (*Quercus lobata*) was found to exhibit the largest rooting depth[17]. Because plants can extract moisture from pore spaces away from the roots themselves, a threshold depth of 30 feet was used as a cutoff for the maximum depth of groundwater that could reasonably be accessed by a GDE within the SASb. Areas within the SASb where depth to groundwater is consistently

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[12] *Available at* https://data.cnra.ca.gov/dataset/natural-communities-commonly-associated-with-groundwater.

[13] This dataset is referred to as SSHCP/Underwood as the data was provided by E. Underwood and R. Hutchinson. *Available at* https://escholarship.org/uc/item/8700x95f.

[14] *Available at* https://wildlife.ca.gov/Data/VegCAMP.

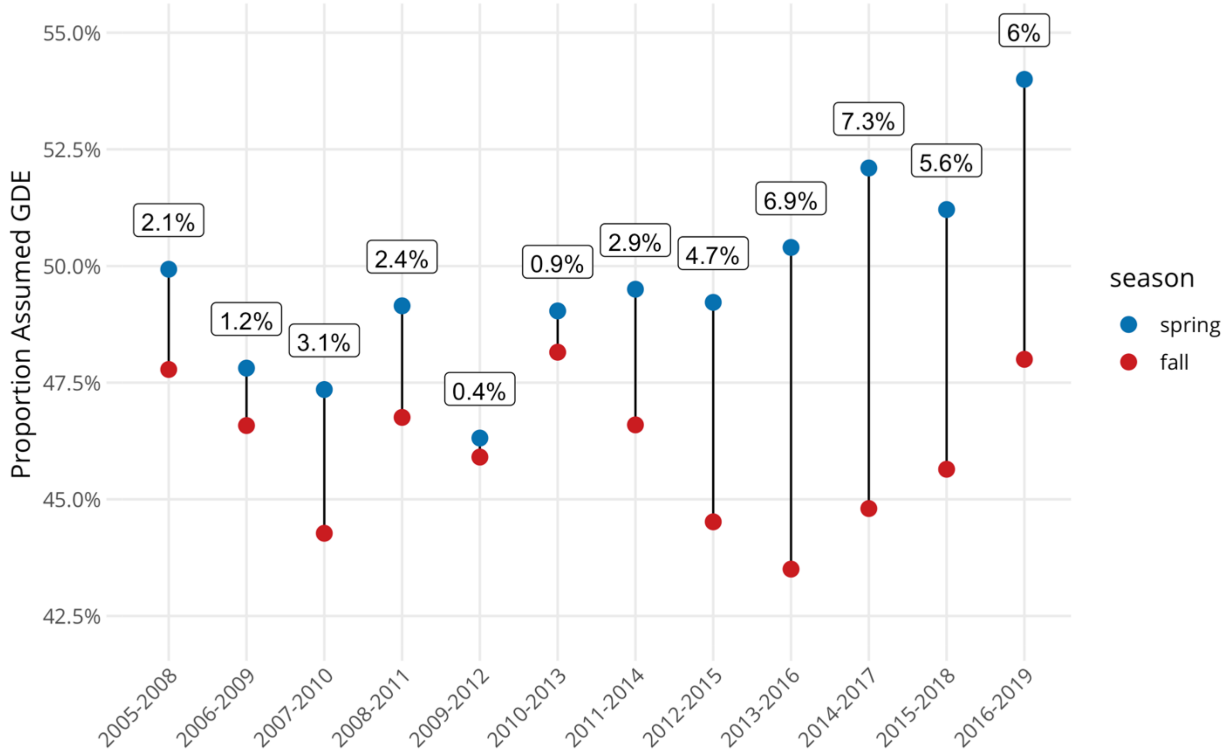
[15] *Available at* https://www.fws.gov/wetlands/Data/Data-Download.html.

[16] *Available at* https://www.sfei.org/cari.

[17] Coast Live Oak (*Querus agrifolia*) is also present in the SASb and has an average maximum rooting depth of 35.1 feet, however, it occupies 2.3 acres, and is thus neglected. By comparison, Valley Oak (*Quercus lobata*) has an area of 2,937 acres, thus we use the Valley Oak to set the upper bound of maximum rooting depth expected in the SASb.

greater than 30 feet are therefore assumed incapable of supporting non-wetland GDE communities and by extension, any GDEs. In the context of identifying GDEs, this 30-foot depth threshold is very conservative and overly inclusive as shallower groundwater is likely required to support a broader array of healthy GDEs in most circumstances.

Like ISW, GDE location varies depending on groundwater level. The same seasonal groundwater levels from 2005-2018 described in the ISW section above were used to evaluate trends in GDE area and evaluate historical inter-seasonal changes in the range of GDE area (**Figure 2-97**).



Text labels indicate the range between the spring and fall GDE area (relative to all potential GDEs).

Figure 2-97: GDE classification based on the application of a 30-foot depth to groundwater threshold on mapped potential GDEs.

Locations of groundwater dependent ecosystems

Long-term historical relationships between potential GDE polygons and groundwater were used to classify all potential GDEs into four (4) categories and estimate the average area and location of potential GDEs occupied by each category (Table 2.3-3, Figure 2-98):

- GDE – Potential GDEs connected 100% of seasons
- Potential GDE – Likely: potential GDEs connected ≥ 50% and < 100% of seasons
- Potential GDE – Unlikely: potential GDEs connected > 0% and < 50% of seasons
- Not GDE – Potential GDEs connected 0% of seasons

Table 2.3-3: GDE likelihood categorization based on all groundwater elevation from 2005-2019

Category	Area (acres)	% of Potential GDE Area
GDE	11,340	43.2%
Potential GDE - Likely	1,695	6.5%
Potential GDE - Unlikely	914	3.5%
Not GDE	12,296	46.9%
Total	26,245	100%

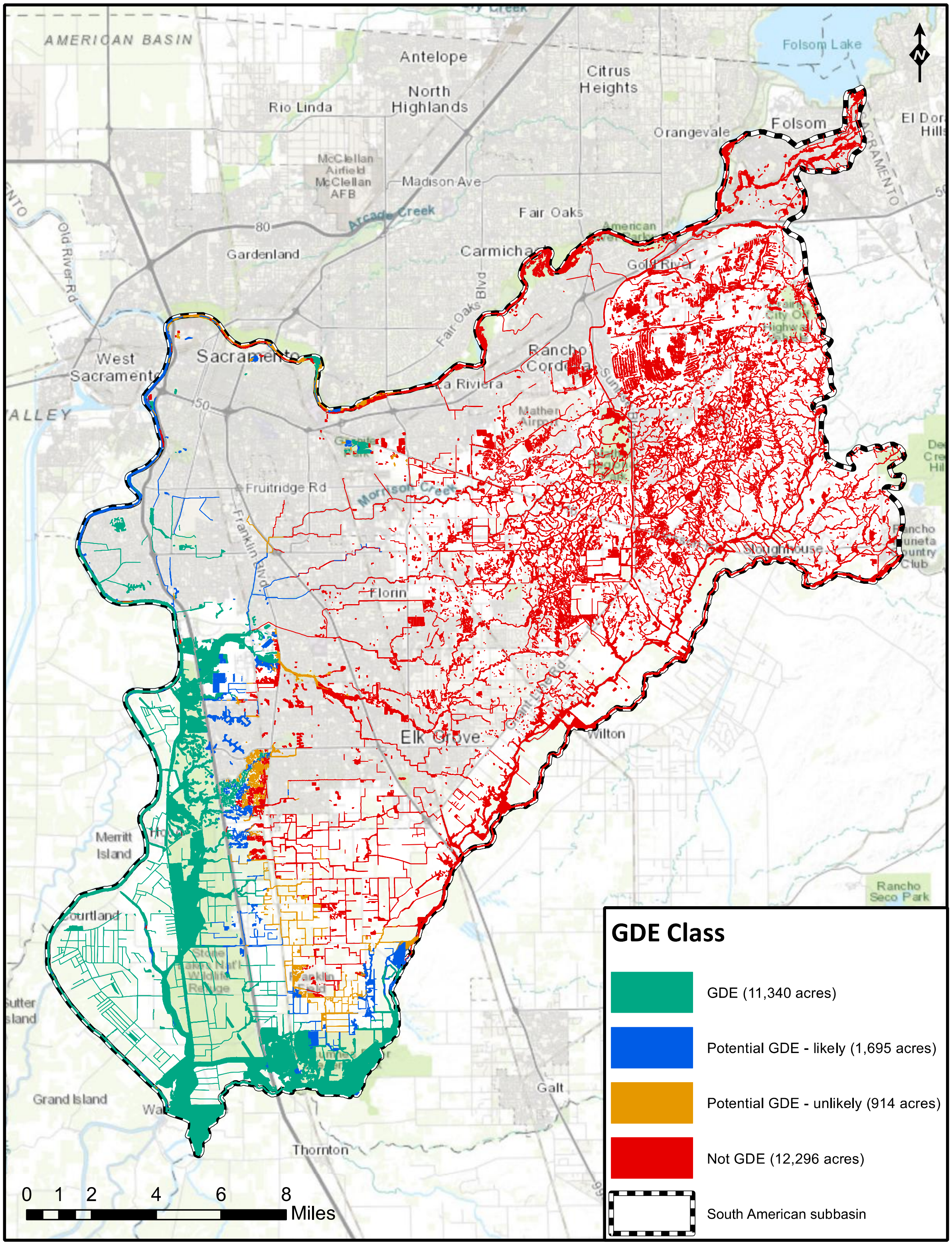


Figure 2-98: GDE likelihood classification of potential GDEs from 2005-2018

2.3.8 Data Gaps

Data gaps were identified for groundwater conditions during the development of the GSP. Many of the data gaps associated with the HCM also affect the understanding of groundwater conditions. Many of these data gaps will be addressed during GSP implementation (see **Section 5**). Additional data gaps are summarized below:

- Vertical gradients in many parts of the subbasin are not well understood due to the lack of wells with completions at different depths located near each other. While hundreds of multiple completion wells are present at the contaminated sites in the northeastern portions of the SASb and SCWA is thought to maintain several multiple completion wells near their facilities, only two multiple completion wells had readily available measurement data within the Subbasin. Both of these wells were located on the eastern portion of the Subbasin and are shallower than 165 feet bgs. Given the limited spatial distribution and well completion depths of these multiple completion wells, vertical gradients could not be analyzed in other areas of the Subbasin and in deeper stratigraphic layers. The development of additional multi-completion wells or cluster wells are recommended, as is efforts to better disseminate data from existing multiple completion monitoring wells. Further, there is inconsistent recent monitoring data in many wells, with a lack of consistency regarding when measurements are taken.

- Certain reaches of the Cosumnes River show sub-seasonal connection but are disconnected on a seasonal level and are hence identified as a Data Gap (Figure 2-98). Paired high-frequency streamflow and groundwater level measurements along this reach will improve understanding of this important natural ecosystem and resource.

2.4 Updated Water Budget

This section provides the data used in water budget development, discusses how the budget was calculated, and provides water budget estimates for historical conditions, current conditions and projected conditions.

The water budget has been updated for the 2027 GSP update to reflect changes made to the groundwater model since the 2022 GSP. The historical model and resulting water budgets have been updated to incorporate additional data that is available through WY 2024-2025. Updates made to the historical model are described in **Section 2.4.1.3** below, and the historical water budget results have been updated in the tables and figures in **Section 2.4.2**. With the exception of minor corrections to the categorization of some water budget components, the water budgets for the current and projected conditions have not changed since the 2022 GSP.

2.4.1 Water Budget Information

Water budgets were developed to provide a quantitative account of water entering and leaving the South American Subbasin (SASb). Water entering the Subbasin includes water entering at the surface and through the subsurface. Similarly, water leaving the Subbasin leaves at the surface and through the subsurface. Water enters and leaves naturally, such as precipitation and streamflow, and through human activities, such as pumping and recharge from irrigation or outdoor water use. **Figure 2-99** highlights the interconnectivity of stream, surface, and groundwater components of the natural and human related hydrologic system used in this analysis.

The water budget provides information on historical, current, and projected conditions as they relate to hydrology, water demand, water supply, land use, population, climate change, groundwater and surface water interaction, and subsurface groundwater flow. This information can assist in management of the Subbasin groundwater and surface water resources, by identifying the scale of different uses, highlighting potential risks, and identifying potential opportunities to improve water supply conditions, among others.

Water budgets can be developed on different scales. In agricultural use, water budgets may be limited to the root zone, improving irrigation techniques by estimating the inflows and outflows of water from the upper portion of the soil accessible to plants through their roots. In a pure groundwater study, water budgets may be limited to water flow within the subsurface. Global climate models simulate water budgets that incorporate atmospheric water, allowing for simulation of climate change conditions. In this document, consistent with the Regulations, the water budget investigates the combined land surface, stream, and groundwater systems for the South American Subbasin.

Water budgets can also be developed at different temporal scales. Daily water budgets may be used to demonstrate how evaporation and transpiration increase during the day and decrease at night. Monthly water budgets may be used to demonstrate how groundwater pumping increases in the dry, hot summer months and decreases in the cool, wet winter months. In this document, consistent with the Regulations, water budgets were developed for monthly periods during a Water Year, which start with October and end with September, because the wet season occurs from November to March.

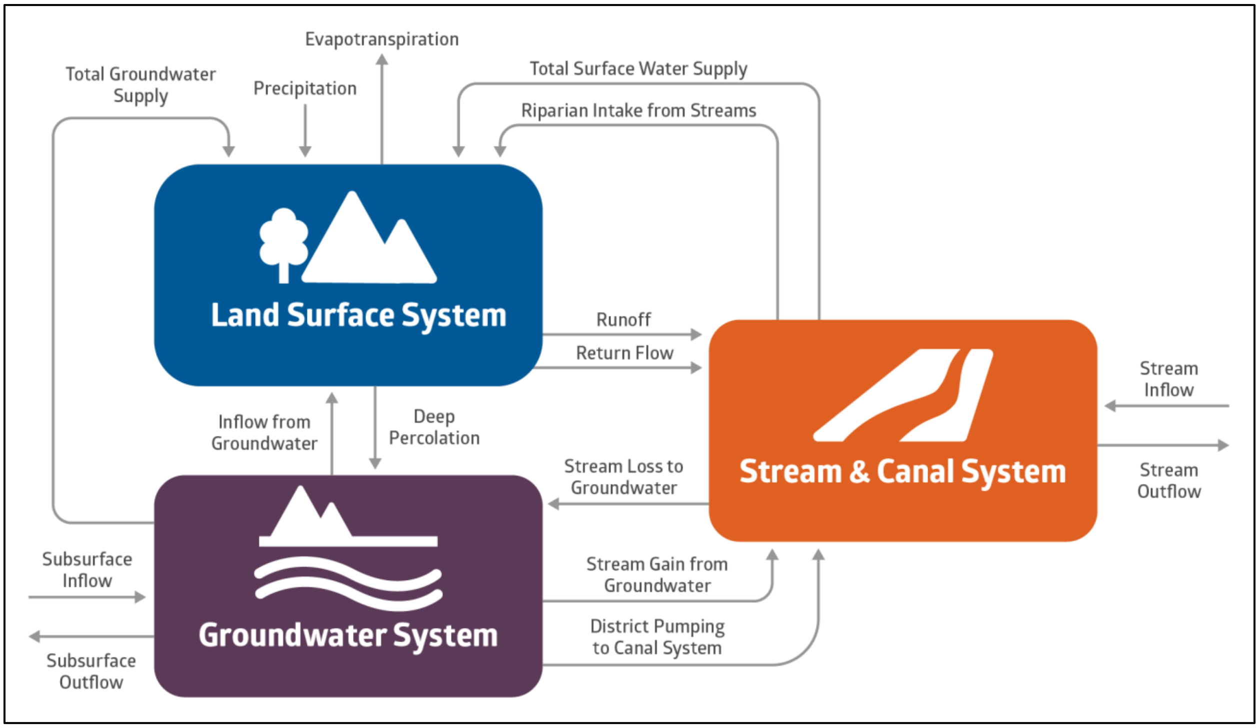


Figure 2-99: Generalized Water Budget Diagram

The Regulations require the annual water budgets be based on three different levels of development: historical, current, and projected conditions. Budgets are developed to capture typical conditions during these time periods. Typical conditions are developed through averaging hydrologic conditions that incorporate droughts, wet periods, and normal periods. By incorporating these varied conditions within the budgets, analysis of the system under certain hydrologic conditions, such as drought, can be performed along with analysis of long-term averages. Information is provided in the following subsections on the hydrology dataset used to identify time periods for budget analysis, the usage of the Cosumnes-South American-North American (CoSANA) model and associated data in water budget development, and on the budget estimates.

2.4.1.1 Identification of Hydrologic Periods

Hydrologic periods were selected to meet the needs of developing historical, current, and projected water budgets. The Regulations require that the projected water budget reflect a 50-year hydrologic period in order to reflect long-term average hydrologic conditions. Precipitation for the South American Subbasin was used to identify hydrologic periods that would provide a representation of wet and dry periods and long-term average conditions needed for water budget analyses.

Rainfall data for the Subbasin is derived from the PRISM (Precipitation-Elevation Regressions on Independent Slopes Model) dataset of the DWR’s CALSIMETAW (California Simulation of Evapotranspiration of Applied Water) model. Identification of periods with a balance of wet and dry periods was performed by evaluating the cumulative departure from mean precipitation. Under this method, the long-term average precipitation is subtracted from annual precipitation within each water year to develop the departure from mean precipitation for each water year. Wet years have a positive departure and dry years have a negative departure; a year with exactly average precipitation would have zero departure. Starting at the first year analyzed, the departures are added cumulatively for each year. So, if the departure for Year 1 is 5 inches and the departure for Year 2 is -2 inches, the cumulative departure would be 5 inches for Year 1 and 3 inches (5 plus -2) for Year 2. **Figure 2-100** illustrate the cumulative departure of the spatially averaged of the rainfall within the Subbasin. The chart includes bars displaying annual precipitation for each water year from 1970 through 2025 and a horizontal line representing the mean precipitation of 19.8 inches. This mean is less than 1 inch per year greater than the long-term (1922-2025) average of 19.2 inches. The cumulative departure from mean precipitation is displayed as a line that starts at zero and highlights wet periods with upward slopes and dry periods with downward slopes. More severe events are shown by steeper slopes and greater changes. Thus, the period from 1976 to 1977 illustrates a short period with a dramatically dry condition (23-inch decline in cumulative departure over 2 years). In addition to the 1976-1977 drought, the 1970-2025 period also includes the extended drought periods of 1987-1992 and 2012-2016 and the historical wet periods of 1982-1983 and 1995-1998.

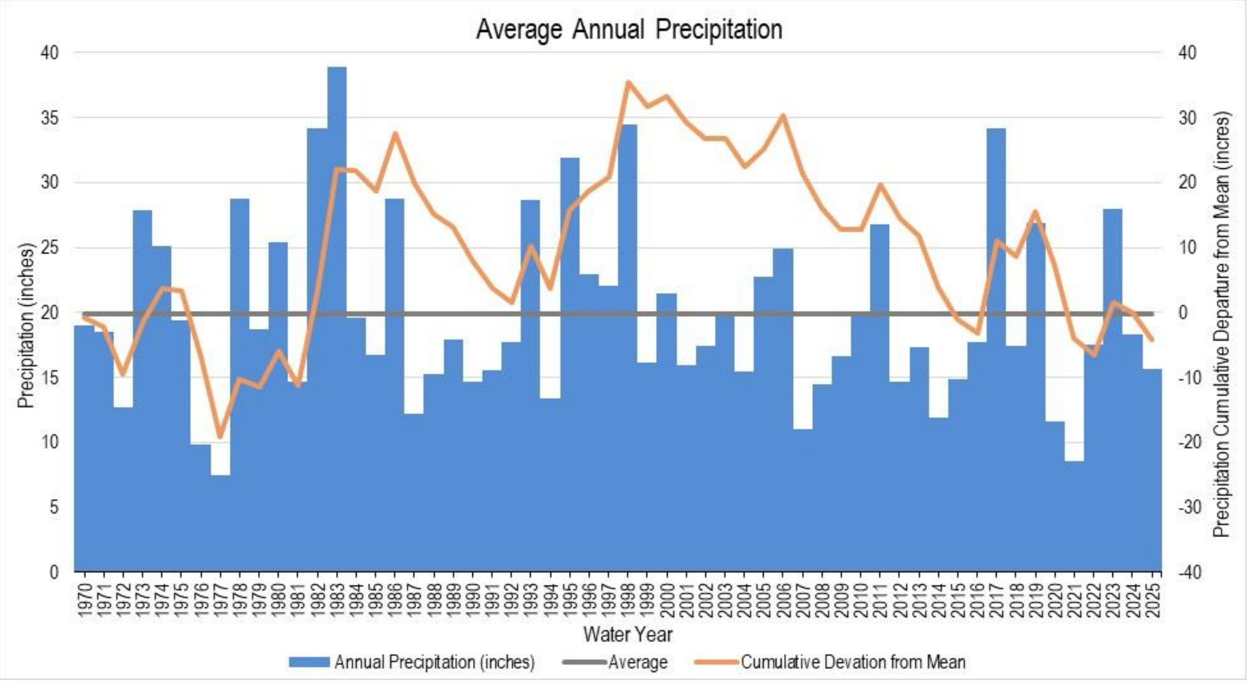


Figure 2-100: 50-Year Historical Precipitation and Cumulative Departure from Mean Precipitation in the South American Subbasin

2.4.1.2 Usage of the CoSANA Model and Associated Data in Water Budget Development

Water budgets were developed utilizing the CoSANA model, a fully integrated surface and groundwater flow model that covers the entire South American Subbasin as well as the adjoining North American and Cosumnes Subbasins. CoSANA was developed in 2021 with the Regional Water Authority (RWA) as the lead agency with collaboration by GSAs in each respective Subbasin. CoSANA is a quasi-three-dimensional finite element model that was developed using the Integrated Water Flow Model (IWFM) 2015 software package to simulate the relevant hydrologic processes prevailing in the region. 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 calibrated for the hydrologic period of October 1994 to September 2025 by comparing simulated evapotranspiration, groundwater levels, and streamflow records with historical observed records. Development of the model involved the study and analyses of hydrogeologic conditions, agricultural and urban water demands, agricultural and urban water supplies, and an evaluation of regional water quality conditions. Two Baseline models were developed reflecting the Current and Projected levels of development for each Subbasin to support the respective GSPs.

Additional information on the data and assumptions used to develop the CoSANA model is included as **Appendix 2-B** to the GSP.

With the CoSANA model as the underlying framework, model simulations were conducted to allow for the estimation of water budgets. Three model simulations were used to establish the water budgets for historical, current, and projected conditions, which are discussed in detail below:

- The **historical water budget** is based on a simulation of historical conditions in the South American Subbasin.
- The **current water budget** is based on a simulation of current (2015) land and water use over historical hydrologic conditions, assuming no other changes in population, water demands, land use, or other conditions.
- The **projected water budget** is based on a simulation of future land and water use over historical hydrologic conditions.

2.4.1.3 CoSANA Model Upgrades in the SASb Area since the 2022 GSP

This section describes the upgrades performed to the CoSANA model in the SASb area to improve representation of the model for the evaluation of historical conditions. The model's representation of current and projected conditions has not been updated since the 2022 GSP.

The hydrologic period of the historical model, which previously included WY 1990 through 2018, was extended to allow for simulation for the period from WY 1990 through 2025. This included the collection and incorporation of stream, hydrological, and water supply data for the period from October 2018 through September 2025, as shown in **Table 2.4-1.**

Table 2.4-1: Summary of Updated CoSANA Model Data

Major Data Category	Minor Data Category	Data Source
Stream Data	Stream Inflow	CDEC and USGS stream gages
Hydrological Data	Precipitation	PRISM
Water Supply	Groundwater Pumping	Local Municipal Water Purveyors
	Surface Water Deliveries	Local Municipal Water Purveyors

In addition, the representation of the wastewater collection network was enhanced by utilizing a new version of the IWFM model that provides the capability to separate the urban stormwater discharge point from the indoor wastewater discharge point. This allowed for indoor water use within the Sacramento Regional County Sanitation District's service area to be routed to their wastewater treatment plant discharge point.

Note that significant additional improvements have been made to the CoSANA model in the NASb area using grant funding provided by DWR. These improvements are described in the technical report *CoSANA Model Upgrade and Refinement for North American Groundwater Subbasin* (NASb) (Woodard & Curran, March 2026). The NASb improvements include incorporation of AEM data, updated land use data, and other improvements that further enhance the simulation of historical, current, and projected conditions. Similar improvements could be made in the future in the SASb area of the model if funding is available.

2.4.1.4 Water Budget Definitions and Assumptions

Definitions and assumptions for the historical, current, and projected water budgets are provided in **Table 2.4-2** and in the sections below.

2.4.1.4.1 Historical Water Budget

The historical water budget is intended to evaluate availability and reliability of past surface water supply deliveries, aquifer response to water supply, and demand trends relative to water year type. The hydrologic period of WY 1990 through 2025 was analyzed to provide a period of representative hydrology while capturing recent operations in the Subbasin. For reporting purposes, the period of 2016 through 2025 was selected to provide the best representation of recent historical conditions. Note that the reporting period has been updated from the period from WY 2009 through 2018 that was previously used in the 2022 GSP. The 10-year period WY 2016 through 2025 has an average annual precipitation of approximately 19.6 inches, compared to the long-term average of 19.8 inches and includes the recent 2020-2022 drought, the wetter years of 2017, 2019, and 2023, and periods of normal precipitation.

2.4.1.4.2 Current Water Budget

While a budget indicative of current conditions could be developed using the most recent historical conditions, like the historical water budget, such an analysis would be difficult to interpret due to the extreme weather conditions of the past several years and its effect on local water system operations. Instead, in order to analyze the long-term effects of current land and water use on groundwater conditions and to accurately estimate current inflows and outflows for the basin, a Current Conditions Baseline scenario is developed using the CoSANA model. This baseline applies current land and water use conditions to historical hydrology.

The Current Conditions Baseline includes the following conditions:

- Hydrologic period:
  - Water Years 1970-2019 (50-year hydrology)
- River flow based on:
  - Historical records from the United States Geological Survey (USGS) and California Data Exchange Center (CDEC), and the simulation of small-stream watersheds
- Land use based on:
  - 2014 statewide California crop mapping
  - 2015 Sacramento County land use survey
  - Local ground truthing and refinement
- Urban water demand based on:
  - 2015 demands as reported in the 2015 Urban Water Management Plan (UWMP)
  - Municipal Pumping Records
- Agricultural water demand based on:
  - 2015 Land use and cropping conditions, adjusted for urban growth areas based on General Plans
  - Irrigation practices are assumed to be similar to those in the 2019 conditions

2.4.1.4.3 Projected Water Budget

The projected water budget is intended to assess the conditions of the Subbasin for estimated projected conditions of water supply, agricultural and urban demand, including quantification of uncertainties in the projected water budget components. The Projected Conditions Baseline applies future land and water use conditions and uses the 50-year hydrologic period of WY 2020-2069, corresponding to historical hydrological conditions from WY 1970-2019. The Project Conditions Baseline is analyzed with and without climate change.

The Projected Conditions Baseline includes the following conditions:

- Hydrologic period:
  - Water Years 1970-2019 (50-year hydrology)
- River flow based on:
  - Historical records from the United States Geological Survey (USGS) and California Data Exchange Center (CDEC), and the simulation of small-stream watersheds
- Land use based on:
  - 2014 statewide California crop mapping
  - 2015 Sacramento County land use survey
  - Agricultural Water Management Plan projections
  - Direct communication on future projections with local agencies
- Urban water demand based on:
  - Decadal population projections from 2015 Urban Water Management Plans (UWMPs) for most users; Sacramento County Water Agency demand is based on draft 2020 UWMP and 2021 Zone 40 Water Supply Master Plan Amendment (SCWA 2021)
- Agricultural water demand based on:
  - 2015 Land use and cropping conditions, adjusted for urban growth areas based on General Plans
  - Irrigation practices are assumed to be similar to those in the 2019 conditions

Table 2.4-2: Summary of Groundwater Budget Assumptions

Water Budget Type	Historical	Current	Projected
Scenario	Historical Simulation	Current Conditions Baseline	Projected Conditions Baseline
Hydrologic Years	WY 1995-2025	WY 1970-2019	WY 1970-2019
Level of Development	Historical	Current	General Plan buildout
Agricultural Demand	Historical Records	Current Conditions	Projected based on projected land use changes
Urban Demand	Historical Records	Current Conditions	Projected based on local UWMP data
Water Supplies	Historical Records	Current Conditions	Projected based on local UWMP data

2.4.2 Water Budget Estimates

For each baseline condition, water budgets have been developed for the stream and canal system, the land surface system, and for the groundwater system.

The water budget components for the stream and canal system are shown separately for the following river reaches:

- American River from Folsom Lake to the confluence with Sacramento River **(Table 2.4-3)**
- Cosumnes River from the Sierra foothills (at SASb boundary) to the Mokelumne River plus the Lower Mokelumne River from the Cosumnes River confluence to the confluence with the Sacramento-San Joaquin Delta (Delta) at the lower SASb boundary **(Table 2.4-4)**
- Sacramento River from the American River to the confluence with the Sacramento-San Joaquin Delta (Delta) at the lower SASb boundary **(Table 2.4-5)**

A composite water budget for these stream reaches is shown in **Table 2.4-6**. The primary components that are reported in each of these tables are:

- Inflows:
    - Upstream inflows
    - Tributary inflows
    - Stream gain from the groundwater system
    - Surface runoff to the stream system
    - Return flow to stream system
- Outflows:
    - Stream losses to groundwater
    - Surface water diversions
    - Riparian evapotranspiration
    - Stream outflows

The primary components of the land surface system in the South American Subbasin (**Table 2.4-7**) are:

- Inflows:
    - Precipitation
    - Surface water supplies
    - Groundwater supplies
    - Recycled water supplies
    - Riparian intake from streams
- Outflows:
    - Evapotranspiration
    - Surface runoff to the stream system
    - Return flow to the stream system
    - Deep percolation

The primary components of the groundwater system in the South American Subbasin (**Table 2.4-8**) are:

- Inflows:
  - Deep percolation
  - Stream losses to the groundwater system
  - Subsurface inflow
- Outflows:
  - Stream gain from the groundwater system
  - Groundwater production
  - Subsurface outflow
- Change in groundwater storage

The estimated water budgets are provided below for the historical, current, and projected water budgets in acre-feet per year (AFY) in the tables below.

Table 2.4-3: Average Annual Water Budget – American River (AFY)

Component	**Historical Condition Water Budget**	**Current Condition Water Budget**	**Projected Condition Water Budget**	**Projected Condition Water Budget with Climate Change**
Hydrologic Period	**WY 2016-2025**	**WY 1970 - 2019**	**WY 1970 - 2019**	**WY 1970 – 2019**
Inflows				
Upstream Inflow	2,872,300	2,688,100	2,688,100	2,337,800
Tributary Inflows[1]	45,900	58,400	66,800	69,100
Stream Gain from Groundwater	33,500	29,400	26,100	24,900
Surface Runoff	-	-	-	-
Return Flow to Streams	16,200	17,800	17,800	17,800
Total Inflow	2,967,900	2,793,700	2,798,700	2,449,500
Outflows				
Stream Losses to Groundwater	44,900	43,900	52,500	53,700
Surface Water Diversions	37,600	43,000	62,900	62,900
Riparian Evapotranspiration[2]	N/A	N/A	N/A	N/A
Flow into Sacramento River	2,885,500	2,706,800	2,683,400	2,333,000
Total Outflow	2,967,900	2,793,700	2,798,700	2,449,500

Notes:

[1] *Local Tributaries include Alder Creek and Buffalo Creek*

[2] *Riparian evapotranspiration is not modeled explicitly on the American River.*

Table 2.4-4: Average Annual Water Budget – Cosumnes River and Lower Mokelumne River (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget	Projected Condition Water Budget with Climate Change
Hydrologic Period	WY 2016-2025	**WY 1970 - 2019**	**WY 1970 - 2019**	**WY 1970 – 2019**
Inflows				
Upstream Cosumnes R Inflow	472,000	378,100	378,100	332,400
Mokelumne R Flow at Cosumnes R Confluence	698,600	615,600	616,400	451,700
Tributary Inflows[1]	206,000	204,300	208,000	201,500
Stream Gain from Groundwater	12,300	12,200	12,000	11,200
Surface Runoff	51,900	51,900	53,300	50,700
Return Flow to Streams	7,900	7,300	8,900	9,200
Total Inflow	1,448,600	1,269,500	1,276,800	1,056,700
Outflows				
Stream Losses to Groundwater	37,500	30,500	31,800	36,500
Surface Water Diversions	7,400	9,500	9,100	9,300
Riparian Evapotranspiration	4,600	4,200	4,200	4,800
Flow into Sacramento-San Joaquin Delta	1,399,100	1,225,200	1,231,700	1,006,100
Total Outflow	1,448,600	1,269,500	1,276,800	1,056,700

Note:

[1] *Local Tributaries include Deer Creek, Badger Creek and Laguna Creek*

Table 2.4-5: Average Annual Water Budget – Sacramento River (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget	Projected Condition Water Budget with Climate Change
Hydrologic Period	**WY 2016-2025**	**WY 1970 - 2019**	**WY 1970 - 2019**	**WY 1970 – 2019**
Inflows				
Sacramento River at Confluence with American R	13,816,300	13,404,800	13,463,900	11,460,500
Upstream Inflow – American River	2,885,500	2,706,800	2,683,400	2,333,000
Tributary Inflows[1]	110,000	142,200	189,100	184,600
Stream Gain from Groundwater	-	-	-	-
Surface Runoff	81,900	82,000	84,900	77,700
Return Flow to Streams[2]	165,100	44,500	65,400	65,800
Total Inflow	17,058,800	16,380,400	16,486,800	14,121,600
Outflows				
Stream Losses to Groundwater	64,500	70,700	75,100	82,700
Surface Water Diversions	77,100	55,300	78,700	78,700
Riparian Evapotranspiration[3]	N/A	N/A	N/A	N/A
Flow into Sacramento-San Joaquin Delta[4]	16,917,300	16,254,400	16,333,000	13,960,200
Total Outflow	17,058,800	16,380,400	16,486,800	14,121,600

Notes:

[1] *Local Tributaries include Morrison Creek*
[2] *Includes the Sac Sewer Discharge*
[3] *Riparian evapotranspiration is not modeled explicitly on the Sacramento River*
[4] *Sacramento River flows into the Delta do not include Lower Mokelumne River flows*

Table 2.4-6: Average Annual Water Budget – Composite of All Major Rivers (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget	Projected Condition Water Budget with Climate Change
Hydrologic Period	**WY 2016-2025**	**WY 1970 - 2019**	**WY 1970 - 2019**	**WY 1970 – 2019**
Inflows				
Upstream Inflow[1]	17,859,300	17,086,600	17,146,500	14,582,300
Tributary Inflows[2]	362,000	404,900	463,900	455,200
Stream Gain from Groundwater	45,700	41,600	38,100	36,000
Surface Runoff	133,800	134,000	138,200	128,400
Return Flow to Streams	189,100	69,700	92,100	92,800
Total Inflow	18,589,900	17,736,800	17,878,900	15,294,800
Outflows				
Stream Losses to Groundwater	146,900	145,100	159,400	172,900
Surface Water Diversions	122,100	107,800	150,600	150,900
Riparian Evapotranspiration	4,600	4,200	4,200	4,800
Flow into Sacramento-San Joaquin Delta	18,316,400	17,479,600	17,564,700	14,966,300
Total Outflow	18,589,900	17,736,800	17,878,900	15,294,800

Notes:

[1] *Upstream inflows include Sacramento River, American River, Cosumnes River, and Mokelumne River flows into the South American Subbasin*

[2] *Local Tributaries include Alder Creek, Badger Creek, Buffalo Creek, Deer Creek, Laguna Creek and Morrison Creek*

Table 2.4-7: Average Annual Water Budget – Land Surface System, South American Subbasin (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget	Projected Condition Water Budget with Climate Change
Hydrologic Period	**WY 2016-2025**	**WY 1970 - 2019**	**WY 1970 - 2019**	**WY 1970 – 2019**
Inflows				
Precipitation	398,800	411,100	411,100	397,200
Total Surface Water Supply				
Municipal and Domestic	84,100	89,000	162,700	162,700
Agricultural	44,700	44,800	44,400	45,200
Total Groundwater Supply				
Municipal and Domestic	49,700	69,200	101,700	101,700
Agricultural	97,200	93,400	86,900	97,400
Ag Residential	22,600	22,600	18,000	19,200
Total Other Water Supply				
Remediated Municipal and Industrial[1]	4,300	4,900	5,000	5,000
Agricultural Reuse	600	600	600	600
Recycled Water	700	900	17,200	17,200
Other Flows[2]	9,600	(5,600)	2,300	2,600
Total Inflow	***712,300***	***730,800***	***849,800***	***848,800***
Outflows				
Evapotranspiration				
Municipal and Domestic	86,800	92,400	146,200	149,400
Agricultural	143,500	143,700	135,700	147,100
Refuge, Native, and Riparian	51,300	53,300	40,800	41,300
Runoff to the Stream System	220,600	220,000	239,000	228,900
Return Flow to the Stream System				
Agricultural	8,100	7,300	6,900	7,600
Municipal and Domestic	87,600	93,000	159,800	159,800
Deep Percolation	*114,400*	*120,900*	*121,300*	*114,700*
Total Outflow	***721,000***	***730,800***	***849,800***	***848,800***

Notes:

[1] Remediated water records represent Golden State Water Company Cordova water from Aerojet. The Current and Projected Conditions estimates are based on last 15-year average records by year types.

[2] Other flows is a closure term that captures the gains and losses due to land expansion and seasonal storage in the root-zone.

Table 2.4-8: Average Annual Water Budget – Groundwater System, South American Subbasin (AFY)

Component	Historical Condition Water Budget	Current Condition Water Budget	Projected Condition Water Budget	Projected Condition Water Budget with Climate Change
Hydrologic Period	**WY 2016-2025**	**WY 1970 - 2019**	**WY 1970 - 2019**	**WY 1970 – 2019**
Inflows				
Deep Percolation	*114,400*	*120,900*	*121,200*	*114,700*
Groundwater Gain from Streams				
American River	24,900	22,100	27,600	28,600
Cosumnes River	21,400	18,200	18,800	20,900
Sacramento River	38,900	37,200	41,200	48,400
Local Tributaries[1]	35,200	36,000	38,100	39,300
Other Recharge				
Groundwater Injection (from ASR and Remediation)	200	200	200	200
Ag Water Conveyance Recharge	200	30	30	30
Subsurface Inflow	35,600	40,200	44,900	46,700
Total Inflow	***270,800***	***274,800***	***292,100***	***298,900***
Outflows				
Groundwater Discharge to Streams				
American River	5,600	7,300	6,800	6,600
Cosumnes River	400	400	400	300
Sacramento River	4,800	3,200	2,700	3,200
Local Tributaries[1]	10,400	11,300	10,200	9,000
Groundwater Production				
Urban and Industrial[2]	49,700	69,200	101,700	101,700
Ag Residential	22,600	22,600	18,000	18,000
Agricultural	97,200	93,400	86,900	98,600
Remediation	28,700	27,600	27,600	27,600
Subsurface Outflow	40,400	37,600	39,000	40,000
Total Outflow	***259,900***	***272,600***	***293,200***	***305,100***
Change in Storage	***10,900***	***2,200***	***(1,100)***	***(6,200)***

Notes:

[1] Local Tributaries include Alder Creek, Deer Creek, Morrison Creek, Beacon Creek, Elder Creek, Buffalo Creek and Laguna Creek.

[2] Under the projected condition with climate change, it is assumed that the total outdoor use is reduced, resulting in no net increase in urban and industrial water use.

2.4.2.1 Historical Water Budget

The historical water budget is a quantitative evaluation of the historical surface and groundwater supply covering the 10-year period from WY 2016 to 2025. This period was selected as the most recent representative hydrologic period to represent recent historical conditions in the subbasin, and is a subset of the CoSANA model calibration period of WY 1995 to 2025. As noted above, the reporting period has been updated since the 2022 GSP, which used the period from WY 2009 through 2018. Because of this, the results presented below and in the tables above are somewhat different from what was presented for the historical water budget in the 2022 GSP. The updated results presented for the period from WY 2016 through 2025 are more representative of recent historical conditions. The goal of the historical water budget analysis is to characterize the supply and demand, while summarizing the hydrologic flow within the Subbasin, including the movement of all primary sources of water such as rainfall, irrigation, streamflow, and subsurface flows.

The existing stream and canal network supplied multiple water users and agencies in the South American Subbasin, including the City of Sacramento, California American Water Company, Golden State Water Company, City of Folsom, Sacramento County Water Agency, and Rancho Murrieta Community Services District. When analyzing the stream and canal system, it is important to note potentially significant effects resulting from the natural interactions and managed operations of adjacent groundwater subbasins. However, because the CoSANA model covers multiple subbasins, it is not always possible to distinguish between stream system inflows and outflows by subbasin. Because of this, the water budget in **Table 2.4-3** through **Table 2.4-5** above attempt to not only quantify the total inflows and outflows on the segments of major rivers adjoining the SASb (i.e. the American, Sacramento, Cosumnes and Mokelumne Rivers). **Figure 2-48** below shows the composite inflows and outflows for portions of the American, Cosumnes, Mokelumne and Sacramento Rivers that are adjacent to the SASb.

During the historical period, average annual surface water inflows of about 17,859,000 acre-feet (AF) entered the CoSANA model boundary via the American, Cosumnes, Mokelumne and Sacramento Rivers. These flows were supplemented by tributary inflows (362,000 AFY), gain from groundwater (46,000 AFY), runoff (134,000 AFY), and direct return flows (189,000 AFY). These volumes were offset by a nearly equal quantity of stream outflows on these river reaches. Most of the streamflows exited the SASb to the Sacramento-San Joaquin Delta (18,300,000 AFY). However, water exited the stream system as Seepage to Groundwater (147,000 AFY), surface water diversions (122,000 AFY), and riparian evapotranspiration (5,000 AFY).

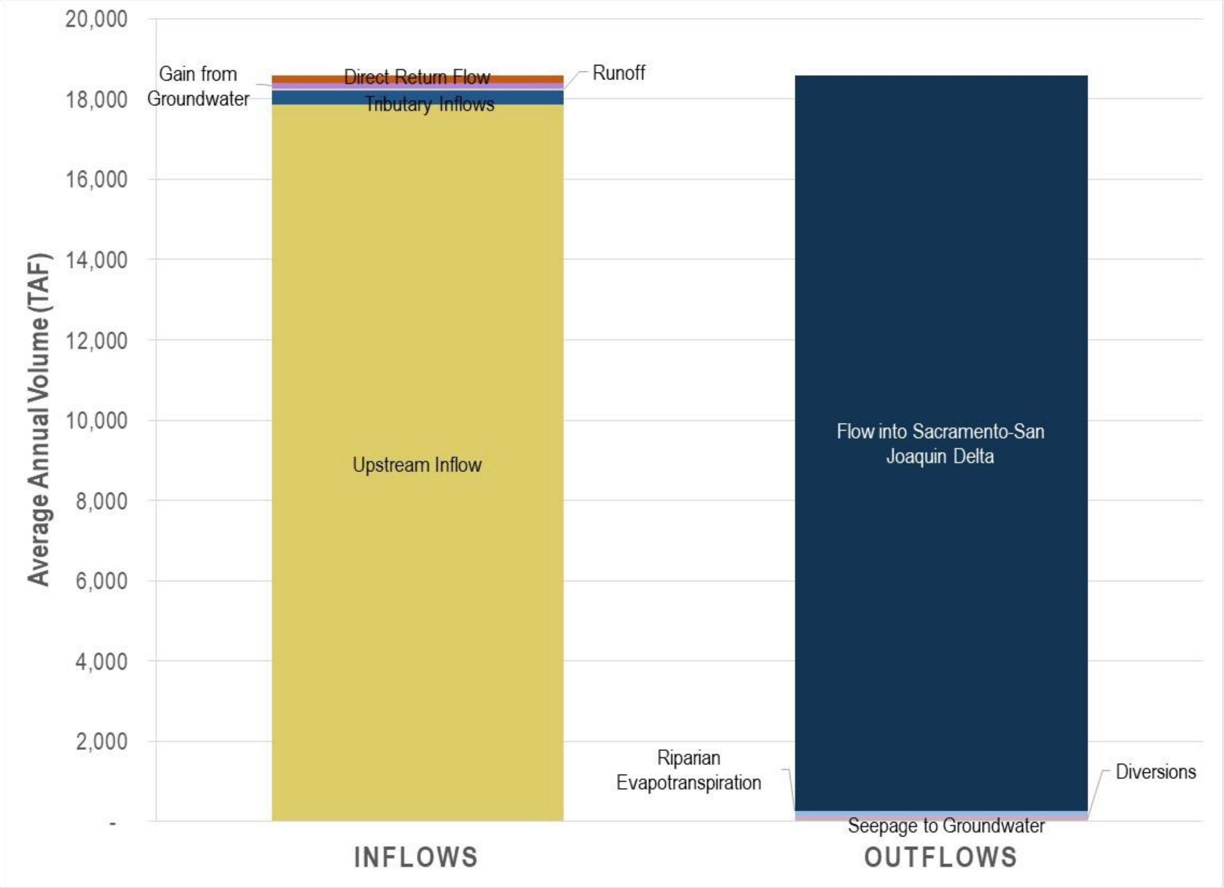


Figure 2-101: Historical Average Annual Water Budget – Stream and Canal Systems, South American Subbasin

The land surface system of the SASb, shown below in **Figure 2-102**, experienced approximately 712,300 AF of inflows each year, a combination of precipitation (398,800 AF), surface water deliveries (128,800 AF), groundwater pumping (169,500 AF), other water supply (5,600 AF) and other flows (9,600 AF). Equivalent to the inflows in magnitude, outflows from the land surface system were comprised of evapotranspiration (281,600 AF), surface runoff (220,600 AF), return flow (95,700 AF) to the stream and canal system, and deep percolation (114,400 AF).

Figure 2-102: Historical Average Annual Water Budget – Land Surface System, South American Subbasin

The groundwater system of the South American Subbasin experienced approximately 270,800 AF of inflows each year, of which 114,400 AF was deep percolation. In addition, streamflow recharged groundwater (120,400 AF), and subsurface inflows (35,600 AF) occurred from the foothills and the neighboring subbasins (primarily North American, Cosumnes and Yolo).

On average, the inflows exceeded the entire groundwater demand. The primary outflow of the groundwater system was pumping (198,200 AF), followed by subsurface flow into neighboring subbasins (40,300 AF) and losses due to local stream-groundwater interaction (21,300 AF).

The SASb average historical groundwater budget has greater inflows than inflows, leading to an average annual increase in groundwater storage of about 10,900 AF. **Figure 2-103** summarizes the average historical groundwater inflows and outflows in the SASb.

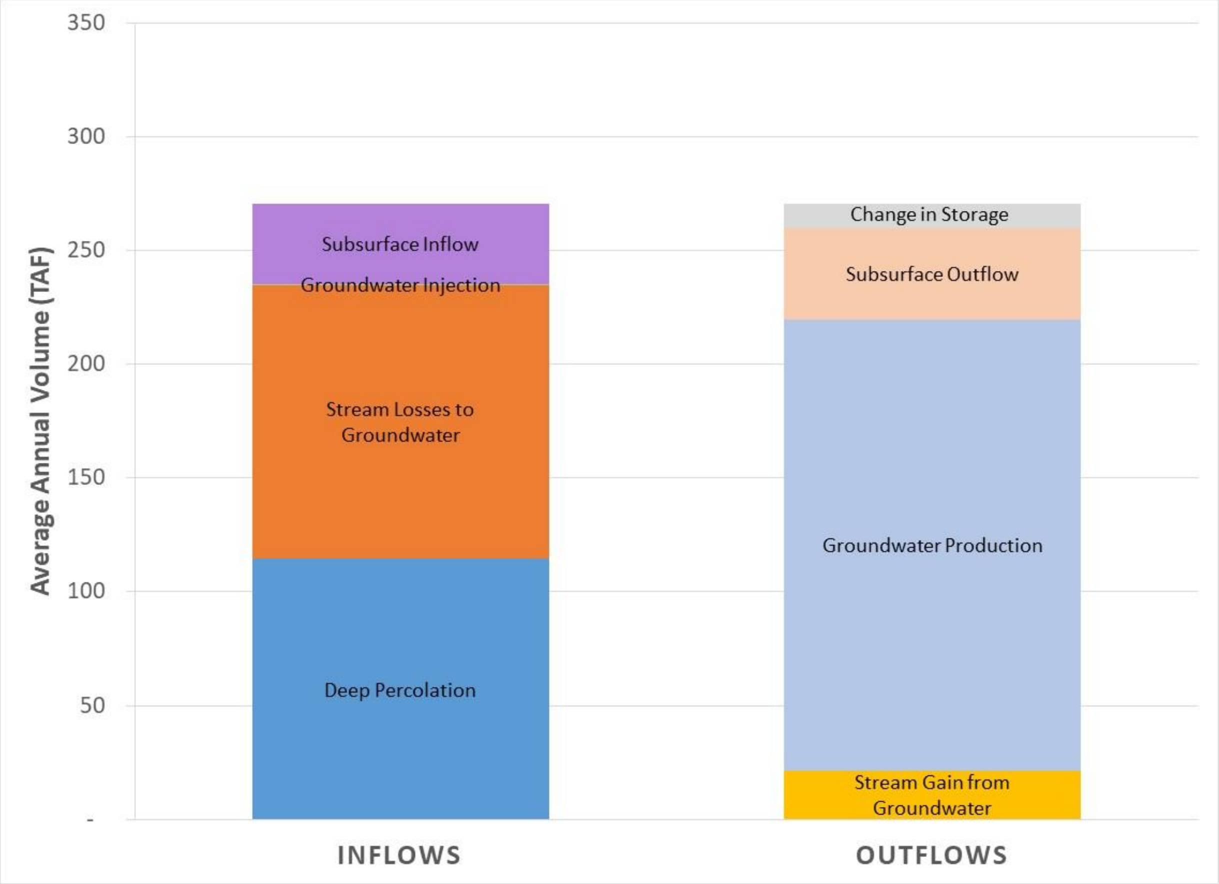


Figure 2-103: Historical Average Annual Water Budget – Groundwater System, South American Subbasin

The historical inflows and outflows changed by water year type. In wet years, precipitation met some of the water demand, and greater availability to surface water reduced the need for groundwater. However, in dry years, more groundwater was pumped to meet the agricultural demand not met by surface water or precipitation, which lead to an increase in groundwater storage in wet years and a decrease in dry years. While demand of applied water increased in dry years due to lack of precipitation, surface water supply remained consistent in most non-critical years. Note the surface water supply in this water budget is reflective of the volume available to the grower, and thus does not include operational spills, canal seepage or evaporative losses. **Table 2.4-9** breaks down the average historical water supply and demand by water year type for the 2016-2025 period.

Table 2.4-9: Average Annual Values for Key Components of Water Budget by Year Type (AFY)

Component	Water Year Type (Sacramento River Index)					
	Wet	Above Normal	Below Normal	Dry	Critical	10-Year Average WY 2016-2025
Water Demand						
Ag Demand	150,900	159,400	170,000	170,200	181,700	164,500
Urban Demand	132,400	144,800	132,500	139,100	145,300	138,800
Total Demand	***283,300***	***304,200***	***302,600***	***309,300***	***327,000***	***303,400***
Water Supply						
Total Surface Water Supply						
Agricultural	42,800	46,500	43,200	43,400	47,600	44,700
Urban	85,100	103,100	81,800	84,400	89,700	89,100
Total Groundwater Supply						
Agricultural	85,500	90,300	104,200	104,200	111,500	97,200
Ag Residential	22,600	22,600	22,600	22,600	22,600	22,600
Urban	47,300	41,700	50,700	54,700	55,600	49,700
Remediation						
Total Supply	283,300	304,200	302,600	309,300	327,000	303,400
Change in GW Storage	***65,800***	***18,600***	***-23,300***	***-21,300***	***-29,800***	***10,900***

2.4.2.2 Current Water Budget

The current water budget quantifies inflows to and outflows from the basin using 50-years of hydrology in conjunction with 2015 water supply, demand, and land use information. These conditions are incorporated in the Current Conditions Baseline simulation of the CoSANA model. **Figure 2-107** summarizes the average projected inflows and outflows in the South American Subbasin surface water network.

In the Current Conditions Baseline, average annual surface water inflows of about 17,090,000 acre-feet (AF) enters the CoSANA model boundary via the American, Cosumnes, Mokelumne and Sacramento Rivers. These flows are supplemented by tributary inflows (400,000 AFY), gain from groundwater (42,000 AFY), runoff (52,000 AFY), and direct return flows (152,000 AFY). These volumes are offset by a nearly equal quantity of stream outflows on these river reaches. Most of the streamflows exit the SASb to the Sacramento-San Joaquin Delta (17,480,000 AFY). However, water exited the stream system as seepage to groundwater (145,000 AFY), surface water diversions (108,000 AFY), and riparian evapotranspiration (4,000 AFY).

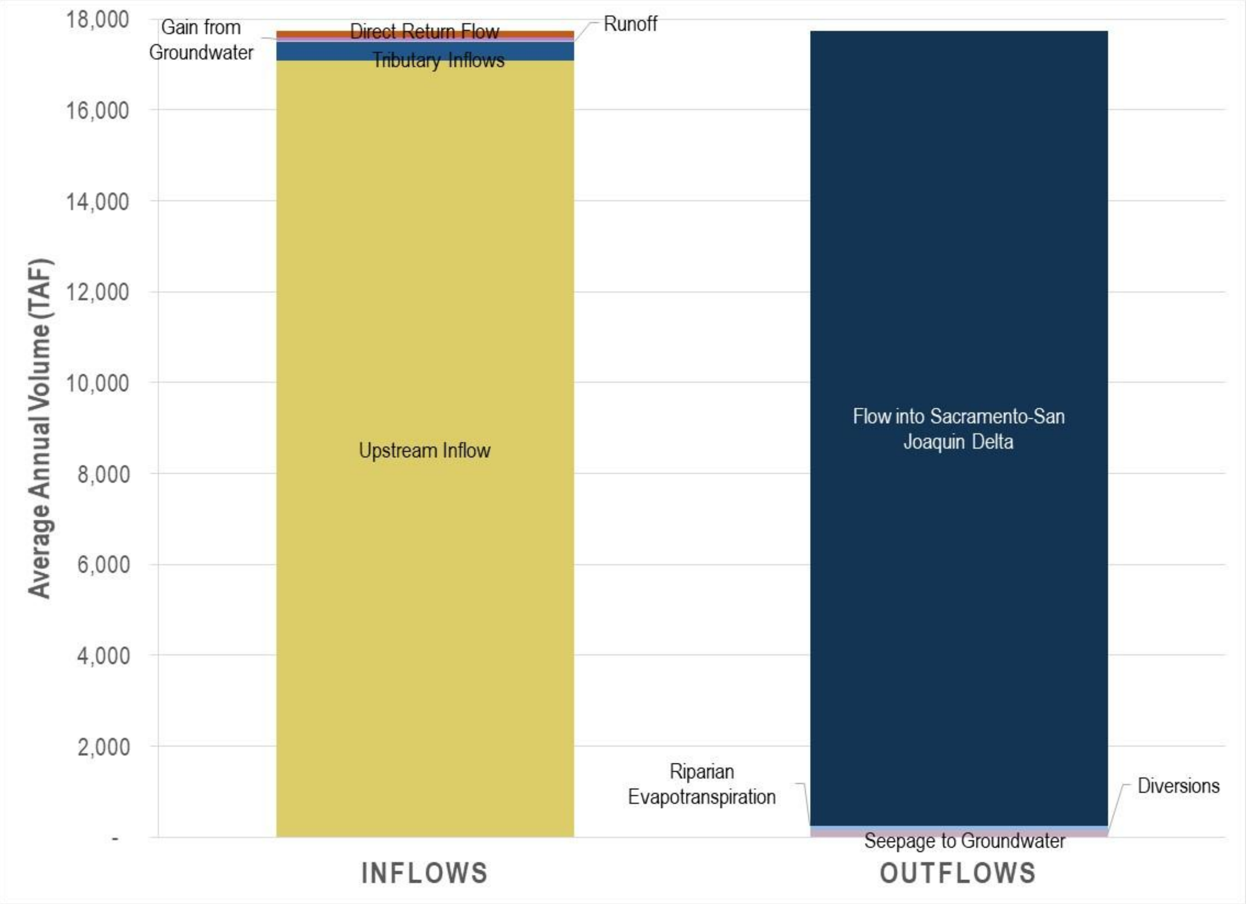


Figure 2-104: Current Conditions Average Annual Water Budget – Stream and Canal Systems, South American Subbasin

Based on pre-drought cropping patterns and 2015 urban buildout, over the simulation period, the Current Conditions land surface water budget includes annual inflows of 730,800 AF, including 411,100 AF of precipitation and 325,300 AF of applied water (138,700 AF of surface water, 185,200 AF of groundwater, and 1,400 AF of other water supplies). To balance the Current Conditions Baseline land surface water budget, the 730,800 AF of outflows includes evapotranspiration (289,500 AF), surface runoff to the stream system (220,000 AF), return flow to the stream system (100,300 AF), deep percolation (120,900 AF), and other flows (5,600 AF). **Figure 2-105** summarizes the average annual current condition inflows and outflows in the SASb land surface budget.

There are small but important differences between the historical and current conditions land surface system water budget. First, the current conditions baseline uses a 50-year hydrology that is more similar to long-term average precipitation conditions in the SASb, while the 2009-2018 recent historical period is slightly drier. The more normal conditions are shown as higher precipitation inflows under the current conditions baseline. Surface water supplies increased by approximately 8%, largely due to the current conditions baseline's incorporation of SCWA's Vineyard Surface Water Treatment Plant throughout the full simulation period, while this facility was only online for the last eight years of the historical simulation. Water supplies under the current condition baseline showed a small shift from agricultural uses to urban uses, as the current condition baseline represented recent development across the full simulation. These changes in land use are also reflected in changes in evapotranspiration, runoff, and return flow. These differences are relatively small, but can have impacts over longer timeframes.

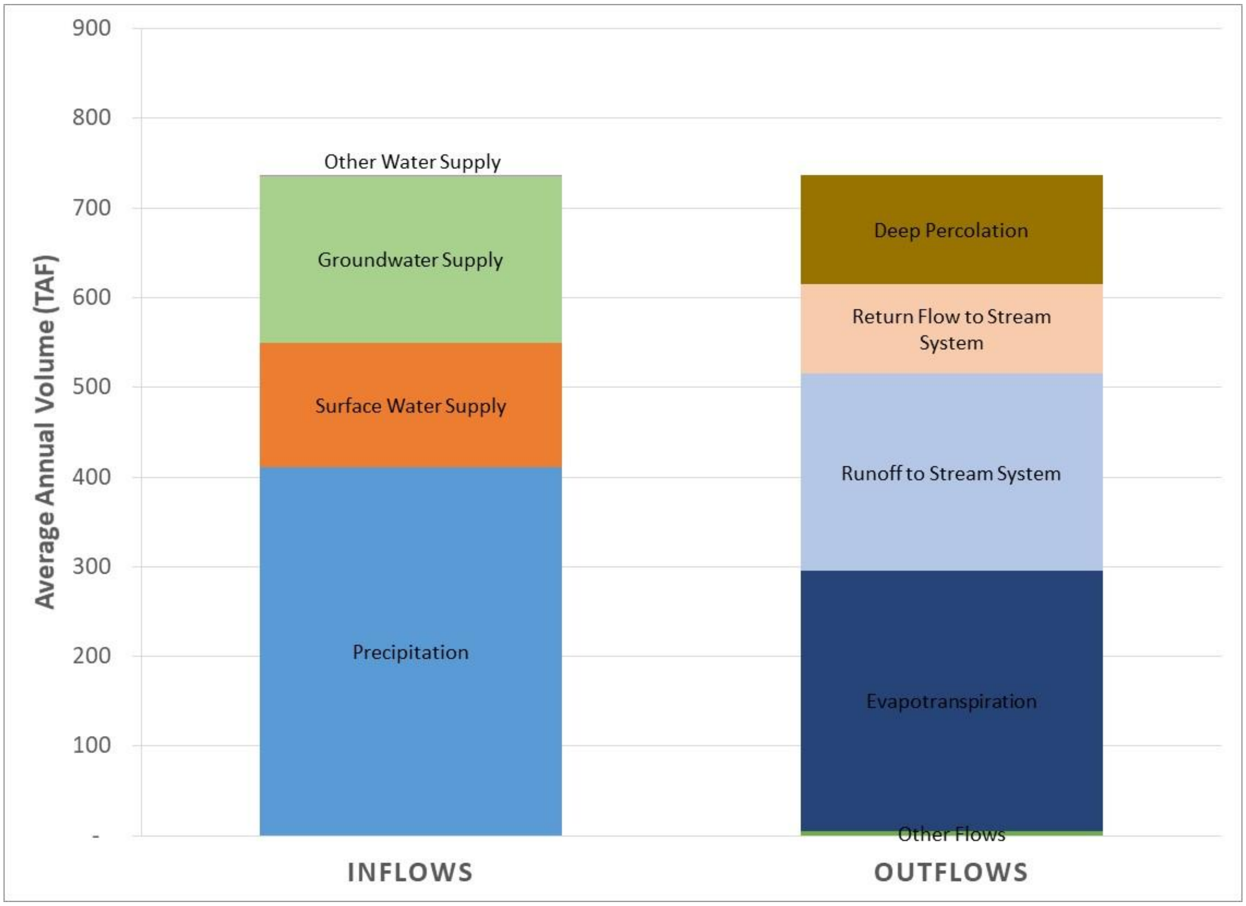


Figure 2-105: Current Conditions Average Annual Water Budget – Land Surface System, South American Subbasin

Over the 50-year simulation period, the Current Conditions groundwater water budget includes annual inflows of 274,800 AF, including 120,900 AF of deep percolation, 113,500 AF of stream and canal seepage, subsurface inflows totaling 40,200 AF, and groundwater injection of 200 AF.

Similar to the historical water budget, average aquifer inflows exceed the outflows under Current Conditions. Groundwater production (212,800 AF) remained the largest point of aquifer discharge, with losses to the local stream system (22,100 AF), and subsurface outflows (37,600 AFY) bringing the total system outflows to 272,600 AF annually.

The SASb Current Conditions groundwater budget has an average annual surplus in groundwater storage of about 2,200 AF. **Figure 2-106** summarizes the average current conditions groundwater inflows and outflows in the South American Subbasin.

Similar to the land surface system water budget, the groundwater system water budget shows the influences of slightly different hydrologic conditions, increased surface water use, and conversion of agricultural land to urban land uses between the historical conditions and current conditions, but also shows influences of slightly higher groundwater levels. Deep percolation from precipitation is higher in the current conditions baseline compared to historical conditions due to the drier conditions in the historical conditions time period. Increased urban surface water use is largely driven by SCWA's Vineyard Surface Water Treatment Plant, which came online in the early portions of the historical condition time period (2012), but is included across the full simulation in the current condition baseline. Finally, conversion of agricultural land to urban land occurring during the historical period is phased in during the historical simulation, but included as urban throughout the current condition baseline, resulting in more urban applied water and groundwater pumping in the current condition and less agricultural applied water and groundwater pumping. The current conditions groundwater system water budget also shows slightly lower levels of stream losses and higher levels of stream gains, likely due to higher groundwater levels under current conditions compared to those in the historical conditions. These differences are relatively small, but can have impacts over longer timeframes.

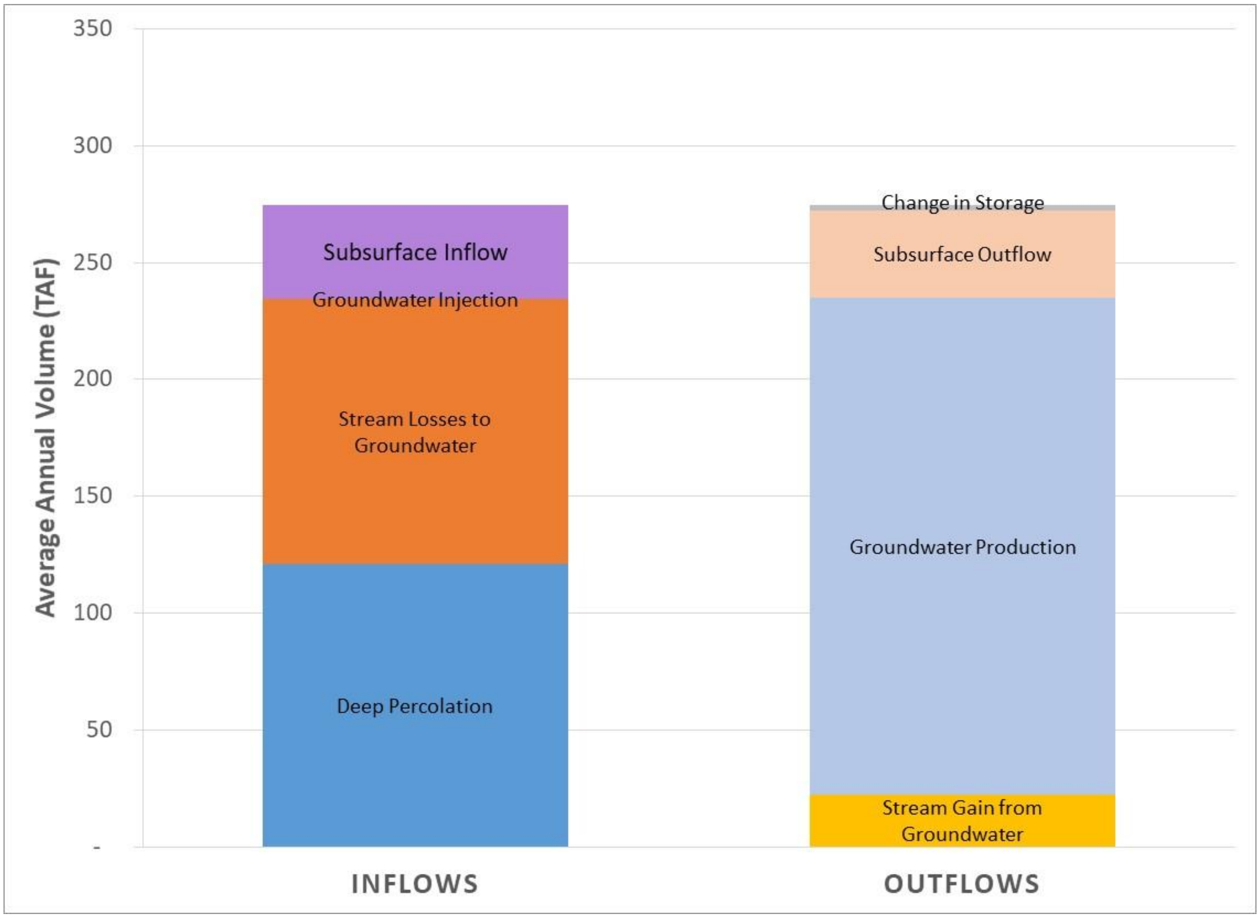


Figure 2-106: Current Conditions Average Annual Water Budget – Groundwater System, South American Subbasin

2.4.2.3 Projected Water Budget without Climate Change

The projected water budget is used to estimate future baseline conditions of supply, demand, and aquifer response to plan implementation. The Projected Conditions Baseline without climate change simulation of the CoSANA model is used to evaluate the projected conditions of the water budget using the unadjusted hydrology from 1970 to 2019. As previously discussed, this approach utilizes a hydrologic period of 50 years and has average precipitation similar to the long-term average. Development of the projected water demand is based on the population growth trends reported in 2015 UWMPs, general plans, and other planning documents, or current information provided by purveyors.

In the Projected Conditions Baseline without climate change, average annual surface water inflows of about 17,150,000 acre-feet (AF) enter the CoSANA model boundary via the American, Cosumnes, Mokelumne and Sacramento Rivers. These flows are supplemented by tributary inflows (464,000 AFY), gain from groundwater (38,000 AFY), runoff (74,000 AFY), and direct return flows (156,000 AFY). These volumes are offset by a nearly equal quantity of stream outflows on these river reaches. Most of the streamflows exit the Sacramento-San Joaquin Delta (17,560,000 AFY) and water also exits the stream system as seepage to groundwater (160,000 AFY), surface water diversions (151,000 AFY), and riparian evapotranspiration (4,000 AFY).

Figure 2-107 summarizes the average projected inflows and outflows in the South American Subbasin surface water network.

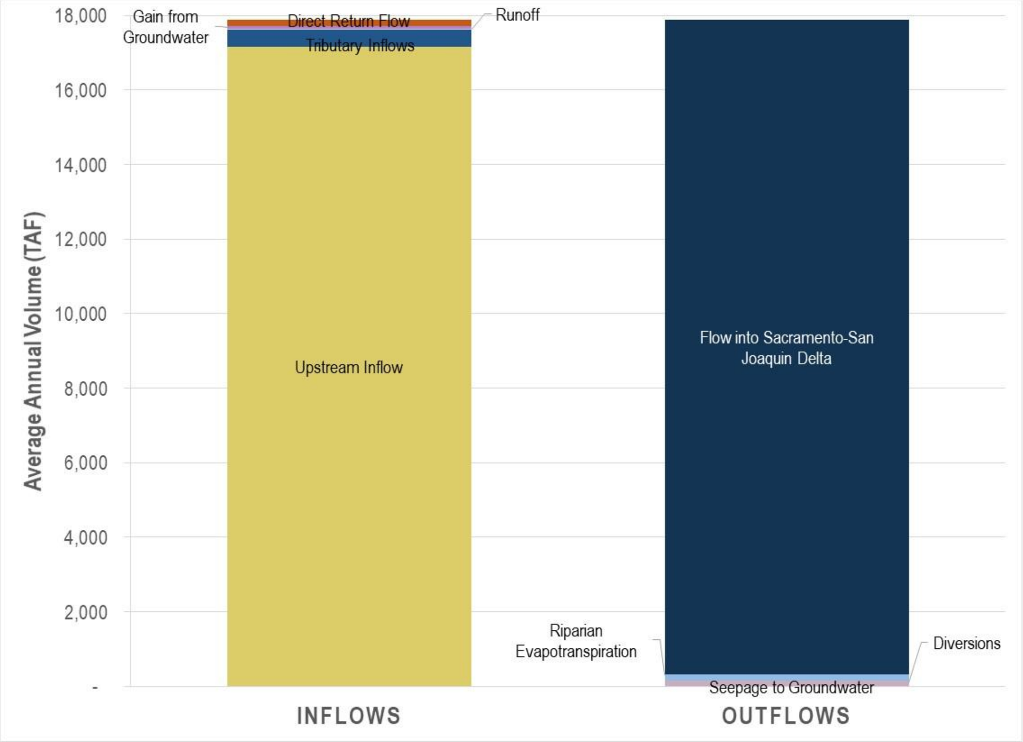


Figure 2-107: Projected Conditions Without Climate Change Average Annual Water Budget – Stream and Canal Systems, South American Subbasin

Based on pre-drought cropping patterns and projected urban buildout, over the simulation period, the Projected Conditions without climate change land surface water budget simulates annual inflows of 849,800 AF, including 411,100 AF of precipitation, 436,400 AF of applied water (212,000 AF of surface water. 206,600 AF of groundwater, and 17,800 AF of other water supplies), and 2,300 AF of other flows. To balance the Projected Conditions without climate change Baseline land surface water budget, the 859,800 AF of outflows include evapotranspiration (322,800 AF), surface runoff to the stream system (239,000 AF), return flow to the stream system (166,700 AF), and deep percolation (121,300 AF). A summary of these flows can be seen below in **Figure 2-108.**

There are several key differences between the current and projected conditions land surface system water budget. The conversion from agricultural and native to urban land uses increases urban water supplies from both groundwater and surface water sources, with the bulk of increased surface water use at the Vineyard Surface Water Treatment Plant and from developments within the City of Folsom and Golden State Water Company. Some of this additional urban supply is met by remediation water, which shows a large increase over current conditions. Agricultural water supplies decline due to reduced acreage in cultivation. These changes in inflows are also reflected in the outflows, with increased urban land and water use resulting in increased urban evapotranspiration, urban return flow, and runoff. Conversely, reduced agricultural uses and native lands results in lower levels of evapotranspiration and return flow from these areas.

Figure 2-108: Projected Conditions Without Climate Change Average Annual Water Budget – Land Surface System, South American Subbasin

Over the simulation period, the Projected Conditions without climate change groundwater water budget include annual inflows of 292,100 AF, including 121,300 AF of deep percolation, 125,700 AF of stream and canal seepage, and subsurface inflows totaling 44,900 AF.

In contrast to the current conditions water budget, average aquifer outflows exceed the inflows under Projected Conditions without climate change. Groundwater production (234,200 AF) remains the largest point of aquifer discharge, with losses to the local stream system (20,000 AF), and subsurface outflows (39,000 AFY) bringing the total system outflows to 293,200 AF annually.

The SASb Projected Conditions without climate change groundwater budget has an average annual deficit in groundwater storage of about 1,100 AF. **Figure 2-109** summarizes the average projected groundwater inflows and outflows in the South American Subbasin.

Similar to the land surface system water budget, the groundwater system water budget shows the influences of land conversion and changes to water supplies when compared to the current conditions budget. Deep percolation from precipitation is lower in the projected conditions baseline compared to current conditions largely due to the changes in land use and increase in impervious surfaces that comes with urban development. Changes in deep percolation of applied water are largely the result of changes in volumes of water supplies, as noted within the land surface system budget. Stream losses increase in the projected condition baseline in comparison to the current condition baseline due to lower groundwater levels caused largely by increases in pumping for urban uses and increases in runoff from urban land.

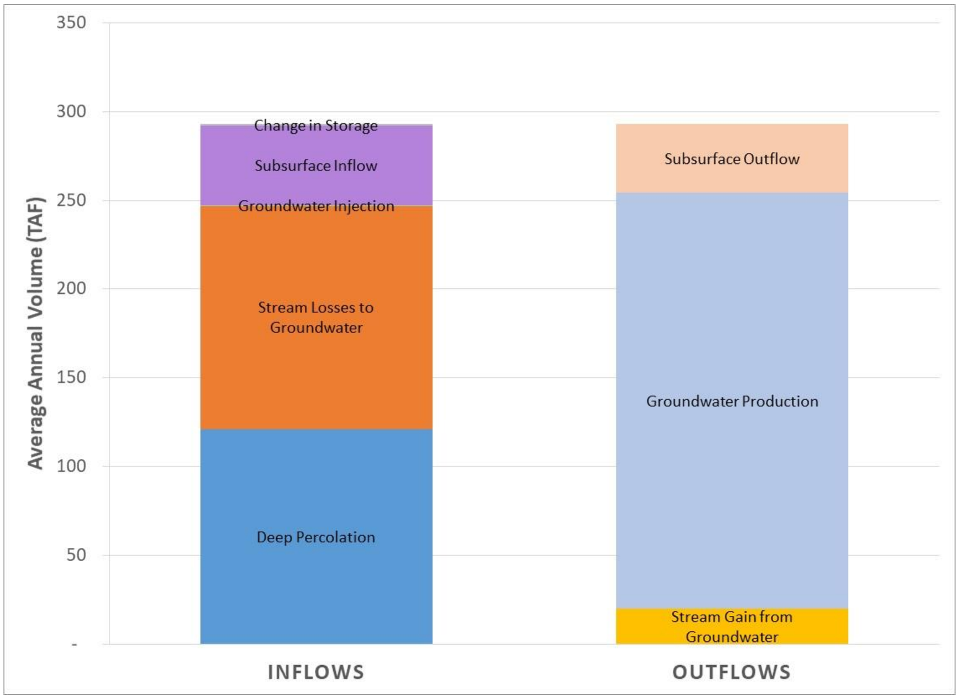


Figure 2-109: Projected Conditions Without Climate Change Average Annual Water Budget – Groundwater System, South American Subbasin

2.4.2.4 Projected Water Budget with Climate Change

The Projected Conditions Baseline with climate change simulation of the CoSANA model is used to evaluate the projected conditions of the water budget using the hydrology from 1970 to 2019, adjusted for projected climate change. As previously discussed, this approach utilizes a hydrologic period of 50 years and has average precipitation similar to the long-term average. In order to incorporate the climate change conditions, precipitation, stream inflow, and evapotranspiration time series data from the projected conditions baseline were modified using the findings from the American River Basin Study (ARBS) (Reclamation, in press). Other model data did not change from the Projected Conditions Baseline without climate change.

The ensemble of climate models used in the ARBS found clear trends with projected temperature changes. Precipitation trends were not found to be as consistent with around half of the projections indicating an increase in precipitation, and the other half indicating a decrease in precipitation. The study includes a suite of future climate scenarios that include three future periods: 2040-2069, 2055-2084, and 2070-2099. For each of these periods, a suite of five climate scenarios was developed, based on percentiles of projected changes to simulate possible temperature and precipitation effects: Warm-Wet, Warm-Dry, Hot-Wet, Hot-Dry, and Central-Tendency scenarios. Upon evaluation of the five climate scenarios, the Central Tendency (CT) was selected for the purpose of groundwater sustainability planning, because it was determined that the CT has the highest probability and likelihood to be experienced. Other climate scenarios are subject to significantly more uncertainty and less likely to occur. Therefore, the 2070 Central-Tendency (2070CT) conditions was selected as the representative future climate change scenario. Additionally, a sensitivity of the Subbasin conditions to the 2070 Hot and Dry scenario was assessed and is described in **Section 2.4.2.5**.

In the Projected Conditions Baseline with climate change, average annual surface water inflows of about 14,580,000 acre-feet (AF) travel enter the CoSANA model boundary via the American, Cosumnes, Mokelumne and Sacramento Rivers. These flows are supplemented by tributary inflows (460,000 AFY), gain from groundwater (36,000 AFY), runoff (75,000 AFY), and direct return flows (146,000 AFY). These are offset by a nearly equal quantity of stream outflows on these river reaches. Most of the streamflows exits the Sacramento-San Joaquin Delta (15,000,000 AFY), and water also exits the stream system as seepage to groundwater (173,000 AFY), surface water diversions (151,000 AFY), and riparian evapotranspiration (5,000 AFY).

Figure 2-110 summarizes the average projected inflows and outflows in the South American Subbasin surface water network.

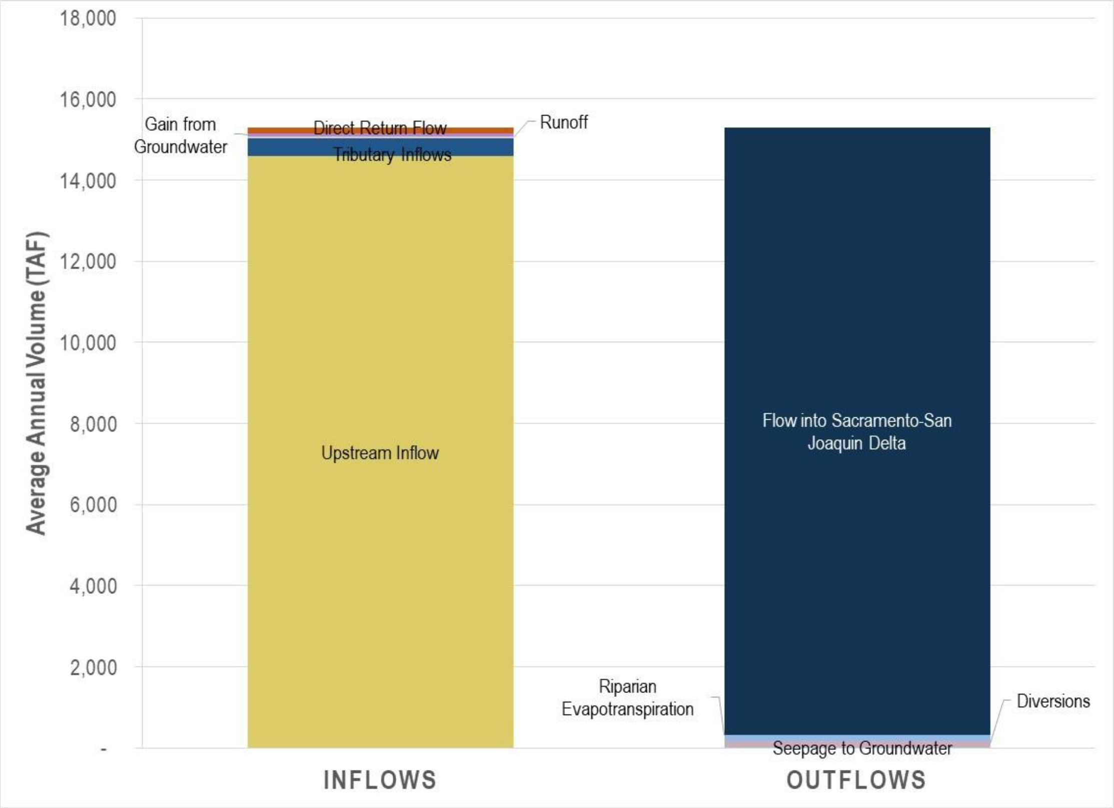


Figure 2-110: Projected Conditions With Climate Change Average Annual Water Budget – Stream and Canal Systems, South American Subbasin

Based on pre-drought cropping patterns and projected urban buildout along with climate change, over the simulation period, the Projected Conditions with climate change land surface water budget includes annual inflows of 848,800 AF, including 397,200 AF of precipitation, 443,900 AF of applied water (212,800 AF of surface water, 218,300 AF of groundwater, and 17,800 AF of other water supplies), and 2,600 AF of other flows. To balance the Projected Conditions without climate change Baseline land surface water budget, the 848,800 AF of outflows include evapotranspiration (337,800 AF), surface runoff to the stream system (228,900 AF), return flow to the stream system (167,300 AF), and deep percolation (114,700 AF). A summary of these flows can be seen below in **Figure 2-111.**

With land and water use conditions the same between the projected conditions baseline and the projected conditions with climate change baseline, the differences between the two associated land surface systems budgets are the result of climate change hydrology. The most substantial changes in the budget are a decrease in precipitation and an increase in agricultural evapotranspiration. These factors result in an increase in irrigation needs for agricultural lands and an associated increase in agricultural groundwater production.

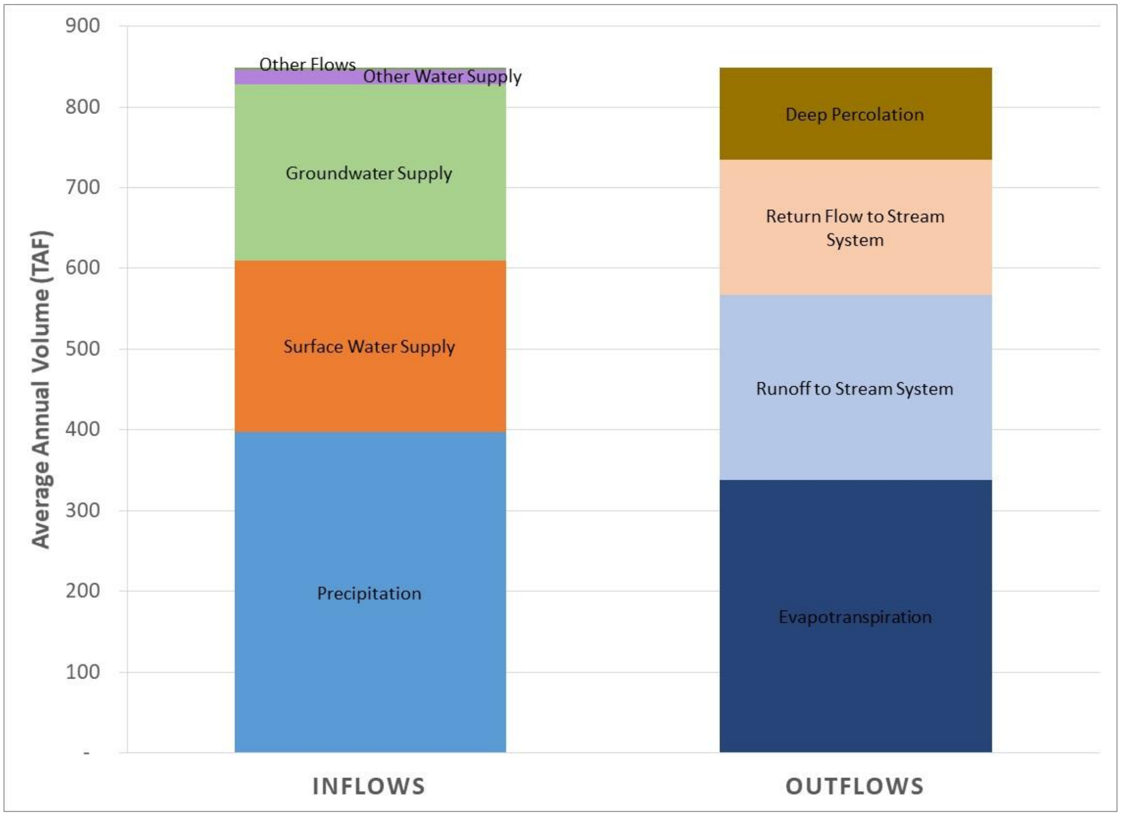


Figure 2-111: Projected Conditions With Climate Change Average Annual Water Budget – Land Surface System, South American Subbasin

Over the simulation period, the Projected Conditions with climate change groundwater water budget includes annual inflows of 298,900 AF, including 114,700 AF of deep percolation, 137,200 AF of stream and canal seepage, and subsurface inflows totaling 46,700 AF.

As with the Projected Conditions without climate change water budget, average aquifer outflows exceed the inflows under Projected Conditions with climate change. Groundwater production (246,000 AF) remains the largest point of aquifer discharge, with losses to the local stream system (19,100 AF), and subsurface outflows (40,000 AFY) bringing the total system outflows to 305,100 AF annually.

The SASb Projected Conditions with climate change groundwater budget has an average annual deficit in groundwater storage of about 6,200 AF. **Figure 2-112** summarizes the average projected groundwater inflows and outflows in the South American Subbasin.

Similar to the land surface system water budget, the groundwater system water budget shows the influences of climate change when compared to the projected conditions budget. Changes are largely the result of increased agricultural pumping resulting from climate increases in demand. This increase in outflow is a large component of increased stream losses, which is the largest change to inflows and is the result of lowered groundwater levels near the rivers and streams due primarily to increased pumping and decreased deep percolation.

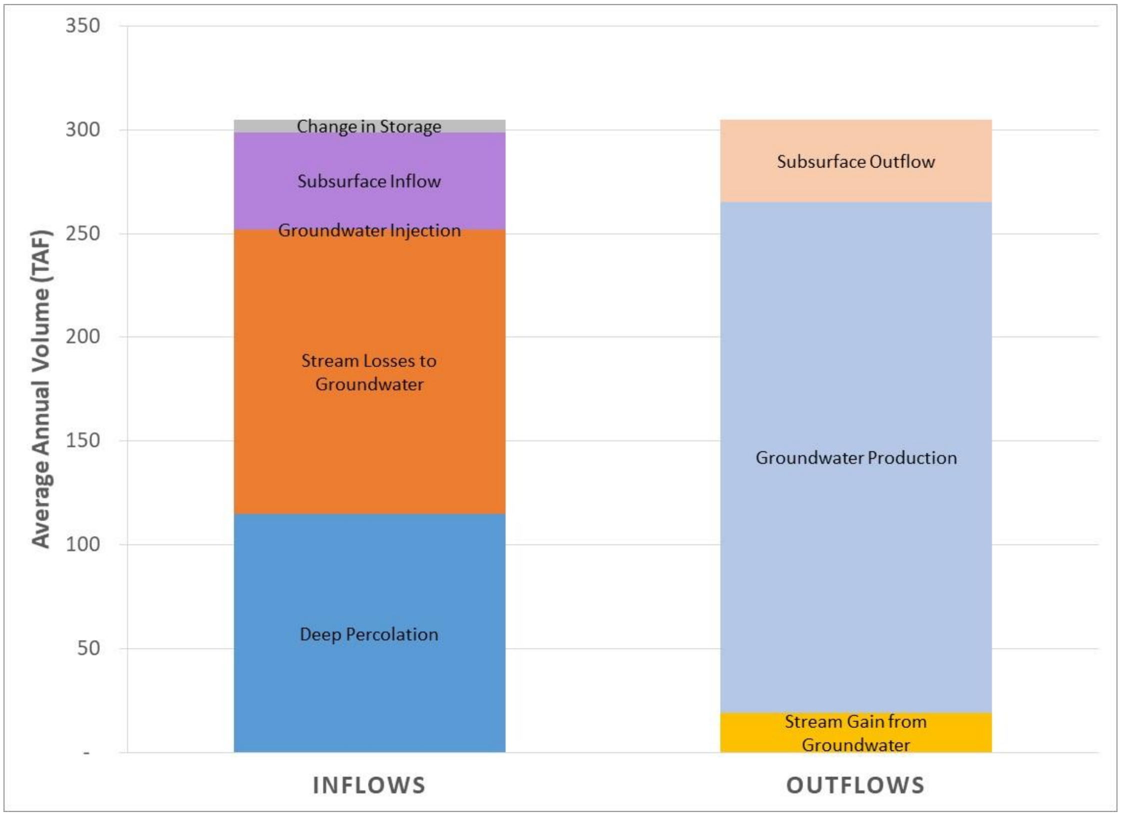


Figure 2-112: Projected Conditions With Climate Change Average Annual Water Budget – Groundwater System, South American Subbasin

2.4.2.5 Hot-Dry Climate Change Scenario Sensitivity Analysis

To assess the effects of a hot and dry future climate, a climate-change sensitivity analysis was performed using the 2070 Hot-Dry (2070HD) conditions to simulate more extreme changes to hydrology. The 2070HD scenario was analyzed as an extreme case to determine the potential effects of the 2070HD scenario on the groundwater and surface water systems. 2070HD climate scenario indicates a potentially lower overall precipitation, and higher temperature than the 2070CT. A comparison of the SASb groundwater budget under the 2070CT and 2070HD climate scenarios is shown in **Table 2.4-10** below.

Table 2.4-10: Projected Conditions Groundwater Budgets under the 2070 Central Tendency and Hot-Dry Climate Scenarios

Model Scenario	Groundwater Pumping (AFY)	Deep Percolation (AFY)	Gain from Stream (AFY)	Boundary Inflows (AFY)	Subsurface Inflow (AFY)	Change in Storage (AFY)
PCBL+CC (2070CT)	245,800	114,700	118,200	6,200	400	-6,200
PCBL+CC (2070HD)	250,400	110,600	122,800	7,100	600	-9,400

The 2070HD scenario can potentially result in an overall increase in pumping of ~2% above the 2070CT. This is largely due to increased evapotranspiration resulting in an increase in agricultural demand. Decreases in deep percolation are largely attributable to decreasing precipitation percolation. Increases in stream seepage, boundary inflows, and subsurface inflows are all due to lower projected groundwater levels expected under the 2070HD scenario. The overall average annual groundwater storage deficit changes from 6,200 AFY to 9,400 AFY. It is noteworthy that the level of uncertainty with the climate change scenarios are significant, and the 2070HD scenario projects a much more unlikely scenario. Therefore, the groundwater sustainability planning is based on the Projected Baseline conditions with less uncertainty relative to climate conditions.

2.5 Sustainable Yield Estimate

2.5.1 Background

The sustainable yield for the Sacramento Central groundwater basin has been previously estimated and established as part of the Sacramento Water Forum basin yield analysis in 1997. This work was conducted using criteria established at the time for the purposes of management of the Sacramento area groundwater basins. The geographic area for the Sacramento Central groundwater basin is similar to the current boundaries of the South American Subbasin (shown in **Figure 2-1**), with differences generally south of the Cosumnes River and in the Delta.

The Sacramento Water Forum defined sustainable yield as the amount of water that can be extracted from the groundwater system over a long period without producing unacceptable effects. At the time, the Water Forum identified the unacceptable effects as declines in groundwater levels and storage to an extent that lowering groundwater levels would result in degradation of water quality, dewatering of wells, increase in cost of pumping, and land subsidence. The Water Forum analysis involved use of the Sacramento Integrated Water Resources Model (SacIWRM) and other analysis of reported and observed water level and quality data to arrive at a sustainable yield of 273,000 AFY for the basin. Additional details on the history, approach and process for establishment of Water Forum sustainable yield is provided in the Sacramento Central Groundwater Authority (SCGA) Groundwater Management Plan (SCGA, 2006).

The Water Forum sustainable yield value has been established and engraved in much of the groundwater and water supply planning process and work over the past 20 years. Adherence of planning process by SCGA and member agencies to the Water Forum sustainable yield has resulted in management of the groundwater demand in the basin, as well as implementation of many water supply projects, that overall has resulted in a well-managed groundwater basin. This is especially evident in the relatively stable groundwater trends observed over the past decade.

2.5.2 Sustainable Yield Under SGMA

Sustainable yield is defined for SGMA purposes as “the maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result.” (CWC §10721(w)).

Sustainable yield for the South American Subbasin is estimated for this GSP using analysis of data and information from a number of CoSANA modeling scenarios for historical, baseline and project conditions reflecting various hydrologic and operational conditions in the Subbasin. The scenarios use a 50-year hydrologic period, which represents reasonably long-term conditions in the Subbasin. The goal of the analysis is to establish a sustainable yield to avoid causing undesirable results as defined and established as part of the GSP Sustainable Management Criteria (SMC). Of the six SGMA Sustainability Indicators (SI), five are applicable to the South American Subbasin (SASb), which are discussed in section 3 of the GSP. The sustainable yield analysis uses the CoSANA model to address the three SI that can directly be analyzed using the CoSANA model. The three SI considered are: Reduction of groundwater storage, chronic lowering of groundwater levels, and depletion of interconnected surface water.

Consistent with the undesirable results statements included in the SMC section of the GSP (**Section 3**), the following criteria have been used to evaluate the sustainable yield of the SASb:

- **Chronic Lowering of Groundwater Levels –** Significant and unreasonable chronic lowering of GWL occurs when 25% (9/35 wells) of RMP fall below their MTs for 3 consecutive years

- **Reduction of Groundwater Storage –** The minimum threshold for changes in groundwater storage is triggered off of changes in groundwater levels as a proxy. It is however, assumed that the groundwater storage sustainability indicator can be addressed when Subbasin-wide change in storage is approximately zero over the 50-year planning horizon

- **Depletion of Interconnected Surface Water –** Significant and unreasonable chronic lowering of GWL occurs when more than 25% (2/8 wells) of ISW RMP fall below their MTs for 3 consecutive years. Additionally, significant and unreasonable depletion of ISW occurs when ISW reach length is reduced by more than 5%

It is important to recognize various uncertainties that can contribute to the assessment and evaluation of sustainable yield, including the following:

- **Historical Data –** Historical data are based on recorded measurements of observed data and are subject to significant uncertainties in measurement methods, instruments, and devices, timing and frequency of measurements and potential data gaps, spatial resolution of data and spatial interpolation made to analyze data at appropriate scales needed for analysis.

- **Projected Data –** Projected data and analysis are subject to uncertainties, including future and projected hydrologic conditions, population growth patterns and rates of development over time and geographic areas, economic factors affecting growth and development, factors affecting land use and trends in agricultural crops, spatial and temporal resolution of data projections, and formulations and assumptions used in modeling analysis.

- **SMC Thresholds –** The minimum thresholds and measurable objectives set in the SMC section (**Section 3**) of the GSP are based on observed data, modeling scenarios and analysis, and inter-relationships among the sustainability indicators, and are subject to significant uncertainties.

- **Sustainable Yield Analysis Approach –** The methodology, formulation, and assumptions used for establishing sustainable yield are subject to uncertainties.

The following analysis resulting in sustainable yield incorporates the above uncertainties based on the information available on the sensitivity of modeling and data analysis on parameters, assumptions and data uncertainties. Future climate change presents additional uncertainty regarding the availability of water and of water demands in the future, which could affect the Basin sustainable yield going forward. The approach to establishing sustainable yield is to define a range of groundwater pumping for the SASb that does not cause significant and unreasonable results based on the set SMC criteria. See **Section 3** for additional explanation of the GSP sustainability criteria. **Figure 2-113(a)** to **Figure 2.5-1(c)** show the relationship between groundwater pumping and the three sustainability indicators considered for sustainable yield analysis (groundwater levels, groundwater storage, and change in ISW stream reach connection). Each point on these charts represents the relationship between long-term average annual groundwater pumping and the value of respective sustainability indicator under a model scenario. **Figure 2-113(a)** shows the subbasin scale average annual groundwater pumping for each of the scenarios and the resulting long-term average annual groundwater levels under that scenario. The scenarios considered are same as those outlined in the PMA section (**Section 4**) of the GSP. Based on modeling analysis, a range of uncertainty in the sustainability indicator is assigned to each SI. Sustainable yield of the basin is estimated as the long-term mean groundwater pumping within the uncertainty range of the groundwater level sustainability indicator; in this case, 235,000 AFY. This value is further verified to be within reasonable range of uncertainty for the other two sustainability indicators (groundwater storage and interconnected surface water), as shown in **Figures 2.5-1(b)** and **2.5-1(c)**. **Figures 2.5-1(b)** and **2.5-1(c)** indicate that the groundwater pumping of 235,000 AFY is well within the acceptable range of the other two sustainable indicators of groundwater storage and interconnected surface water. The sustainable yield of 235,000 AFY, therefore, meets the criteria for all three sustainability indicators used in the modeling. As such, the sustainable yield is established at 235,000 AFY. Although, the groundwater quality and land subsidence sustainability indicators are not directly used in this analysis, in the absence of an analytical tool for these sustainability indicators, it is expected that a sustainable yield defined based on the groundwater levels, storage, and interconnected surface water would also meet the criteria for groundwater quality and land subsidence as well.

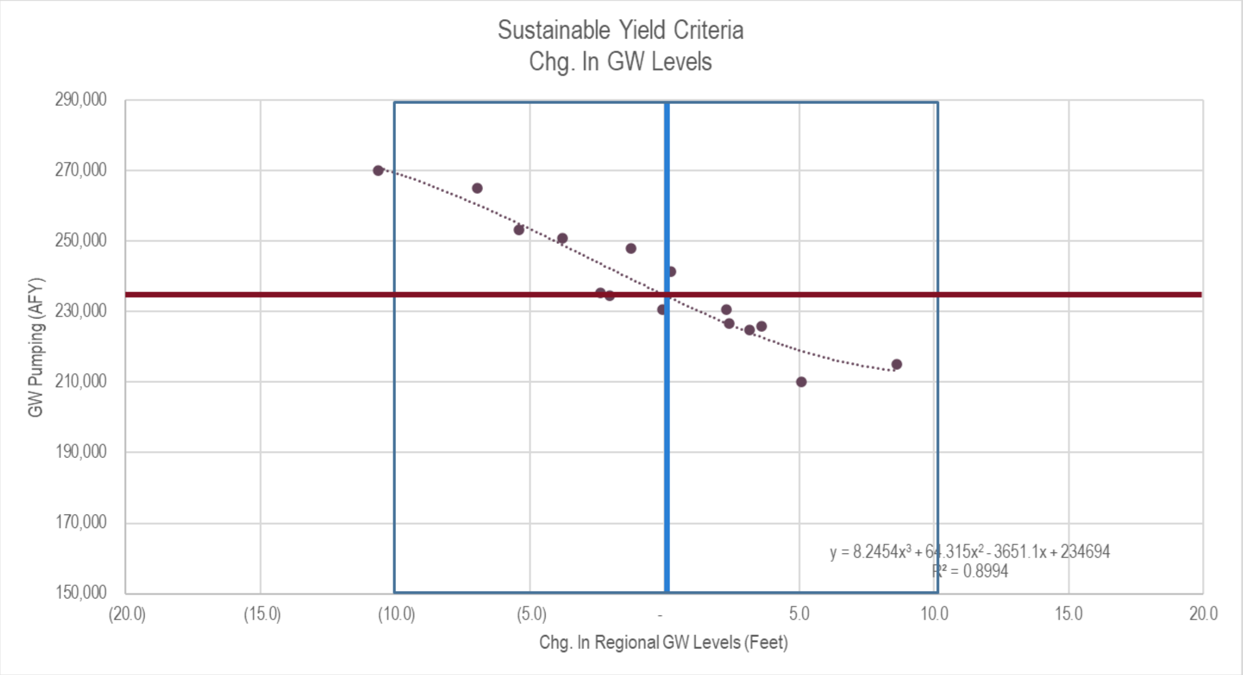


Figure 2-113(a) **Relationship between Groundwater Pumping and Change in Groundwater Levels**

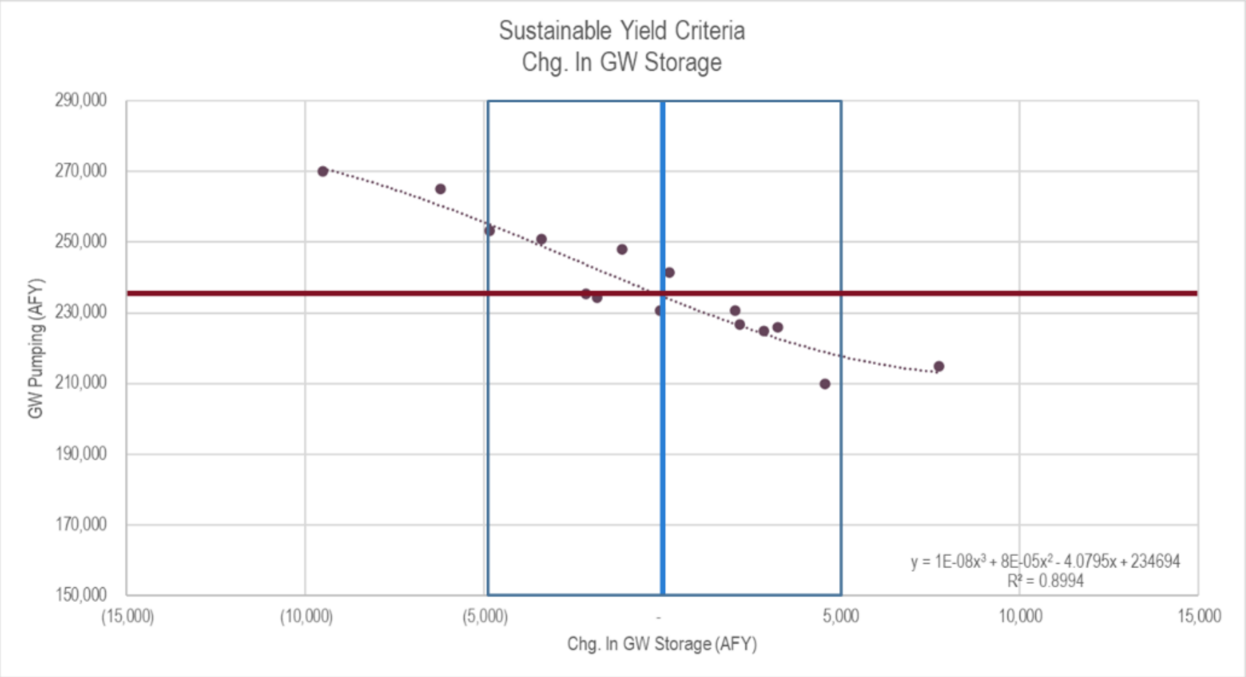


Figure 2.5-1(b) **Relationship between Groundwater Pumping and Change in Groundwater Storage**

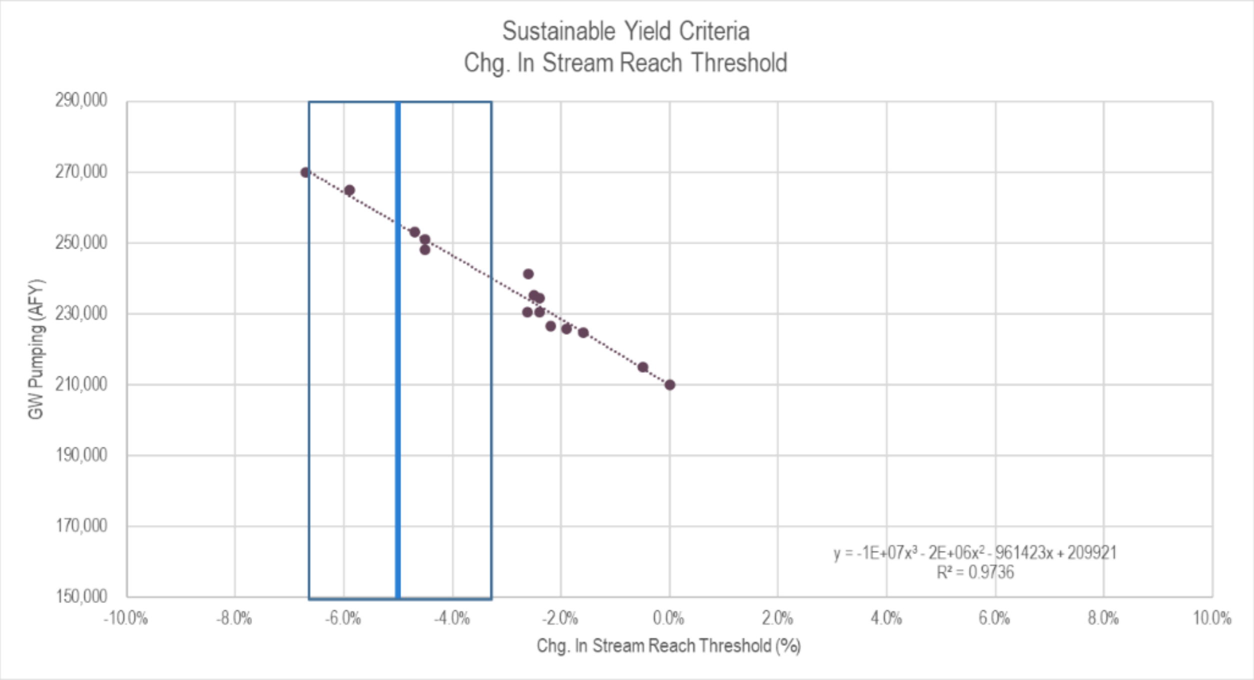


Figure 2.5-1(c) Relationship between Groundwater Pumping and Change in ISW Stream Reach

The sustainable yield of SASb (235,000 AFY) represents the long-term average annual groundwater pumping for the SASb that would not result in significant and unreasonable impacts. **Figure 2-113(a)** through **Figure 2.5-1(c)** also indicate that a sustainable range of groundwater pumping in SASb includes typical variation in pumping in any given year ranging from about 210,000 AF in a wet year to about 270,000 AF in a dry year, with the long-term average annual target of 235,000 AFY continuing to be maintained. **Figure 2-114** shows the sustainable yield and ranges of groundwater pumping that can potentially be used as a guideline for various year types (according to the Sacramento River index). This groundwater pumping range can be used as a guideline and not a requirement by the groundwater users in order to provide the operational flexibility for variabilities in hydrologic conditions, monthly and annual water demand needs, and maintaining operational needs for urban water purveyors to provide safe drinking water to the population served. Although the range of groundwater pumping from the Subbasin needs to be within the general range of sustainable yield, the metrics for monitoring and measuring the sustainability conditions of the Subbasin are based on the sustainability indicators, as discussed in **Section 3**.

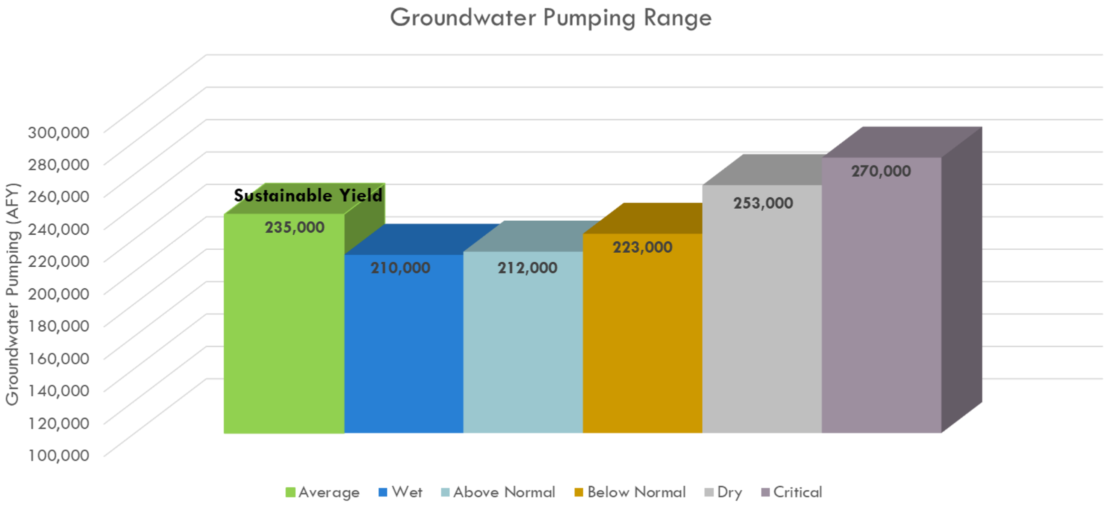


Figure 2-114: Operational Flexibility Provided by the SASb Sustainable Yield

Section 3: Sustainable Management Criteria

> *23 CCR § 354.22. Introduction to Sustainable Management Criteria: This Subarticle describes criteria by which an Agency defines conditions in its Plan that constitute sustainable groundwater management for the basin, including the process by which the Agency shall characterize undesirable results, and establish minimum thresholds and measurable objectives for each applicable sustainability indicator.*

The Sustainable Groundwater Management Act (SGMA) requires each Groundwater Sustainability Agency (GSA) to develop a Groundwater Sustainability Plan (GSP, or Plan) that outlines definitions of "significant and unreasonable" impacts to sustainability indicators (California Water Code [CWC] § 10727(a)). Furthermore, SGMA defines Sustainable Management Criteria (SMC) as measurable steps towards a Sustainability Goal, which culminates in the absence of undesirable results within 20 years of Plan implementation.

SGMA defines six sustainability indicators (CWC § 10721(x)), which are used to determine if "significant and unreasonable" impacts occur for beneficial users and uses of groundwater:

7. Chronic Lowering of Groundwater Levels,
8. Reduction of Groundwater Storage
9. Seawater Intrusion
10. Degraded Water Quality
11. Land Subsidence
12. Depletions of Interconnected Surface Water (ISW)

This Section focuses on all sustainability indicators except for "Seawater Intrusion" which does not apply to the Basin. The avoidance of significant and unreasonable impacts to sustainability indicators is guided by SMC, which include three components:

- Minimum thresholds (MTs): "a numeric value for each sustainability indicator used to define undesirable results" (23 CCR § 351(t))
- Measurable Objectives (MOs): "specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin" (23 CCR § 351(s))
- Interim Milestones (IMs): "a target value representing measurable groundwater conditions, in increments of five years, set by an Agency as part of a Plan" (Title 23, California Code of Regulations (23 CCR § 351(q)))

SMC are thus "management goalposts" that inform discrete actions to be taken over the management and implementation horizon and provide a quantitative means to evaluate progress towards the Sustainability Goal. The scientifically-informed SMC presented herein have been designed to protect beneficial uses and users of groundwater in the basin against significant and unreasonable impacts that may be caused by unsustainable groundwater management, and reflect the values expressed in stakeholder-driven discussions. The specific beneficial uses and users this Plan emphasizes include domestic, agricultural, and public wells,[18] groundwater dependent ecosystems (GDE),[19] and interconnected surface waters (ISW) that support sensitive aquatic habitats and species such as salmonids.[20] Detailed Technical Memoranda for each of these uses and users are provided as Appendices to this Section; within this Section, an overview of these uses and users and the specific, quantitative criteria that demonstrate the avoidance of significant and unreasonable impacts to these users is presented and explained.

The SMC for groundwater levels, storage, and interconnected surface water have been co-developed within an integrated approach to promote ease and efficiency of monitoring and interpretation. As more information is collected, and understanding of the Basin improves over time, certain SMC may change, for instance, during five-year Plan updates. However, at the time of Plan submission, the SMC in this Section reflect the best available science applied to the sustainable management of groundwater in the Basin. These SMC will ensure the Basin operates in a steady condition over the implementation horizon, and achieves then maintains the Sustainability Goal beyond the implementation period ending in 2042.

This Section of the Plan first presents the Sustainability Goal (**Section 3.1**). Next, significant and unreasonable definitions for each of the six sustainability indicators are presented and discussed (**Section 3.2**), followed by SMC for each sustainability indicator – these include MTs (**Section 3.3**), followed by MOs and IMs (**Section 3.4**). Finally, the network of Representative Monitoring Points at which SMC will be measured for each sustainability indicator (**Section 3.5**) is described, and data gaps to be addressed during the implementation period are reviewed.

3.1 Sustainability Goal (23 CCR § 354.24)

> *23 CCR § 354.24. Sustainability Goal: Each Agency shall establish in its Plan a sustainability goal for the basin that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The Plan shall include a description of the sustainability goal, including information from the basin setting used to establish the sustainability goal, a discussion of the measures that will be implemented to ensure that the basin will be operated within its sustainable yield, and an explanation of how the sustainability goal is likely to be achieved within 20 years of Plan implementation and is likely to be maintained through the planning and implementation horizon.*

The Sustainability Goal of the Basin is to protect and ensure the long-term viability of groundwater resources for domestic, urban, agricultural, industrial, and environmental beneficial users of groundwater. The Sustainability Goal will be achieved by rigorous 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 overarching Sustainability Goal of the Basin is rooted in a vision of cooperative, multi-benefit, multi-stakeholder coordination to protect all beneficial uses and users of groundwater and maintain a healthy, sustainable groundwater basin through the implementation period and beyond. This Plan acknowledges that climate change, unplanned growth, and complex inter-

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[18] See Appendix 3-C: Vulnerable well impact analysis in the South American Subbasin: well inventory, historical groundwater trends, and analysis to inform Sustainable Management Criteria (October 1, 2021)

[19] See Appendix 3-D: Groundwater Dependent Ecosystems in the South American Subbasin (April 21, 2021)

[20] See 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 (June 18, 2021)

basin coordination all challenge sustainable groundwater management. Thus, this Plan advances solutions to these challenges via:

- SMC rigorously tested on data and modeling of historical and projected groundwater use, analyzed specifically with respect to the most sensitive groundwater users (vulnerable wells, GDEs, and ISW) and designed to avoid significant and unreasonable impacts to these users;
- the shared use of a regional integrated surface and groundwater model that spans the Basin and neighboring basins to the north and south (North American and Cosumnes basins), thus accounting for inter-basin flows, regional conjunctive use, and projected water use in each basin;
- improved monitoring and scientific studies across the Basin to refine models and address data gaps;
- substantial inter-basin and inter-agency coordination on conjunctive use projects and management actions already underway (**Section 4**) that are estimated to increase net basin storage over the implementation period and that will support sustainable pumping, bolster well reliability, improve GDE water access, and maintain critical surface water flows.

Next, undesirable results for beneficial users of groundwater are defined and quantified, which informs the following sections detailing SMC designed to avoid these undesirable results.

3.2 Undesirable Results (23 CCR § 354.26)

> *23 CCR § 354.26. Undesirable Results*
>
> *(a) Each Agency shall describe in its Plan the processes and criteria relied upon to define undesirable results applicable to the basin. Undesirable results occur when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin.*
>
> *(b) The description of undesirable results shall include the following:*
>
> *(1) The cause of groundwater conditions occurring throughout the basin that would lead to or has led to undesirable results based on information described in the basin setting, and other data or models as appropriate.*
>
> *(2) The criteria used to define when and where the effects of the groundwater conditions cause undesirable results for each applicable sustainability indicator. The criteria shall be based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the basin.*
>
> *(3) Potential effects on the beneficial uses and users of groundwater, on land uses and property interests, and other potential effects that may occur or are occurring from undesirable results.*
>
> *(c) The Agency may need to evaluate multiple minimum thresholds to determine whether an undesirable result is occurring in the basin. The determination that undesirable results are occurring may depend upon measurements from multiple monitoring sites, rather than a single monitoring site.*
>
> *(d) An Agency that is able to demonstrate that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin shall not be required to establish criteria for undesirable results related to those sustainability indicators.*

SGMA states that Undesirable Results occur "when significant and unreasonable effects for any of the sustainability indicators are caused by groundwater conditions occurring throughout the basin". Definitions for undesirable results that pertain to each of the six sustainability indicators are qualitatively presented in this section, and quantitatively defined in the following sections on SMC, including MTs (**Section 3.3**), and MOs and IMs (**Section 3.4**).

3.2.1 Undesirable Results for Chronic Lowering of Groundwater Levels

3.2.1.1 Potential Causes of Undesirable Results

Undesirable Results due to chronic lowering of groundwater levels in the Basin may be caused by an *increase in outflows from groundwater*, a *decrease in inflows to groundwater*, or *a combination of both* that results in substantial groundwater level decline and significant and unreasonable impacts to beneficial users.

Undesirable Results may be caused by a combination of factors, such as excessive groundwater pumping, climate change with increased evapotranspiration and reduced recharge, and unsustainable management of groundwater use in neighboring subbasins.

Sustained groundwater pumping can create undesirable results when it exceeds the basin sustainable yield,[21] which is the "maximum quantity of water, calculated over a base period representative of long-term conditions in the basin and including any temporary surplus, that can be withdrawn annually from a groundwater supply without causing an undesirable result." (CWC § 10721(x)(1)). Major uses of groundwater in the Basin include pumping for agricultural, urban, industrial, and rural domestic use. Hence, expansion of groundwater use associated with irrigated agriculture, groundwater substitution transfers, urban development, industry, and/or rural residential growth (although *de minimis* extractors are unlikely to substantially impact the overall water budget) that outstrips the Basin's sustainable yield may cause Undesirable Results. Importantly, the Basin may stay within the limits of the sustainable yield, but still cause Undesirable Results in a subarea of the Basin if the spatial distribution of pumping and recharge in the subarea significantly changes and creates local water budget conditions that lead to persistent groundwater level decline.

Climate change is expected to bring an increasingly drier and warmer California climate (Diffenbaugh et al., 2017; Cook et al., 2015) characterized by more frequent, more spatially extensive heat waves and extended droughts (Tebaldi et al., 2006; Lobell et al. 2011) which typically occur during dry summer months. In addition to putting pressure on groundwater extraction to supplement lost surface water supply, an increasingly drier climate will increase evapotranspiration (ET), which may result in increased agricultural demand and less groundwater recharge.

Extended droughts and heat waves may also reduce precipitation and streamflow, and thus reduce recharge and stream leakage into the Basin from these inputs. Furthermore, streamflow

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[21] The Basin sustainable yield in the SASb is expected to increase over time, as conjunctive use projects and management actions add water to groundwater storage during wet years, which may be recovered later as needed during dry years. At the time of writing, sustainable yield estimates are still preliminary.

reduction may reduce imported surface water diversions and by extension, recharge from irrigation return flow.

Finally, water management decisions made in adjacent basins may alter cross-basin hydraulic gradients and thus reduce stream leakage and subsurface inflow from adjacent basins or reverse the flow direction altogether. Inter-basin coordination and cross-boundary flow management is critical.

The GSAs in the Basin will coordinate with the relevant agencies and stakeholders – both in the Basin and in adjacent basins – to set SMC and implement projects and management actions that avoid Undesirable Results related to the chronic lowering of groundwater levels.

3.2.1.2 Criteria to Define Undesirable Results

Stakeholder-driven discussions that considered impacts to beneficial users of groundwater helped define the criteria to classify Undesirable Results due to the chronic lowering of groundwater levels. Potential impacts and the extent to which they are considered significant and unreasonable were determined by the GSAs with input by technical advisors and members of the public. During GSP development, potential Undesirable Results (specifically related to groundwater level decline) for beneficial users of groundwater identified by stakeholders included the following issues:

- percentage of domestic, agricultural, or public wells going dry,
- need for well rehabilitation (lowering pumps and deepening wells),
- reduction in the pumping capacity of existing wells,
- financial burden to beneficial users of groundwater,
- adverse impacts to environmental uses and users, including interconnected surface water (ISW) and groundwater-dependent ecosystems (GDEs),
- substantial reduction of surface water flows that threaten salmonid habitat and migration;
- substantial loss of GDEs;
- land subsidence that impacts critical infrastructure (canals and roads).

Based on these values (and the absence of existing or anticipated land subsidence, see **Section 3.2.5**), the level of impact to beneficial users of groundwater level that constitute undesirable results for chronic lowering of groundwater were summarized to three quantitative criteria for vulnerable wells, GDEs, and ISW:

1. **percentage of impacted domestic, agricultural, or public wells exceeds 5% for any well type**
2. **percentage decrease in potential GDE area exceeds 5%**
3. **percentage decrease in ISW reach length exceeds 5%; percentage decrease in the 50th percentile of ISW streamflow exceedance during October-December spawning months exceeds 10% of historical conditions**

The scientific rationale behind Undesirable Results is based on a determination of impact analyses to beneficial users of groundwater and discussed in detail in **Section 3.3.1.1**.

Criteria to define undesirable results for chronic lowering of groundwater are:

> ***Significant and unreasonable chronic lowering of groundwater levels resulting from groundwater extraction occurs when more than 25% (9/35 wells) of representative monitoring wells for groundwater levels and storage in the Basin fall below their MTs for 3 consecutive years.***

As discussed in **Section 3.3.1**, MTs for groundwater level are based on historic and projected groundwater lows, which occur during the 2012-2016 drought and the drought based on repeated hydrology (a modeling assumption). Thus, declines beyond MTs at 25% of monitoring wells for 3 consecutive years is designed to reflect the anticipated return of a 4 year drought similar in intensity to the 2012-2016 drought, plus an additional 3 years of drought to account for hydrologic uncertainty. Importantly, impacts to beneficial users at these thresholds were tested and do not suggest the presence of significant and unreasonable impacts.

Moreover, SGMA specifies that "chronic lowering of groundwater levels" indicates continued groundwater level decline over the implementation horizon.

> *(CWC § 10721(x)(1)): Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.*

Thus, the quantitative *criteria* to identify Undesirable Results consider reasonable hydrologic variability (e.g., water year type) that may be experienced in the Basin, the interaction of this hydrologic variability with projected water use and climate change at an inter-basin scale, and the long-term trajectory of groundwater levels in non-drought periods.

3.2.1.3 Potential Effects of Undesirable Results on Beneficial Uses and Users of Groundwater

Undesirable Results that stem from chronic lowering of groundwater levels will primarily impact shallow well users, ISW, and GDEs. If lowering groundwater levels in confined clays causes land subsidence, critical infrastructure could be impacted, and subsurface contaminants may be mobilized, but projected groundwater budgets do not suggest either of these will happen in the Basin.

If groundwater levels decline, shallow domestic, agricultural, public, and industrial wells that supply groundwater may become partially or fully dewatered and require physical rehabilitation such as pump lowering and well deepening (Gailey et al, 2019; Pauloo et al, 2020; EKI, 2020; Pauloo et al., 2021). Shallow, domestic wells tend to be impacted first as groundwater levels fall, and rural residents may be faced with the significant financial burden of well rehabilitation. Lower groundwater levels also imply increased pumping costs for all groundwater well users, but these costs tend to be negligible compared to the costs of well rehabilitation (EKI, 2020).

The magnitude and direction of depletions of ISW depend on hydraulic gradients between the surface water and adjacent groundwater. Hence, lowering groundwater levels that propagate to streams may steepen hydraulic gradients and cause additional depletions of ISW that reduce in-stream flows, prevent salmonid migration, impact riparian ecosystems, and reduce surface water availability for downstream beneficial users of surface water with riparian or appropriative surface water rights. These beneficial users of surface water may be GSAs and associated users within the Plan area, or users outside of the Plan area.

GDEs are "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (23 CCR § 354.24(m)). Hence, lowering groundwater levels may disconnect vegetative GDEs from saturated groundwater or reduce baseflow to streams that depend on groundwater baseflow (especially during dry months), thus impacting riparian ecosystems and aquatic species associated with GDEs.

3.2.1.4 Relationship to Other Sustainability Indicators

Sustainable management of groundwater levels can directly address the avoidance of other sustainability indicators that correlate with groundwater levels. Chronic lowering of groundwater level may impact the other sustainability indicators and GDEs in the following ways:

- **Reduction of Groundwater Storage**: Groundwater level is a two-dimensional representation of groundwater storage (three-dimensional). Lowering groundwater levels generally indicate groundwater storage reduction.
- **Seawater Intrusion**: This sustainability indicator is not applicable in the Basin.
- **Degraded Water Quality**: As in the case of depletions of ISW, lowering groundwater levels may alter hydraulic gradients and thus change groundwater flow paths and cause contaminant migration to previously unimpacted areas. Moreover, lowering of groundwater levels may also leach arsenic-rich water from fine-grained sediments (Smith et al., 2018) in localized areas.
- **Land Subsidence**: Lowering groundwater levels and reduction of storage in certain fine-grained sediments can cause land subsidence and deformation of the land surface that damages critical infrastructure such as canals and roads. Land subsidence is a combination of *elastic* and *inelastic* subsidence. In the latter case, the subsidence incurred is permanent. Such impacts are not anticipated in the Basin.
- **Depletions of ISW**: Groundwater level defines the steepness of the hydraulic gradient between ISW and saturated groundwater, and hence the rate, volume, and direction of ISW depletion. Dropping groundwater levels can result in increased ISW depletion.
- **Impacts to GDEs**: Although not technically a sustainability indicator according to SGMA, GDEs are still a beneficial user of groundwater. Lowering groundwater levels may disconnect GDEs from saturated groundwater or reduce baseflow to streams that depend on groundwater baseflow, thus impacting GDE-associated aquatic species.

3.2.2 Undesirable Results for Reduction of Groundwater Storage

3.2.2.1 Potential Causes of Undesirable Results

Chronic lowering of groundwater levels is directly correlated with reduction of groundwater storage. Thus, groundwater levels may be used as a proxy for groundwater storage, and the potential causes of Undesirable Results related to reduction in groundwater storage are identical to those related to chronic lowering of groundwater levels (**Section 3.2.1.1**).

3.2.2.2 Criteria to Define Undesirable Results

Due to the direct correlation between groundwater levels and storage, the quantitative criteria used to determine Undesirable Results due to reduction of groundwater storage are identical to those for chronic lowering of groundwater levels (**Section 3.2.1.2**):

> ***Significant and unreasonable reduction of groundwater storage resulting from groundwater extraction occurs when more than 25% (9/35 wells) of representative monitoring wells for groundwater levels and storage in the Basin fall below their MTs for 3 consecutive years.***

Additionally, GSAs will track and project groundwater storage with the CoSANA model, and calibrate groundwater storage estimates based on data collected throughout the Basin.

3.2.2.3 Potential Effects of Undesirable Results on Beneficial Uses and Users of Groundwater

As before, potential effects of Undesirable Results on beneficial uses and users of groundwater due to reduced groundwater storage are identical to those outlined due to chronic lowering of groundwater levels (**Section 3.2.1.3**).

3.2.2.4 Relationship to Other Sustainability Indicators

Potential effects of Undesirable Results on beneficial uses and users of groundwater due to reduced groundwater storage are identical to those outlined due to chronic lowering of groundwater levels (**Section 3.2.1.4**), except that storage and groundwater levels are related in the following manner:

- **Chronic Lowering of Groundwater Levels**: Groundwater storage is the three-dimensional equivalent of groundwater level (two-dimensional) over a depth. Reduction in groundwater storage generally indicates groundwater level decline, and vice versa.

3.2.3 Undesirable Results for Degraded Groundwater Quality

Significant and unreasonable degradation of groundwater quality is the degradation of water quality that would impair beneficial uses of groundwater within the South American Subbasin (SASb) or result in failure to comply with groundwater regulatory thresholds including state and federal drinking water standards and Basin Plan water quality objectives.

The violation of water quality objectives, which are established in accordance with the CWC to protect beneficial uses of waters, is arguably significant and unreasonable. Also, based on the State's 1968 antidegradation policy,[22] water quality degradation inconsistent with the provisions of Resolution No. 68-16 may also be significant and unreasonable. In the Subbasin, the Central Valley Water Board and the State Water Board enforce compliance with water quality objectives and determine if water quality degradation is inconsistent with Resolution No. 68-16.

Federal and state water quality standards, water quality objectives defined in the Basin Plan, and the management of known and suspected contaminated sites within the Basin will continue

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[22] State Water Resources Control Board. "Resolution No. 68-16: Statement of Policy with Respect to Maintaining High Quality of Waters in California", California, October 28, 1968.

to be the jurisdictional responsibility of the relevant regulatory agencies. The role of the GSAs is to provide additional local monitoring and oversight of groundwater quality, report issues to appropriate parties with jurisdiction over water quality, and to evaluate and monitor, as needed, water quality effects of projects and actions implemented to meet the requirements of other sustainability management criteria.

As noted above, groundwater in the Basin is used for a variety of beneficial uses including agricultural, industrial, domestic, and municipal water supply. Groundwater supports groundwater-dependent ecosystems (GDEs) and instream environmental resources in some areas. These beneficial uses, among others, are protected, in part, by the CVRWQCB through the water quality objectives adopted in the Basin Plan. Projects and management actions implemented as a result of the GSP need to consider, and monitor for, potential impacts to groundwater quality that could cause degradation below these water quality objectives and affect beneficial uses of groundwater in the Basin.

The constituents of concern in the Basin, and their associated regulatory thresholds, are listed in **Section 2.3.4**. The quantification of an undesirable result is included in the discussion of minimum thresholds in **Section 3.3.3**.

3.2.3.1 Criteria to Define Undesirable Results

Significant and undesirable results for degraded groundwater quality are defined to occur when the number of RMPs experiencing exceedances above the MT is greater than the number of RMPs with exceedances as of May 22, 2020. For the groundwater quality monitoring network, this corresponds to more than two RMPs exceeding the minimum threshold for nitrate, or more than two RMPs exceeding the minimum threshold for specific conductance.

Maintaining high water quality is important to GSAs, and these conservative criteria reflect that value.

3.2.3.2 Potential Causes of Undesirable Results

Future activities by the SASb GSAs with potential to negatively affect water quality may include changes to pumping in the Basin, declining groundwater levels, and recycled water projects. Altering the location or rate of groundwater pumping could change the direction of groundwater flow, which may result in a change in the overall direction in which existing or future contaminant plumes move and thus, potentially compromise remediation efforts.

The ongoing contaminated site remediation efforts in the Basin as described in **Section 2.1** are effectively managed and are regulated by agencies with jurisdiction over the monitoring, reporting and compliance activities. In the Basin, existing leaks from underground storage tanks (USTs) are currently being managed and additional degradation is not anticipated from these known contaminant sources. New leaks from USTs may locally impact groundwater quality, depending on the contents of the UST, which may include petroleum hydrocarbons, solvents, or other contaminants. Such sources will be regulated by the State Water Board. Agricultural activities in the Basin are dominated by vineyards and pasture production. The risk for fertilizer nitrate leaching from these activities is considered low (Harter et al., 2017). The Basin is not currently categorized as a priority subbasin for nitrates under the Central Valley Salinity

Alternatives for Long-Term Sustainability (CV-SALTS) program managed by the Central Valley Water Board.

3.2.3.3 Potential Effects of Undesirable Results on Beneficial Uses and Users

Concerns over potential or actual non-attainment of the beneficial uses designated for groundwater in the Basin are related to certain constituents measured at elevated or increasing concentrations, and the potential local or regional effects that degraded water quality can have on such beneficial uses.

The following provides greater detail regarding the potential impact of poor groundwater quality on several major classes of beneficial users:

- Municipal Drinking Water Users – Under California law, agencies that provide drinking water are required to routinely sample groundwater from their wells and compare the results to state and federal drinking water standards for individual chemicals (primary and secondary MCLs). Groundwater quality that does not meet state drinking water standards may render the water unusable for that use or may cause increased costs for treatment. For municipal suppliers, impacted wells may potentially be taken offline until a solution is found, depending on the configuration of the municipal system in question. Where this temporary solution is feasible, it will add stress to and decrease the reliability of the overall system.
- Rural and/or Agricultural Residential Drinking Water Users – Residential users not located within the service areas of the local municipal or private water suppliers will typically obtain their water supply through private domestic groundwater wells. Such wells may not be monitored routinely, and their groundwater quality may be unknown unless the landowner has initiated testing and shared the data with other entities. Degraded water quality in such wells can lead to rural residential use of groundwater that does not meet potable water standards and may result in the need for installation of new or modified domestic wells and/or well-head treatment that will provide groundwater of acceptable quality.
- Agricultural Users – Irrigation water quality is an important factor in crop production and has a variable impact on agriculture due to different crop sensitivities. Impacts from poor water quality (e.g., elevated salinity) may include declines in crop yields, crop damage, changes in crops that can be grown in an area, and other effects. Salinity levels in ambient groundwater in the SASb are generally deemed to be high quality and not impacting agricultural uses.
- Environmental Uses – In gaining streams, poor quality groundwater could possibly affect GDEs, instream environments, and their resident species by supplying nutrients to streamflow. However, there are limited gaining stream reaches in the SASb and ambient groundwater has low nutrient levels, greatly reducing such concerns in the Basin.

3.2.3.4 Relationship to Other Sustainability Indicators

Groundwater quality typically cannot be used to predict responses of other sustainability indicators. However, groundwater quality can, in some circumstances, be affected by changes in groundwater levels and reductions in groundwater storage or can affect ISW quality, as described below.

- Groundwater Levels – In some basins, declining groundwater levels potentially can lead to increased concentrations of constituents of concern in groundwater and may alter the existing hydraulic gradient, which can result in the movement of contaminated groundwater plumes. Changes in water levels may also mobilize some contaminants that may be present in unsaturated soils. In such cases, the minimum thresholds established for groundwater quality may influence groundwater level minimum thresholds by affecting the location or number of projects, such as groundwater recharge or conjunctive use projects. In the SASb, these issues are not of general concern. Contaminated plumes are highly regulated and sufficiently managed in the SASb, as described in **Section 2**, including the use of groundwater wells as barriers to prevent plume migration and use of extensive ongoing monitoring networks. Recharge projects will use high quality surface water, which will have a positive impact on nitrate and specific conductance in the SASb. The Harvest Water project (**Section 4.4.1**) will introduce recycled water with higher nitrate and specific conductance concentrations than ambient groundwater, but will not cause groundwater quality to exceed minimum thresholds for these constituents of concern (Ascent Environmental, 2020).
- Groundwater Storage – Groundwater quality at or near the minimum threshold for nitrate in specific wells may result in limited use of those wells. The groundwater quality evaluation described in **Section 2.3** indicates that such occurrences in SASb would be rare and would not impact attainment of groundwater storage SMC in SASb. The degraded groundwater quality maximum thresholds do not promote pumping in excess of sustainable yield, and therefore these maximum thresholds will not result in an exceedance of the groundwater storage minimum thresholds.
- Depletion of ISW – Groundwater quality at or near minimum thresholds may affect stream water quality. However, most of the stream reaches within the SASb are losing reaches and, therefore, groundwater quality will not influence surface water quality in these reaches. There are, however, gaining stream reaches, especially within the southern Cosumnes and Mokelumne Rivers. The GSAs and Regional San will evaluate the relationship between surface and groundwater quality data from wells in this area, including Harvest Water monitoring wells, when these data become available. The results of this evaluation will be included in the next five-year evaluation report.
- Seawater Intrusion – This sustainability indicator is not applicable in this Subbasin.
- Subsidence – Subsidence has been evaluated and is not a problem in SASb. Conditions will continue to be monitored but no impacts associated with groundwater quality are anticipated.

3.2.4 Undesirable Results for Depletions of Interconnected Surface Water

3.2.4.1 Potential Causes of Undesirable Results

Depletions of ISW are related to chronic lowering of groundwater levels via changes in the hydraulic gradient. Darcy's Law is a fundamental tenet of groundwater hydrogeology that explains this ISW depletion.[23] It states that the amount of water that flows through an aquifer (e.g., ISW depletion) is proportional to the hydraulic gradient (in this case, the difference between stream stage elevation and adjacent groundwater elevation).

Hence, declines in groundwater level which increase the hydraulic gradient also increase ISW depletion. Due to the strong dependence of increased ISW depletion on lowering of groundwater levels, the potential causes of Undesirable Results due to depletions in ISW are identical to those for groundwater level decline (**Section 3.2.1.1**).

Interestingly, increased streamflow due to climatic variability (or conjunctive use that leaves more water in streams) may increase the duration of stage elevation at times and thus increase the stream to groundwater hydraulic gradient and hence, ISW depletion. In fact, the CoSANA integrated hydrologic model shows that wet periods are associated with increased seepage into groundwater along major surface water bodies. However, increases in stream seepage due to relatively wet conditions should not be confused with ISW depletion caused by unsustainable groundwater management, but rather, hydrologic and streamflow variability. Taking this hydrologic behavior into consideration, monitoring of near-stream groundwater levels which represent the impacts of *pumping*, are used to develop SMC and monitor for ISW depletion, instead of the hydraulic gradient. Reduced streamflow and reduced baseflow to streams, particularly during dry critical salmonid migration months (October – December) may threaten aquatic ecosystems, thus special attention is paid towards the maintenance of flows during these dry months in projected management scenarios.

The ISW Guidance, when issued by DWR, will be utilized to evaluate and, if needed, modify monitoring of ISW depletion and update SMC.

3.2.4.2 Criteria to Define Undesirable Results

> *23 CCR § 351(o): "Interconnected surface water" refers to surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted.*

Active ISW depletion is occurring in the basin according to CoSANA-calculated stream seepage and data analysis that indicates losing conditions (i.e., groundwater elevation less than stream stage elevation along major surface water reaches at seasonal time scales (**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**). ISW depletion shown in the CoSANA model and data analyses are explained by historical groundwater pumping in the Basin and adjacent basins. Therefore, this Plan acknowledges that ISW depletion is occurring in the Basin, and extends the assumptions and methodology of Hall, Babbitt, Saracino, and Leake (2018), that a basin with active ISW depletion should emphasize management actions that arrest groundwater levels, which arrest hydraulic gradients, and finally, arrest streamflow depletion.

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[23] Darcy's Law, $Q = K \cdot A \cdot i$ states that the volumetric rate of flow *Q* is proportional to the hydraulic conductivity (*K*, or resistance to flow), the cross-sectional area (*A*, in this case, of the streambed), and the hydraulic gradient *i* (in this case, the difference between stream stage and adjacent groundwater level). Thus, as the difference in stream stage and groundwater level increases, say due to groundwater pumping, the hydraulic gradient (*i*) increases, which makes streamflow depletion (*Q*) increase.

Given the practical difficulty of measuring stream seepage (it must be modeled), and the strong dependence of ISW beneficial users on streamflow during critical months, the criteria to define undesirable results for ISW depletion are based on maintaining ISW locations (not disconnecting ISW) and maintaining ISW flows (not depleting surface flows), rather than maintaining ISW seepage (although this is calculated and discussed).

First, historical and present-day groundwater and surface water data (**Section 2.2**) are used to classify surface water reaches as “Interconnected” or “Disconnected,” in order to separate ISW from surface water that is *not* “hydraulically connected at any point by a continuous saturated zone to the underlying aquifer.” Disconnected reaches are considered out of the scope of sustainable groundwater management due to persistent disconnection from groundwater over the period of record from spring 2005 to present-day fall 2019 (**Appendix 3-A**). Depths to groundwater along Disconnected reaches are significantly lower than the bottom of the streambed clogging layer, and thus disconnected from actions that affect the groundwater levels in the Basin. Actions developed for groundwater management by the GSAs are not expected to have an impact on Disconnected reaches. After reaches are classified as Interconnected (ISW) or Disconnected, SMC are developed for ISW reaches.

CoSANA was used to estimate ISW locations, depletion volume, rate, and streamflow near the groundwater level MT (**Section 3.3.1**), which represents a worst-case ISW depletion scenario. Then, MTs for ISW depletion (**Section 3.3.4**) are defined at representative wells consistent with groundwater level and groundwater storage MTs such that hydraulic gradients are maintained at or above critical levels to avoid significant and unreasonable impacts. Importantly, the wells selected to monitor ISW depletion were chosen because they represent changes in groundwater level caused by groundwater pumping, and not near-stream influences, like stream seepage. Each ISW monitoring well is assigned to particular stream reach, and paired with stream gages. Three locations lack adequate, high-frequency, stream gage and groundwater monitoring and these are discussed in the Data Gap subsection, **Section 3.5.5**. Finally, a detailed monitoring well selection criteria is available in **Appendix 3-A**.

Significant and unreasonable depletion of ISW occurs when the percentage decrease in ISW reach length exceeds 5%, or when percentage decrease in the 50th percentile of ISW streamflow exceedance during October-December spawning months exceeds 10% of historical conditions. The rationale behind these criteria is that anything less than a maintenance of roughly current conditions plus reasonable hydrologic variability constitutes an undesirable result. Impacts to ISW were simulated at groundwater level MTs to confirm the avoidance of undesirable results. Using groundwater level at wells as a proxy:

> ***Significant and unreasonable depletion of interconnected surface water resulting from groundwater extraction occurs when more than 25% (2/8 wells) of representative monitoring wells for ISW fall below their MTs for 3 consecutive years.***

Importantly, MTs associated with ISW depletion are measured at a subset (8 wells) of the groundwater level monitoring network (see **Appendix 3-A** for details), and thus, a particular reach may temporarily experience impacts but the Basin as a whole does not experience undesirable results. It is important therefore, to remember that over the implementation period and beyond, modeling suggests that ISW conditions are expected to remain similar to current conditions or improve, although climate change uncertainties may pose challenges.

The ISW monitoring network and SMC will be assessed against DWR's ISW Guidance and, if needed, a five-year plan will be developed to complete any additional analysis and updates to the monitoring plan. The GSAs have initiated and plan to continue coordination with neighboring subbasin GSAs to agree upon a consistent ISW analysis framework according to DWR's ISW Guidance.

3.2.4.3 Potential Effects of Undesirable Results on Beneficial Uses and Users of Surface Water

Depletions of ISW caused by groundwater level decline may impact riparian and wetland ecosystems, habitat, fish, special species, recreation, and other environmental users of surface water. Moreover, beneficial users of surface water inside and outside of the basin (e.g., water rights holders) may be impacted by streamflow reduction caused by ISW depletion resulting from unsustainable groundwater management. Lowering groundwater levels may disconnect vegetative GDEs from saturated groundwater or reduce baseflow to streams that depend on groundwater baseflow. A detailed overview of the beneficial users and uses of surface waters is provided in **Appendix 3-A**.

3.2.4.4 Relationship to Other Sustainability Indicators

Increased ISW depletion results from chronic lowering of groundwater levels when lowering groundwater levels and reduction of groundwater storage lead to an increase in the stream-aquifer hydraulic gradient, and hence, increased depletion. Therefore, by effectively managing groundwater levels that reflect an expanding cone of depression in centers of pumping, ISW depletion can also be managed. Moreover, monitoring and forecasting basin-wide storage also provides a big picture view of how ISW depletion may be impacted, although spatially distributed changes in groundwater level are much more useful in isolating local-scale ISW impacts.

3.2.5 Undesirable Results for Land Subsidence

An undesirable result occurs when subsidence substantially interferes with beneficial uses of groundwater and surface land uses.

3.2.5.1 Potential Causes of Undesirable Results

Subsidence occurs due to compaction of (typically) fine-grained aquifer materials (i.e., clay) resulting from groundwater overdraft, however these aquifer materials are only moderately present in the Subbasin, mainly constricted to the western side of the Basin, and groundwater depletion estimates are not sufficient to lead to significant land subsidence.

3.2.5.2 Criteria to Define Undesirable Results

Significant and unreasonable subsidence is not historically observed in the Basin. The aquifer materials are only moderately likely to present such a risk and only in certain, limited areas of the Basin. The subbasin-wide undesirable result for land subsidence is defined as occurring when subsidence creates a significant and unreasonable impact on land uses or critical infrastructure and occurs when subsidence is greater than 0.1 foot [0.03 m] in any single year and a cumulative 0.5 foot [0.15 m] in any five-year period as measured in at least a 5 square mile area of the Subbasin. The Interferometric Synthetic Aperture Radar (InSAR) data will be used for measuring subbasin-wide land subsidence consistently each year.

could have significant impact on surface land use and critical infrastructure.

3.2.5.3 Potential Effects of Undesirable Results on Beneficial Uses and Users

Undesirable Results would occur when substantial interference with land use occurs, including significant damage to critical infrastructure such as building foundations, roadways, other urban infrastructure elements, canals, pipes, and other water conveyance facilities, including flooding agricultural practices.

3.2.5.4 Relationship to Other Sustainability Indicators

By managing groundwater pumping and avoiding the undesirable result of chronic lowering of groundwater levels, the possibility of land subsidence will be mitigated. Mitigating land subsidence through sustainably managed groundwater levels in the Basin will also mitigate impacts to undesirable groundwater storage declines.

3.2.6 Undesirable Results Summary

Table 3-1: Summary of Criteria to Identify Undesirable Results for Each Sustainability Indicator

Sustainability Indicator	Criteria to Identify Undesirable Results
Chronic lowering of Groundwater Levels	*More than 25% (9/35 wells) of representative monitoring wells for groundwater level and storage in the Basin fall below their MTs for 3 consecutive years.*
Reduction of Groundwater Storage	*Criteria for Chronic Lowering of Groundwater Levels (above) used as proxy (**Section 3.3.2**).*
Degraded Groundwater Quality	*More than two representative monitoring wells exceed the minimum threshold for nitrate, or more than two representative monitoring wells exceed the minimum threshold for specific conductance.*
Depletion of Interconnected Surface Water	*More than 25% (2/8 wells) of representative monitoring wells for ISW fall below their MTs for 3 consecutive years.*
Land Subsidence	*When subsidence exceeds 0.1 foot in a single year and a cumulative 0.5 foot [0.15 m] in any five-year period as measured in at least a 5 square mile area of the Subbasin.*

3.3 Minimum Thresholds (23 CCR § 354.28)

23 CCR § 354.28. Minimum Thresholds

> (a) *Each Agency in its Plan shall establish minimum thresholds that quantify groundwater conditions for each applicable sustainability indicator at each monitoring site or representative monitoring site established pursuant to Section 354.36. The numeric value used to define minimum thresholds shall represent a point in the basin that, if exceeded, may cause undesirable results as described in Section 354.26.*
>
> (b) *The description of minimum thresholds shall include the following:*

(1) The information and criteria relied upon to establish and justify the minimum thresholds for each sustainability indicator. The justification for the minimum threshold shall be supported by information provided in the basin setting, and other data or models as appropriate, and qualified by uncertainty in the understanding of the basin setting.
(2) The relationship between the minimum thresholds for each sustainability indicator, including an explanation of how the Agency has determined that basin conditions at each minimum threshold will avoid undesirable results for each of the sustainability indicators.
(3) How minimum thresholds have been selected to avoid causing undesirable results in adjacent basins or affecting the ability of adjacent basins to achieve sustainability goals.
(4) How minimum thresholds may affect the interests of beneficial uses and users of groundwater or land uses and property interests.
(5) How state, federal, or local standards relate to the relevant sustainability indicator. If the minimum threshold differs from other regulatory standards, the Agency shall explain the nature of and basis for the difference.
(6) How each minimum threshold will be quantitatively measured, consistent with the monitoring network requirements described in Subarticle 4.

Minimum thresholds (MTs) are numeric values set at Representative Monitoring Points (RMPs), that quantitatively define the values that may cause Undesirable Results for a given Sustainability Indicator if exceeded during the planning and implementation horizon. This section presents MTs for each Sustainability Indicator in the Basin.

3.3.1 Minimum Threshold for Chronic Lowering of Groundwater Levels

23 CCR § 354.28. Minimum Thresholds

(c) Minimum thresholds for each sustainability indicator shall be defined as follows:
  (1) Chronic Lowering of Groundwater Levels. The minimum threshold for chronic lowering of groundwater levels shall be the groundwater elevation indicating a depletion of supply at a given location that may lead to undesirable results. Minimum thresholds for chronic lowering of groundwater levels shall be supported by the following:
    (A) The rate of groundwater elevation decline based on historical trends, water year type, and projected water use in the basin.
    (B) Potential effects on other sustainability indicators.

Of all the sustainability indicators, groundwater levels are the easiest to understand and monitor, they directly relate to key beneficial uses of water, they can be used to interpolate groundwater level maps over space and time which are key for analysis, and they provide valuable calibration targets for groundwater flow models. For these reasons, this Plan emphasizes MTs and a monitoring approach built on groundwater level data, and relating the groundwater storage and ISW depletion sustainability indicators to the chronic lowering of groundwater levels, and GDE beneficial users. This, in this subsection, MT development for chronic lowering of groundwater is related to vulnerable wells, GDEs, and ISW.

3.3.1.1 Minimum Threshold Development

Minimum thresholds for chronic lowering of groundwater levels in the Basin were defined based on an analysis of historical, present-day, and projected groundwater level trends. Moreover, MT development considered climate change and extended drought conditions that may pose challenges to achieving the Plan’s MOs during the implementation time horizon, as well as simulations of projects and management actions that improve basin storage and increase groundwater levels.

CWC §10727.2(b)(4) states that "The plan may, but is not required to, address undesirable results that occurred before, and have not been corrected by, January 1, 2015". Thus, the starting assumption in setting Basin MTs is that a return to previously experienced historically low groundwater level conditions observed after 2015-01-01 would *not* result in significant and unreasonable impacts to beneficial uses and users of groundwater. By contrast, groundwater level declines *in excess* of relatively recent groundwater level lows experienced in the Basin around 2015-01-01 could represent unknown, significant and unreasonable impacts to beneficial uses and users.

First, these assumptions were tested with modeling and data analysis to estimate impacts to beneficial users (i.e., vulnerable wells, ISW, GDEs) assuming a return to historically low groundwater level conditions observed after 2015-01-01 (henceforth, post-2015 low)[24]. Results suggest minimal impact to beneficial uses and users of groundwater and support the assertion that a return to the post-2015 low would not lead to significant and unreasonable impacts on beneficial uses and users of groundwater.

However, future projected water use, inter-basin changes in flow, and climatic variability may put strain on SASb groundwater levels and cause even lower groundwater levels that those experienced after 2015-01-01. Therefore, a second round of analyses were conducted on 4 scenarios run by the CoSANA model, to "stress test" MTs lower than the post-2015 low caused by the combined effect of projected groundwater use, the impacts of climate change, and the benefits offered by regional conjunctive use and groundwater banking projects[25]. Across all scenarios evaluated, climate change reduced groundwater levels with impacts most acutely observed in ISW and GDEs; vulnerable wells were largely unaffected owing to their relatively deep depths compared to groundwater levels. Being closer to the land surface, GDEs and ISW are more easily impacted. Conversely, projects and management actions (PMA) substantially contributed to basin sustainability by offsetting the impacts of climate change and leading to the avoidance of significant and unreasonable impacts to ISW, GDEs, and vulnerable wells.

Thus, in this Plan, MTs are set at each RMP (Error! Reference source not found.**)** at the post-2015 low or the lowest groundwater level in the projected scenario with PMA and climate change, whichever is lower.[26]

The MT can be interpreted as the *lowest anticipated groundwater level assuming moderate temperature increases due to climate change, the best estimate of future water demand from water agencies, and the continued implementation of projects and management actions* (**Figure 3-1**).

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[24] The post-2015 low typically occurs in the fall of 2015 at most RMPs and is thus at times referred to as the "2015 fall low".

[25] For GSP planning purposes, only projects with adequate funding and a high probability of implementation (i.e., Harvest Water, OHWD recharge, regional conjunctive use – see Section 4) were considered. Henceforth these highly feasible, in-motion projects and management actions are referred to as PMA.

[26] In about half of representative monitoring points for groundwater 53%, projected management and climate change resulted in lower groundwater levels than the post-2015 low, although declines were minimal. The range (0 - 15.3 ft), median (0.5 ft), and mean (2.8 ft) values by which post-2015 lows are exceeded by those implied under the projected scenario tend to occur away from ISW and GDEs and are shown to not impact vulnerable wells.

Furthermore, because Undesirable Results due to chronic lowering of groundwater occur when "more than 25% (9/35 wells) of representative monitoring wells for groundwater levels and storage in the Basin fall below their MTs for 3 consecutive years" (**Section 3.2.1.2**), and numerical model simulations suggest the lowest groundwater levels during hydrologic conditions experienced from 2012-2016, the definition of, and criteria used to identify Undesirable Results, can be interpreted as *groundwater level conditions comparable to the combined impact of a 7 year-long extended drought*.

Importantly, groundwater levels may at times decline beyond MTs, but in non-drought years and over the long-term 20-year implementation time horizon of the Plan (and beyond), the basin is projected stay above MTs, trend towards Measurable Objectives (MOs), and achieve the Sustainability Goal. The Plan may also be granted an extension of five years beyond the 20-year sustainability timeframe if there is need for an extension, and if the Basin has made progress towards MOs and adopts a feasible work plan for achieving the Sustainability Goal within the extension timeframe (CWC Section 10727.2(b)(3)).

3.3.1.2 Groundwater Level Analysis: trends, water year type, projected water use, well protection, impacts to GDEs, ISW depletion

Groundwater level analysis and interpolation were used to evaluate the impact of historically observed groundwater conditions (and MTs based historical conditions) on well failure (i.e., domestic, agricultural, and public wells), depletions of ISW, and impacts to groundwater dependent ecosystems (GDEs). Although some Basin RMPs have historical groundwater level data as far back as 1970, these monitoring well data are sparse and insufficient for basin-wide interpolation and analysis. However, from spring 2005 to fall 2019, groundwater level data density is adequate for interpolation, thus data during this period were analyzed at a seasonal level (**Figure 3-2**) and used to define MTs .[27] The impact of these MTs on well protection measures, ISW depletion, and impacts to GDEs were assessed and found to not lead to significant and unreasonable impacts.

Trends: Trends, or linear projections based on groundwater level hydrographs over a time frame, were considered but not used to define MTs for two reasons. First, most groundwater level trends at RMPs in the Basin are not unambiguously upwards or downwards across the period of record, and hence, in this Basin the direction and magnitude of the resulting trendline is highly sensitive to the selected historical period.[28] Second, the period of record at RMPs are often not equivalent and contain missing data points, which give the points that are present excessive leverage (i.e., outlier influence over the slope of the resulting trendline). Therefore, the approach to define MTs developed in this Plan is based on observed groundwater conditions, water year type, projected water use, well protection, and the avoidance of impacts to ISW and GDEs.

Water Year Type: Hydrographs and interpolated groundwater elevation maps demonstrate seasonal oscillations that correspond to recharge and pumping (**Figure 3-3**), increasing groundwater levels during above normal and wet water year types, and declining groundwater

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[27] These groundwater level analyses extend the historical and current groundwater level summary presented in Chapter 2.

[28] Strong dependence of the trendline on the historical period chosen is demonstrated in hydrologic research, which shows that differences in the historical period used to project groundwater level trends can result in significantly different modeling results. For example, Pauloo et al., 2000 demonstrate that the difference between 1998-2017 and 2008-2017 linear groundwater level projections leads to a doubling of estimated well failure in California's Central Valley.

levels during dry and critical water year types (**Figure 3-14**). Prolonged dry and critical water year types have historically led to increased groundwater use to supplement unavailable surface water supply in the Basin. Conjunctive use and other projects and management actions (see **Section 4**) during wet periods are expected to bolster groundwater levels and thus and reduce groundwater level drawdown in the Basin during dry and critical water year types.

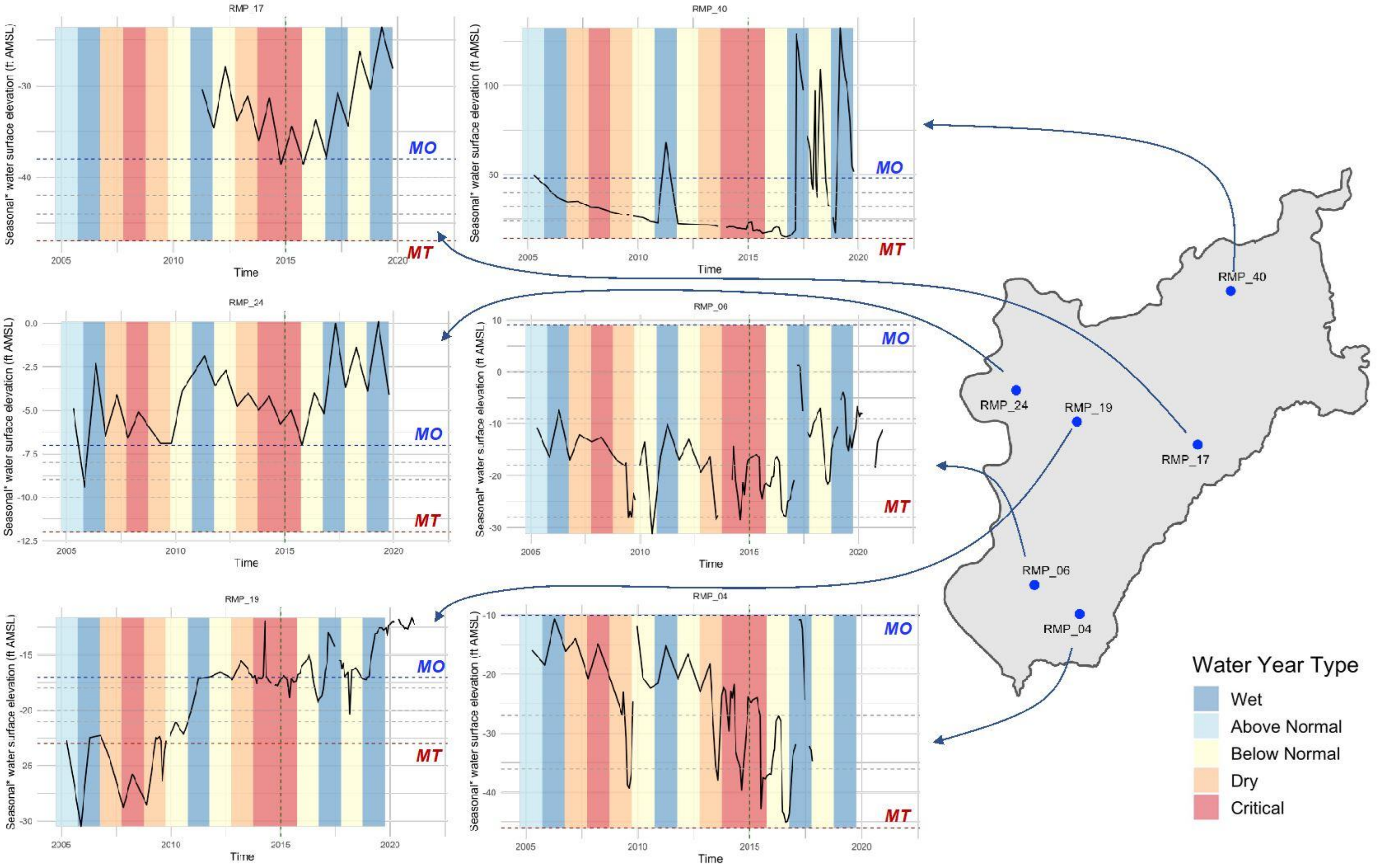

Figure 3-1: MTs, MOs, and IMs at 6 example RMPs in the GSP groundwater elevation monitoring network. MTs (red vertical dashed lines) are set at the lowest level in the projected budget (first column of hydrographs) or the 2015 low (second column of hydrographs), whichever is lower. MOs are set at the mean post-2015 low groundwater level and adjusted by the head difference between the 2015 low and the projected budget – for instance, this difference is negative where declines are expected, and positive within and near the Harvest Water plan area (a groundwater mound is expected). Interim milestones are spaced at integer values between the MT and MO. A green vertical dashed line at 2015-01-01 is drawn for reference.

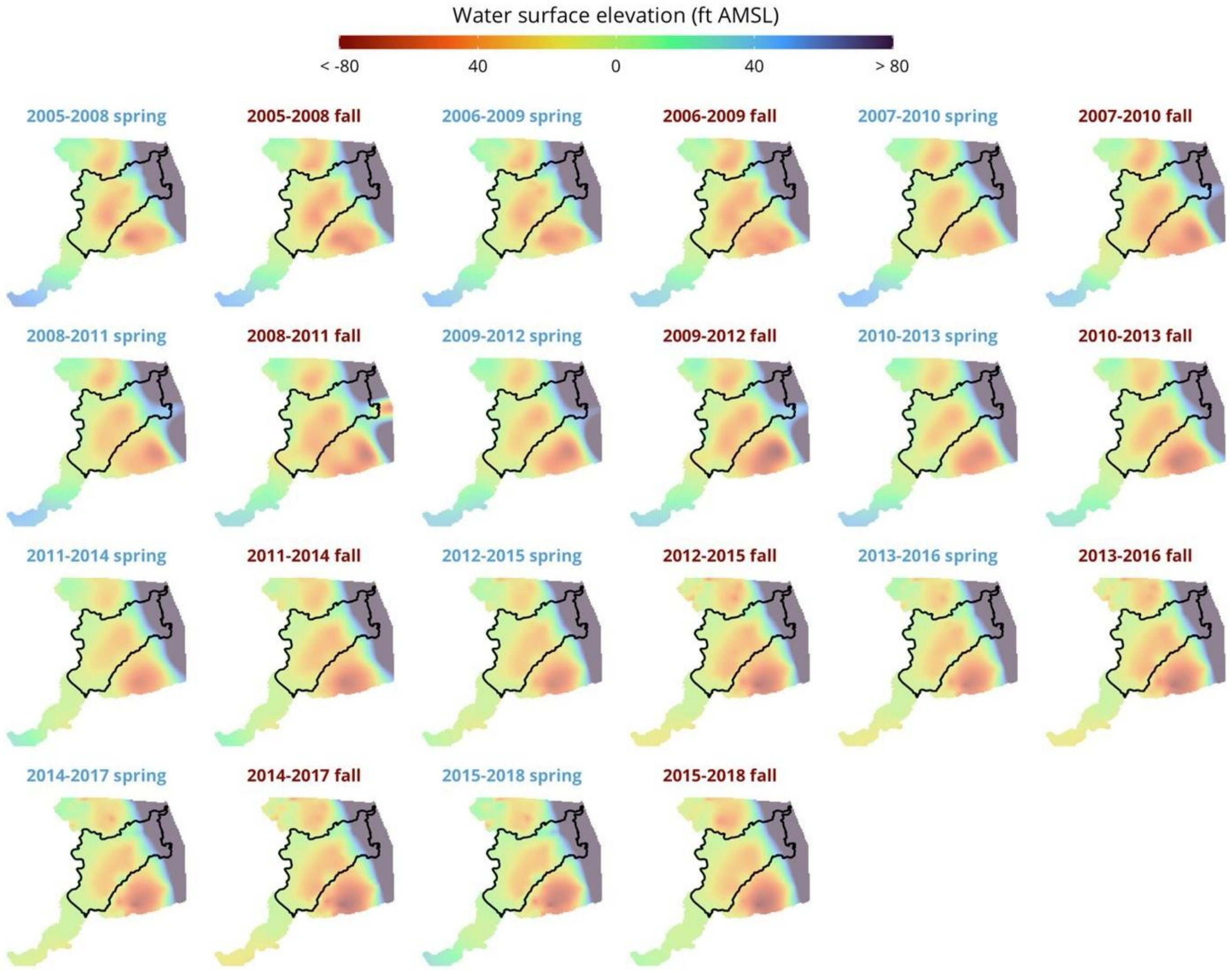

Figure 3-2: **Seasonal, 4 year running mean interpolated groundwater elevations in the Basin from spring 2005 to fall 2018.**

Levels show seasonal oscillation, with generally higher (blue) groundwater elevation in spring, and generally lower (red) groundwater elevation in the fall. Higher elevations occur along surface water corridors (north, south and west basin boundaries). Groundwater flows from areas of high (blue) to low (red) elevation. Mapping suggests groundwater flow inwards towards the center of the basin, coincident with areas of groundwater pumping.

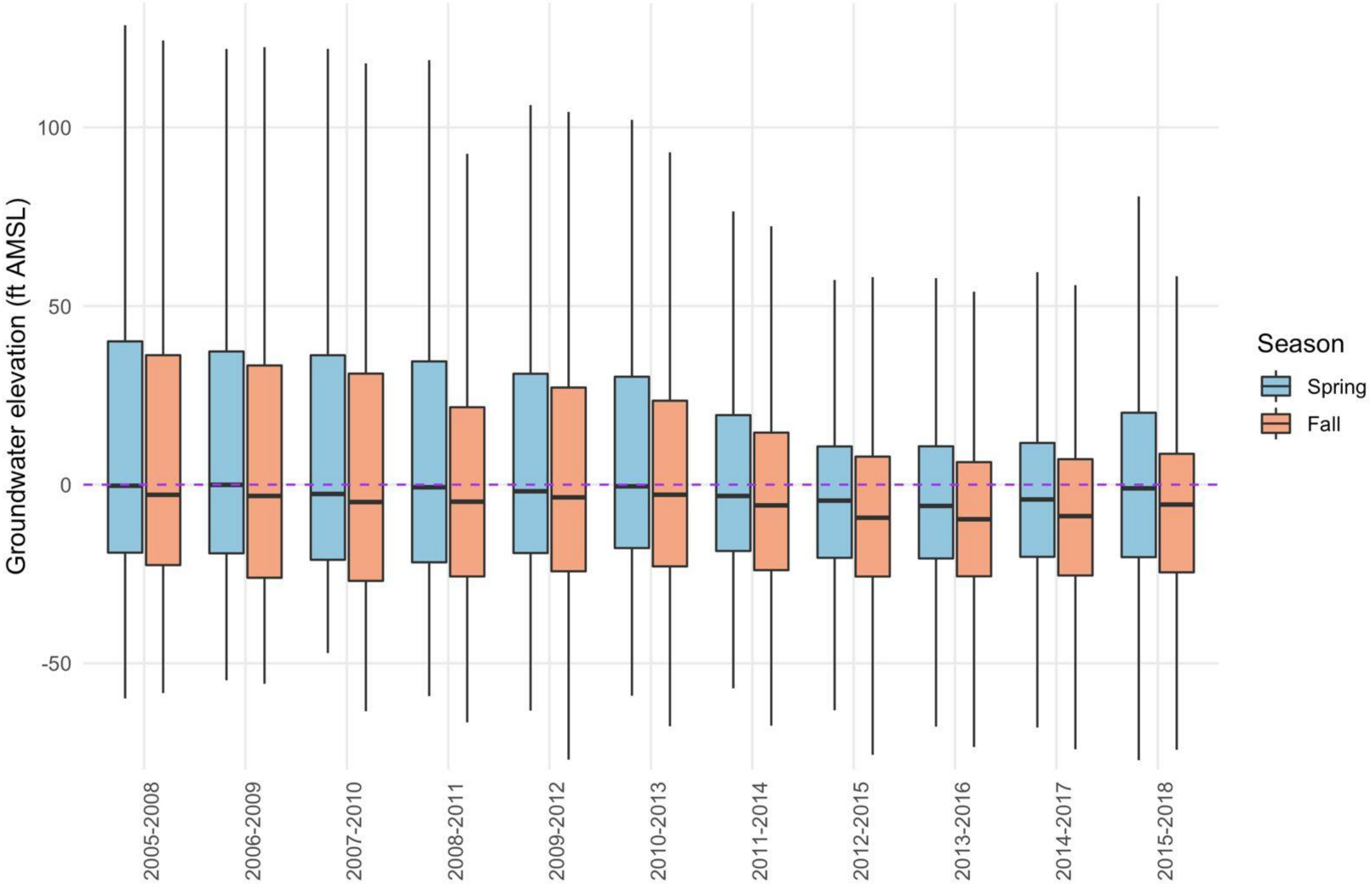

Figure 3-3: **Seasonal summary of interpolated groundwater elevations in the Basin** show oscillating seasonal medians, with consistently higher groundwater elevation in spring, and lower groundwater elevation in fall. Median fall groundwater elevation decreases over the period of record and reaches its lowest value during the average period of 2013-2016 due to the combined impact of 4 years of drought. After this minimum, spring and fall median groundwater levels trend upward. A purple, horizontal dashed line is shown at mean sea level elevation (0 feet) for reference.

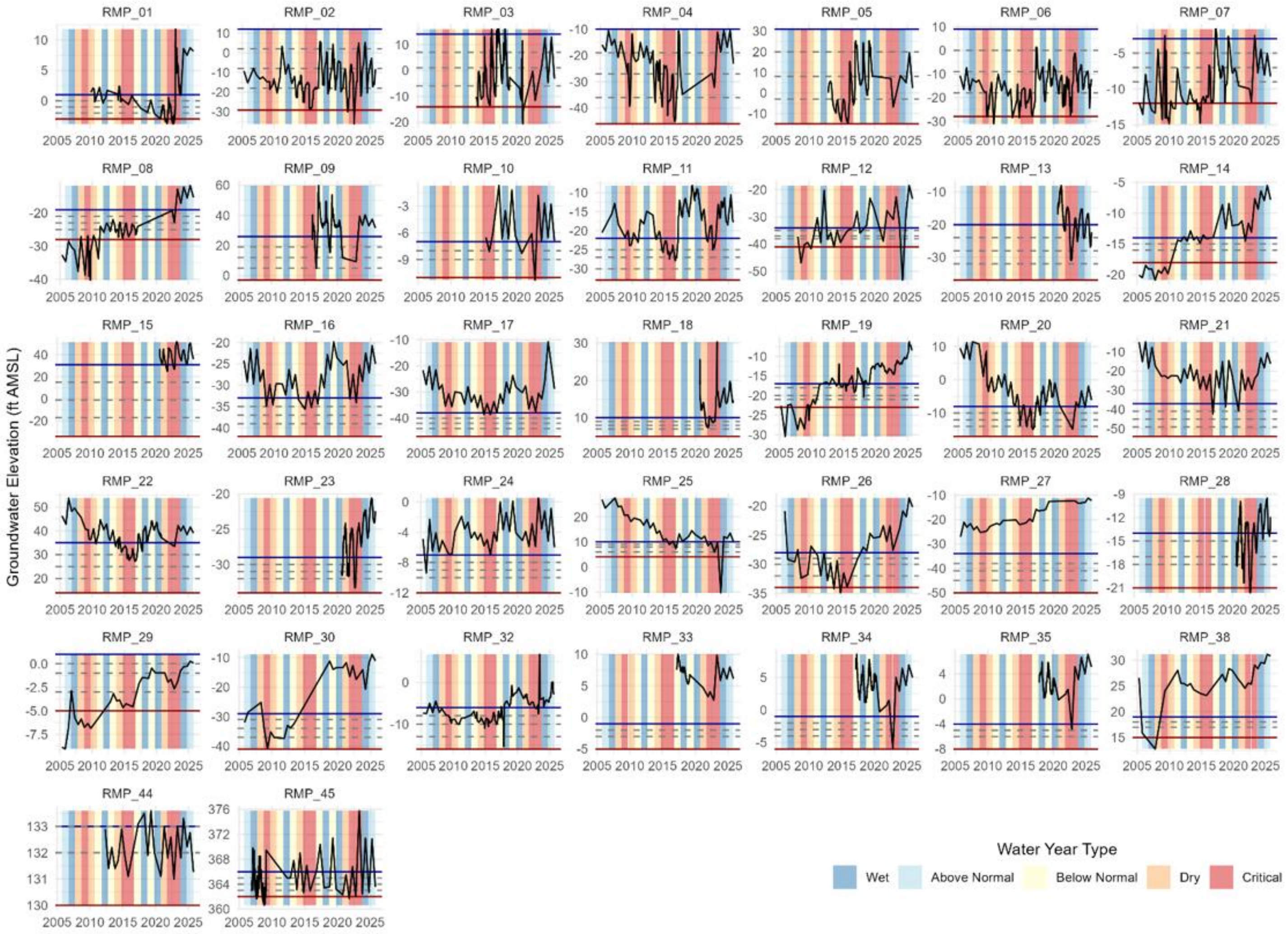

Figure 3-4: **Groundwater elevation and SMC at all 35 RMPs in the Basin.**
SMCs (Table 3-4) are drawn as horizontal dashed lines and indicate the MO, IMs and MT. In cases when the MT and MO differ by 3 feet or less, the operational flexibility is small, and an interim milestone may overlap with the MT or MO (

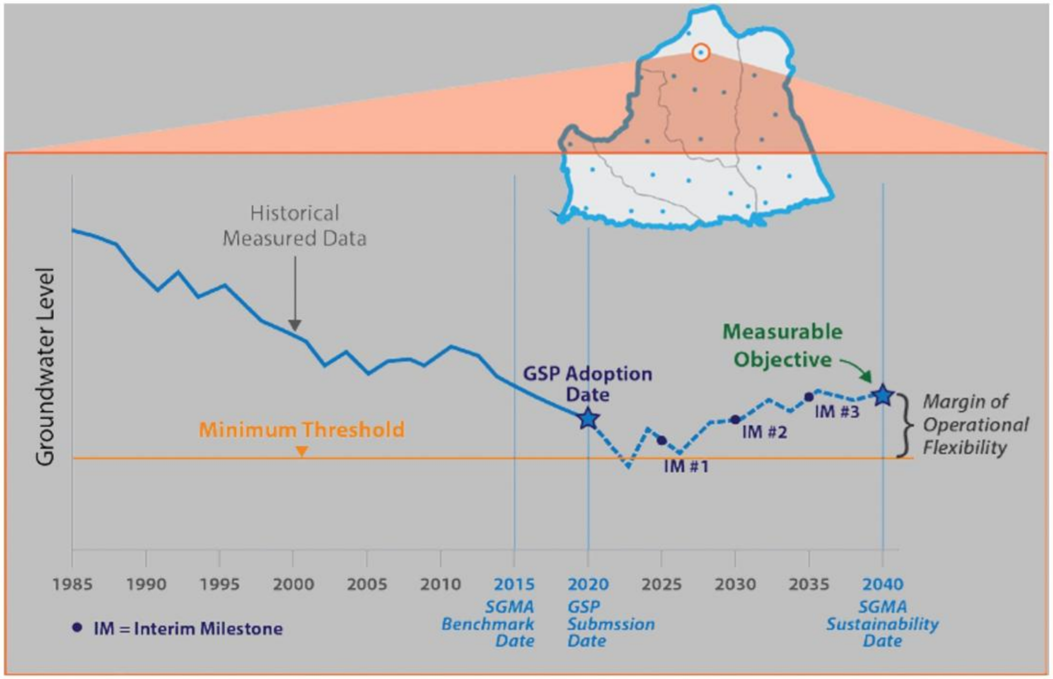

Figure 3-11: Minimum threshold, measurable objective, interim milestones, and operational flexibility at an example representative monitoring point
drawn from DWR Best Management Practices (CA-DWR, 2017).

Importantly, some RMPs are in critical monitoring locations, but may lack historical data or perforation interval information. These data gaps will be addressed during the Plan implementation by collecting monitoring data and performing field investigations (**Section 3.5.5**); thus, the MTs presented herein (**Table 3-4**) may change in the five-year Plan update pending new information.

To ease interpretation and implementation, MTs are rounded to the nearest integer value.

). A green vertical dashed line at 2015-01-01 is drawn for reference. Of these wells, 8 double as ISW monitoring wells.

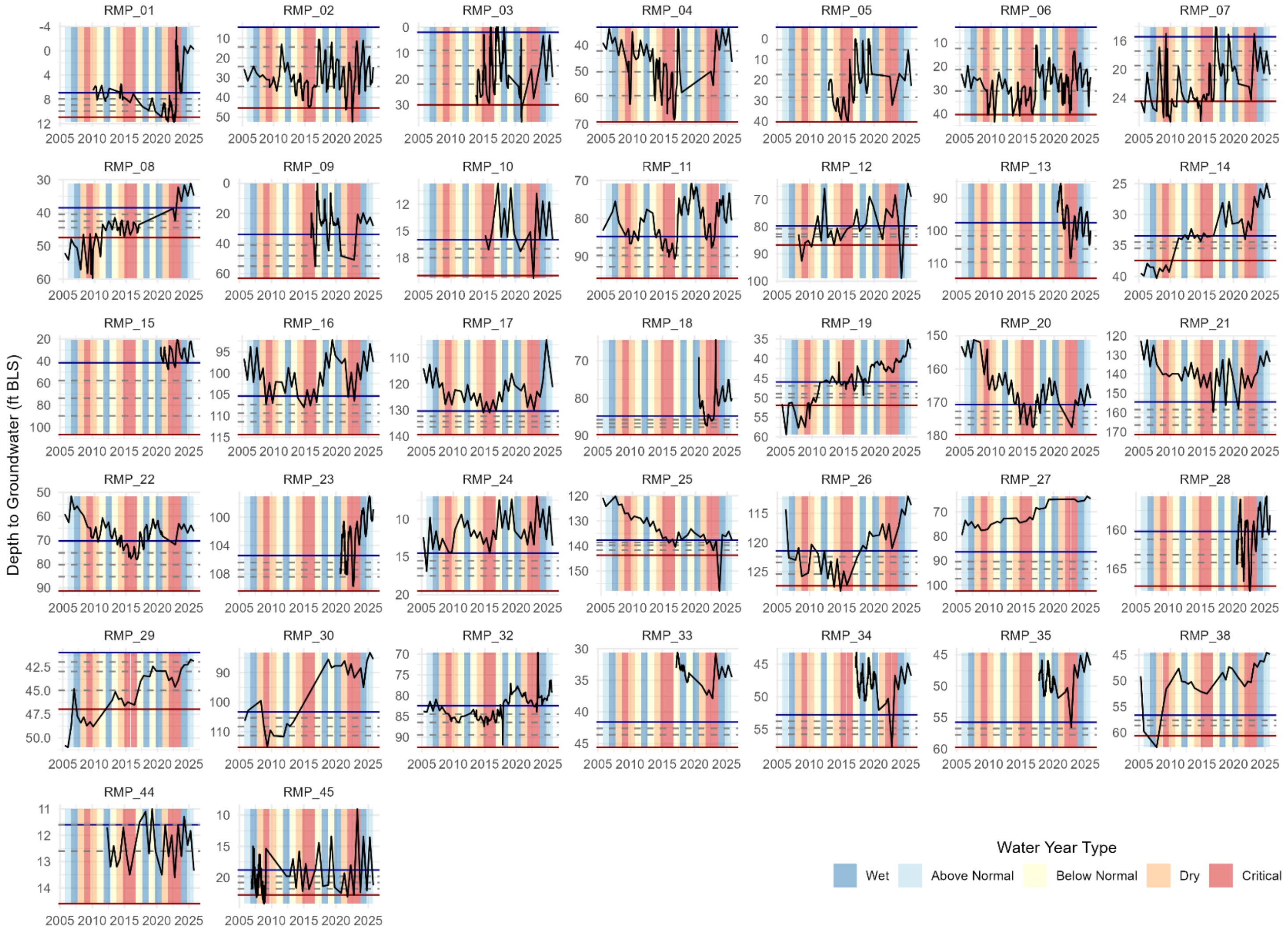

Figure 3-3-5: Depth to groundwater and SMC for all 35 RMPs in the Basin.
See **Appendix 3-B** for an RMP ID to SITE CODE key.

Projected Water Use: The CoSANA model was used to simulate:

- the combined effects of projected water use in the Basin;
- projects and management actions (PMA) already underway (Harvest Water, OHWD recharge, and regional conjunctive use); and
- climate change.

Estimates of future groundwater basin storage, groundwater level, and seepage from streams were then used to analyze impacts to key beneficial users of groundwater including: vulnerable wells (**Figure 3-3-6** and **Figure 3-3-7**), GDEs (**Figure 3-3-8**), and ISW (**Figure 3-9** and **Figure 3-10**). Results show minimal impacts to vulnerable wells, GDE area, and ISW locations and flow assuming projects and management actions occur, and median climate change outcomes are experienced.[29] Due to their importance as beneficial users of groundwater that the GSAs aim to protect, three attached technical memoranda detail in-depth studies and recommended management criteria for vulnerable wells, GDEs, and ISW.[30]

In all subsections that follow, groundwater level conditions at Fall 2015 are compared to groundwater level conditions at Fall 2015 in the repeated hydrology and corresponding to Fall 2065. Scenario abbreviations are:

- ***Baseline***: fall 2015
- ***Projected***: projected groundwater use
- ***Projected CC***: projected groundwater use with a median climate change warming scenario
- ***Projected PMA***: projected groundwater use considering feasible, in-progress projects and management actions (Harvest Water, OHWD recharge, regional conjunctive use)
- ***Projected PMA CC***: projected groundwater use considering feasible, in-progress projects and management actions (Harvest Water, OHWD recharge, regional conjunctive use) and with a median climate change warming scenario

Climate change (CC) scenarios are driven by changes in temperature and streamflow provided by the American River Basin Study (USBR, 2020) “central tendency” scenario, which reflect median temperature and precipitation outcomes. See **Section 2.4** for a more detailed description of this climate change scenario and the rationale for its use.

Well Protection: A detailed analysis of well protection is presented in **Appendix 3-C: Vulnerable well impact analysis in the South American Subbasin: well inventory,**

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[29] Significant variation in climate change scenarios is controlled for by evaluating the median outcome. Temperature primarily drives water consumption in conjunction with a land use model and assumes no intervention or land use change. Thus, modeled water use is conservative.

[30] See Appendix 3-C: Vulnerable well impact analysis in the South American Subbasin: well inventory, historical groundwater trends, and analysis to inform Sustainable Management Criteria (October 1, 2021), Appendix 3-D: Groundwater Dependent Ecosystems in the South American Subbasin (April 21, 2021), and 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 (June 18, 2021).

historical groundwater trends, and analysis to inform Sustainable Management Criteria, and a summary is given here.

The impact of a return to post-2015 low groundwater levels on wells in the Basin was evaluated and did not suggest significant and unreasonable impacts to wells exceeding 5% for any well type measures. Next, projected groundwater levels for each of the forward-simulated scenarios were analyzed alongside well construction information; results did not suggest a significant and unreasonable increase in impacts to wells (**Figure 3-3-6**). These results are unsurprising, as no wells were reported dry in the Basin during the 2012-2016 drought according to data from Cal OPR (Pauloo et al., 2020).

Well Completion Reports (CA-DWR, 2026) in the Basin were analyzed alongside groundwater elevation data to estimate the number of active wells (i.e., by filtering out wells older than a specified retirement age) assumed to be in operation at present-day groundwater level initial conditions (i.e., wells not already dry at initial groundwater level conditions). Next, potential significant and unreasonable impacts to vulnerable wells were evaluated at the lower of the post-2015 low or the lowest projected groundwater level (MTs). The count, cost, and location of impacted wells was estimated assuming MT levels were reached across the entire Basin.

The initial set of active wells included all wells completed on or after 1995-01-01 (31-year retirement age) with pump locations (estimated as 30 feet of operating margin above the total completed depth) below the present-day groundwater level (following Pauloo et al., 2021). To evaluate the sensitivity of retirement age on impacted wells, a second analysis was conducted for all wells completed on or after 1986-01-01 (40-year retirement age). Based on stakeholder feedback, additional scenarios were run with 50-year and 60-year retirement ages (1976 and 1966 respectively) to further evaluate the sensitivity of retirement age on expected well impacts.

Results across all scenarios suggest a range of 1-4 wells would be impacted under 31-year, 40-year, and 50-year retirement ages, and accounting for uncertainty in projected management and climate change (**Figure 3-3-6** and **Figure 3-3-7**). For a conservative estimate of PMA with climate change, impacted well count is around 0.3-0.5% of domestic wells and 0-1.1% of public wells, and 0.6-1.7%of agricultural wells, primarily in the greater Sacramento urban area. This is unsurprising, as groundwater level simulations indicate drawdown in these areas – areas which are also far away from the agriculture-rural interface where most vulnerable domestic wells are located. The 60-year retirement age shows 3.8% of domestic wells impacted under PMA with climate change, but the impacted estimate is 3.2% under Fall 2015 conditions (**Figure 3-3-7**). Given no wells were reported dry during 2012-2016 in the Subbasin, this suggests the 48 wells with ages between 50 and 60 years identified as impacted during Fall 2015 may have already retired or independently deepened. Wells that are retired between 50-60 years would not be impacted by future declines, and wells that may have been deepened are better protected from future declines. These well impact percentages align with GSA-driven definitions of unreasonable results to vulnerable wells.

Further, unacceptable well impacts are defined as dewatering or lost access to groundwater at a well that requires well deepening or pump lowering. Well rehabilitation costs for impacted wells, assuming a return to the MT at all RMPs, were estimated at around $300,000 - $700,000 following the cost structure of Pauloo et al. (2021), EKI (2020), and Gailey (2019), but would likely be less, as significant and unreasonable impacts occur when 25% of RMPs exceed MTs (**Section 3.2.1.2**), and less expensive rehabilitation costs such as pump lowering may be more appropriate in some situations (e.g., when operating margin exists). Estimated well impacts and their associated rehabilitation costs have been discussed with GSAs and shared during public meetings to solicit feedback from groundwater users in the basin, including domestic well users. The GSAs are committed to using information gleaned in these conversations and public meetings, and the insights in these analyses to design a shallow well rehabilitation fund to address well protection costs in the Basin (**Appendix 3-C**).

Furthermore, GSAs in the Basin are committed to engaging and coordinating with vulnerable well owners to anticipate, mitigate, and help remediate impacts to wells that directly result from unsustainable groundwater management.

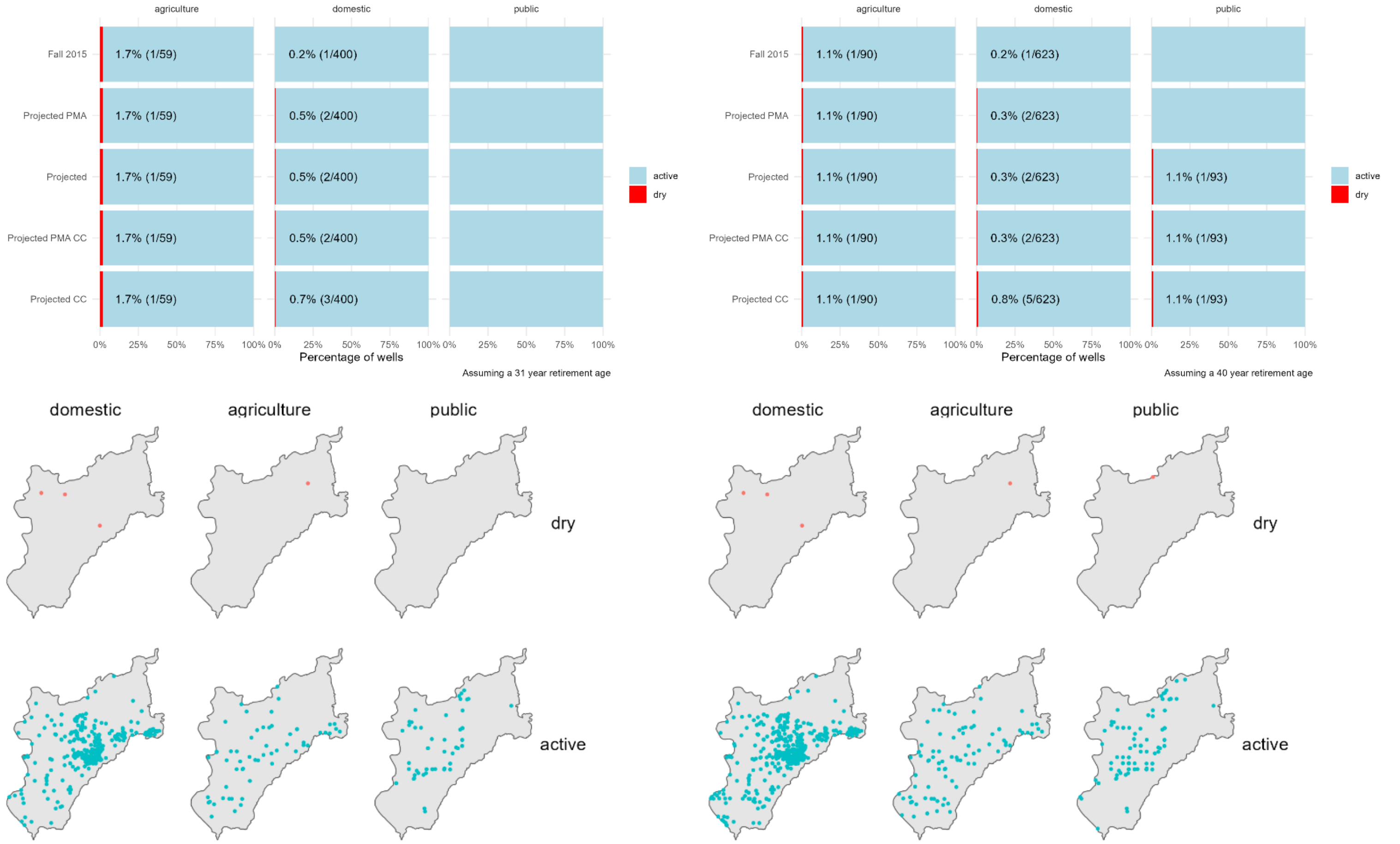


Figure 3-3-6: Vulnerable well impact analysis of a Fall 2015 baseline and 4 projected management conditions for a 31-year (left) and 40-year (right) well retirement age

Projected = Projected water use in the Basin. PMA = projects and management actions including Harvest Water, OHWD recharge, and regional conjunctive use. CC = climate change. Bar plots show well impact summary statistics for all scenarios and well types. Maps show results for the “Projected PMA CC” scenario on which groundwater level MTs are based.

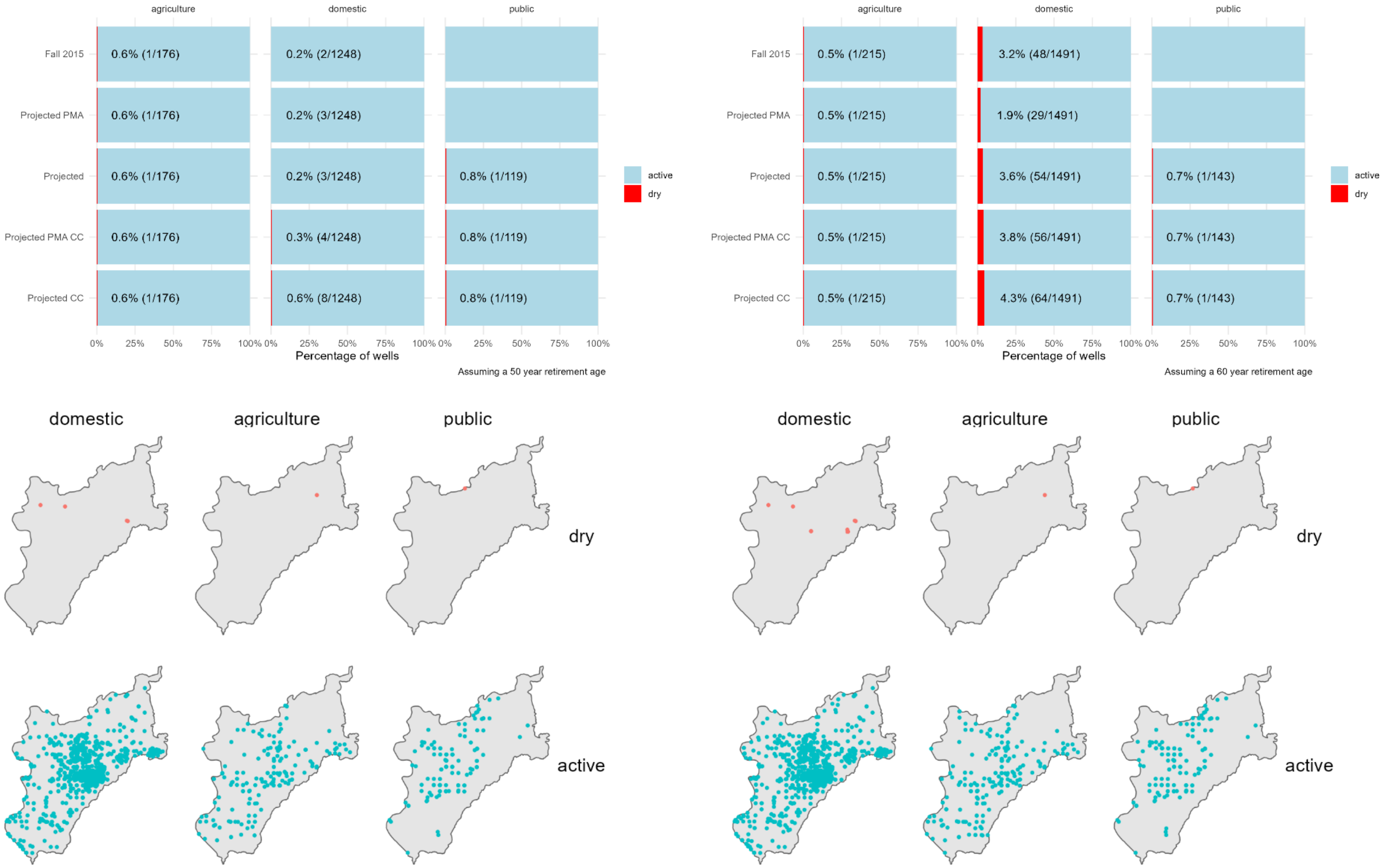


Figure 3-3-7: Vulnerable well impact analysis of a Fall 2015 baseline and four projected management conditions for a 50-year (left) and 60-year (right) well retirement age

Projected = Projected water use in the Basin. PMA = projects and management actions including Harvest Water, OHWD recharge, and regional conjunctive use. CC = climate change. Bar plots show well impact summary statistics for all scenarios and well types.

GDE Protection: A detailed analysis of well protection is presented in **Appendix 3-D: Groundwater Dependent Ecosystems in the South American Subbasin**, and a summary is given here.

GDEs were mapped using best available datasets across the Basin, and special status species were cataloged. The analysis focused on plant species which provide habitat for these special status species, in addition to providing valuable ecosystem functions and recreational benefits. The maximum reported rooting depths of the plant species found in the Basin range from near-surface for grasses like creeping wildrye (3.84 feet) to deep-rooted trees like the Valley Oak (24.31 feet). Rooting depths of species within the Basin show that the Valley Oak (Quercus lobata) was found to exhibit the largest rooting depth. Because plants can extract moisture from pore spaces away from the roots themselves, a threshold depth of 30 feet was used as a cutoff for the maximum depth of groundwater that could reasonably be accessed by a GDE within the Basin. Areas within the Basin where depth to groundwater is consistently greater than 30 feet are assumed incapable of supporting non-wetland GDE communities and by extension, any GDEs. In the context of identifying GDEs, this 30-foot depth threshold is conservative and overly inclusive as shallower groundwater is required to support a broader array of healthy GDEs for most plant species.

The historical areas occupied by potential GDEs were then classified into 4 categories (GDE, Potential GDE – likely, Potential GDE – unlikely, Not GDE) by relating observed, interpolated historical groundwater levels to GDE polygons and an assumed 30-foot rooting depth. Over the historical period analyzed (2005-2018), GDEs are found to occupy 43.2% of Potential GDE polygons considered (11,340 / 26,245 acres).

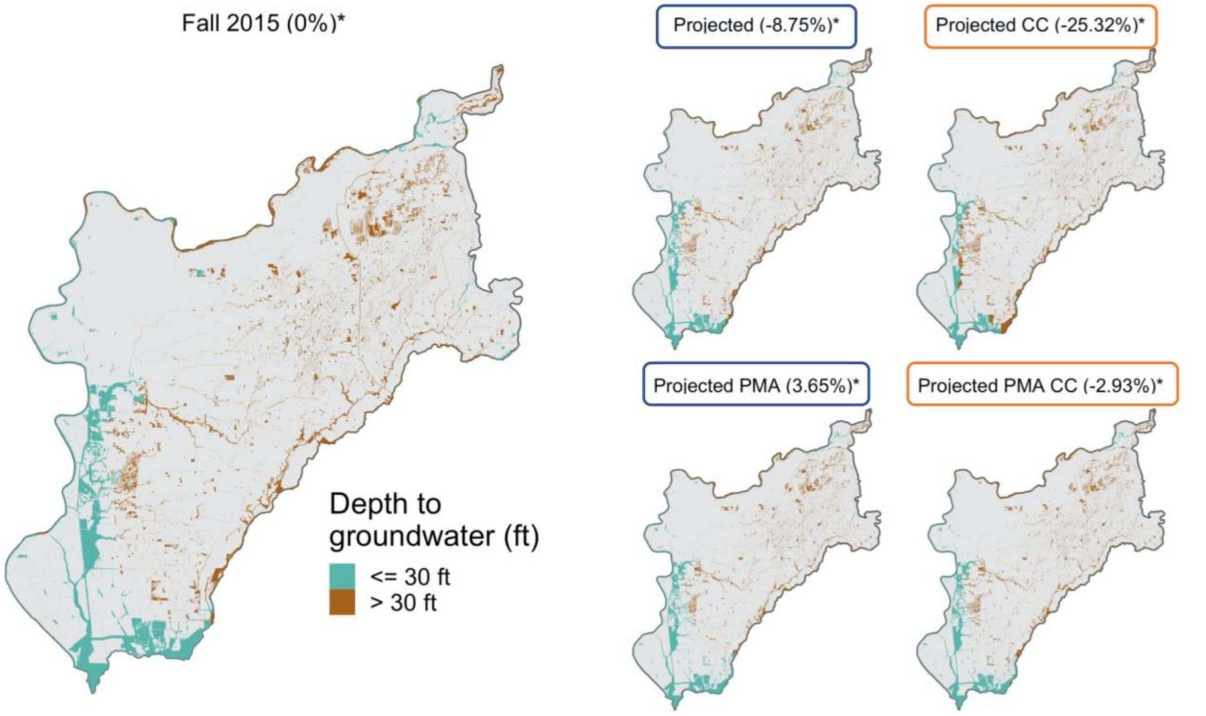
Next, NDVI was calculated across the 4 categories described above to determine historical variance in vegetation health. NDVI in GDE categories is consistently higher than non-GDE categories, which suggests remotely sensed estimates of plant health capture significant differences between GDE and non-GDE polygons.

These analyses informed the development of two quantitative criteria which may be used during Plan implementation to detect if GDE area or health fall below historically observed values (**Table 3-2**).

Table 3-2: Criteria to determine changes in GDE area and health that exceed historically observed minima

Criteria	Historical minimum observed	Quantitative metric
A: Proportion of Mapped Potential GDE Classified as “Assumed GDE” in Tier 1 GDE Likelihood Analysis	2013-2016 Fall	44%
B: Lowest Median NDVI for “GDE” in Tier 2 GDE Likelihood Analysis	June 2009	0.023

If either criteria A or B are observed for 3 consecutive years, Undesirable Results for GDEs occur. Importantly, 44% represents the minimum area of Potential GDE polygons classified as GDEs in the historical record and occurs during the 2012-2016 drought. Thus, a decline in GDE area (determined by a 30 foot depth to groundwater) exceeding 44% indicates a deviation from historically observed values and an undesirable result.



*compared to the 'Fall 2015' scenario

Figure 3-3-8: Impact analysis of projected groundwater level scenarios shows appreciable GDE impacts without PMA. However, PMA substantially buffer against impacts to GDEs, even given climate change, and especially in the southern portion of the Basin near the Harvest Water project. Percent changes reported are with respect to the Fall 2015 GDE area. For example, the "Projected PMA" scenario (projected conditions with projects and management actions) results in a 3.65% increase in potential GDE area compared to Fall 2015. The "Projected" and "Projected PMA" scenarios (blue border) should be compared, and the "Projected CC" and "Projected PMA CC" scenarios (orange border) should be compared. In each pair of comparable scenarios, scenarios with PMA lead to a less than 5% reduction of GDE area, and are generally more protective of GDEs than scenarios without PMA.

Projected management changes groundwater elevation, which directly impacts groundwater access for plants. Results indicate that PMA result in a 3.65% increase in potential GDE area to a -2.93% decrease in GDE area, depending on climate change. Without PMA, GDE area may decrease from -8.75% to -25.32%, depending on climate change. Percent change in all scenarios was evaluated with respect to a Fall 2015 baseline. Overall, considering climate uncertainties, results suggest that projected groundwater use with PMA is likely to maintain GDE area consistent with historical levels and thus avoid undesirable results experienced at the 44% area criteria for historical GDEs.

GSAs in the Basin are committed to cooperative, multi-benefit projects in coordination with land trusts, resource conservation agencies, neighboring basins, and other stakeholders to anticipate and mitigate impacts to GDEs that directly result from unsustainable groundwater management.

Avoidance of ISW Depletion: A detailed analysis of the scientific studies that led to the development of ISW SMC are presented in **Section 3.2.4** and **Appendix 3-A**, and a summary is given here.

A return to post-2015 low groundwater levels was evaluated and did not suggest significant and unreasonable reduction in ISW location, streamflow, or seepage. Compared to a Fall 2015 baseline, ISW locations in each of the projected scenarios evaluated do not appreciably change. These analyses indicate that significant and undesirable impacts to ISW are avoided at groundwater level MTs set at the lower of the post-2015 low (typically occurring in Fall 2015) or the low under projected management with PMA and climate change.

SGMA defines ISW as “surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted” (23 CCR § 351(o)). Thus, seasonal groundwater elevation mapping was used to separate persistently disconnected, stream nodes from connected nodes, and reach-level “Disconnected” and “Interconnected” classifications were assigned based on connection history (**Figure 3-9**). SMCs were then developed for Interconnected reaches. ISW characterization is consistent with ISW characterization in The Nature Conservancy’s ICONS web tool (TNC, 2021) and those in adjacent basins (North American and Cosumnes basins) that share boundaries with the South American Subbasin.

At Interconnected reaches in the Basin, CoSANA-calculated stream seepage indicates present-day and historical ISW depletion (**Section 3.2.4**). The magnitude of ISW depletion is controlled by the relative elevation between ISW and adjacent groundwater (i.e., the hydraulic gradient) – thus a management approach that arrests groundwater level decline also arrests the hydraulic gradient and places an upper limit on expected ISW depletion. However, for this monitoring approach to work, wells must be selected to capture the effects of an expanding cone of depression and a steepening of the hydraulic gradient which will eventually propagate to ISW and cause depletion. Hydraulic gradient analysis along transects from ISW were used to identify an appropriate distance (3,000 ft) from ISW at which to monitor hydraulic gradients, and this informed the subset of shallow groundwater level monitoring wells to use. Then, groundwater levels at these wells in projected management scenarios were related to impacts to ISW locations, streamflow, and seepage.

Projected management with PMA leads to a -2.62% to 0% reduction in ISW reach length depending on climate change and calculated over CoSANA stream nodes, which is within the 5% reduction in ISW reach length determined as significant and unreasonable. Note that the metrics to calculate ISW reach connection depend on sufficient groundwater level elevation data nearby and under ISW, as well as accurate ISW streambed elevation. Some uncertainty exists in these data which may be addressed in the future with high-resolution mapping and site surveys (**Section 3.5.5**).

Furthermore, ISW streamflow exceedance during the Chinook salmon fall-run (October – December) spawning migration was evaluated under each projected scenario and compared to baseline flow conditions (e.g., current long-term fall conditions from 1969-2018). Maintenance of flows (especially during dry months) is most important in the undammed Cosumnes River which is a focal point of local conservation efforts. By contrast, flows in the American and Sacramento rivers are heavily managed. Findings suggest sufficient flows to support spawning migration in Projected and Projected PMA scenarios, and importantly, that projected groundwater management will increase streamflow in the lower Cosumnes River compared to the current conditions baseline scenario and scenarios without PMA. Climate change has a substantial negative impact on streamflow that would cause greater than 10% change in the 50th percentile of exceedance flows in all rivers. Importantly, streamflow declines result from climate-driven changes in stream inflow (USBR, 2020), not unsustainable groundwater management. Reduced impacts to streamflow in the Cosumnes (compared to the American and Sacramento rivers) is largely due to benefits from the Harvest Water recharge project. This underscores the importance of multi-benefit conjunctive use and groundwater banking projects to offset the impacts of climate change (e.g., reduced streamflow).

A general concern is that groundwater management in the Basin may negatively impact critical flows for fish passage. Multiple studies report minimum flow targets at Michigan Bar for fish passage on the Cosumnes River. Anderson et al. (2004), Fleckenstein et al., (2004), Mount et al. (2001), which estimate flows of 32.8, 54.7, and between 40-45 cfs, respectively. Most recently, hydraulic modeling by US Fish and Wildlife Service (USFWS) as part of an initial passage analysis identified 180 cfs as the minimum bypass flow condition for both the McConnell and Michigan Bar locations along the Cosumnes River. Therefore, at the time of writing, the range of flow conditions required for fish passage based on the best available science ranges from 32-180 cfs. A 90% exceedance probability for the 32 cfs flow target reported by Anderson et al. (2004) is achieved in current conditions and in all scenarios evaluated (**Table 3-3**). Further, a 75% exceedance probability for the 45 cfs target from Mount et al (2001) is met across all scenarios. The projected PMA scenario has a median exceedance probability at 177 cfs, which is close to the USFWS estimate of 180 cfs needed for fish passage. Climate change has outsized effects of simulated streamflow and deserves more attention.

Table 3-3: October-December simulated streamflow for the American, Cosumnes, and Sacramento rivers under current conditions (Baseline), and projected scenarios.

River	Scenario	10th percentile (cfs)	25th percentile (cfs)	50th percentile (cfs)	75th percentile (cfs)	90th percentile (cfs)	% Difference in 50th percentile exceedance compared to Baseline
American	Baseline	4037	2714	2025	1283	914	0%
American	Projected PMA	4019	2699	2005	1266	892	-1%
American	Projected PMA CC	2346	2181	701	584	507	-65%
American	Projected	4020	2692	2000	1261	888	-1%
American	Projected CC	2337	2177	694	579	503	-66%
Cosumnes	Baseline	1662	523	154	47	35	0%
Cosumnes	Projected PMA	1695	564	178	59	45	16%
Cosumnes	Projected PMA CC	1752	462	143	52	37	-7%
Cosumnes	Projected	1679	537	164	52	40	6%
Cosumnes	Projected CC	1742	443	134	48	34	-13%
Sacramento	Baseline	36150	19323	13857	11294	8554	0%
Sacramento	Projected PMA	36441	19537	13969	11424	8672	1%
Sacramento	Projected PMA CC	24794	14612	11300	8206	6822	-18%
Sacramento	Projected	36421	19514	13943	11401	8648	1%
Sacramento	Projected CC	24763	14585	11270	8181	6797	-19%

Future studies may investigate functional flow metrics for the river, but insofar as SGMA pertains to flow in the Cosumnes, modeling suggests that projected management will not appreciably change streamflow from current conditions, thus avoiding significant and unreasonable impacts to beneficial users of groundwater. More work is needed to assess climate change impacts to ISW (**Section 3.5.5**) and will be completed before the 5 year plan update (2027).

Figure 3-9: Probable ISW reaches by name, Probable Disconnected reaches, and GSAs in the Basin.

Classification of reaches follows the methodology summarized in **Section 3.3.1.2**, and **Appendix 3-A**. Grey points indicate the locations of ISW RMPs in the GSP monitoring network.

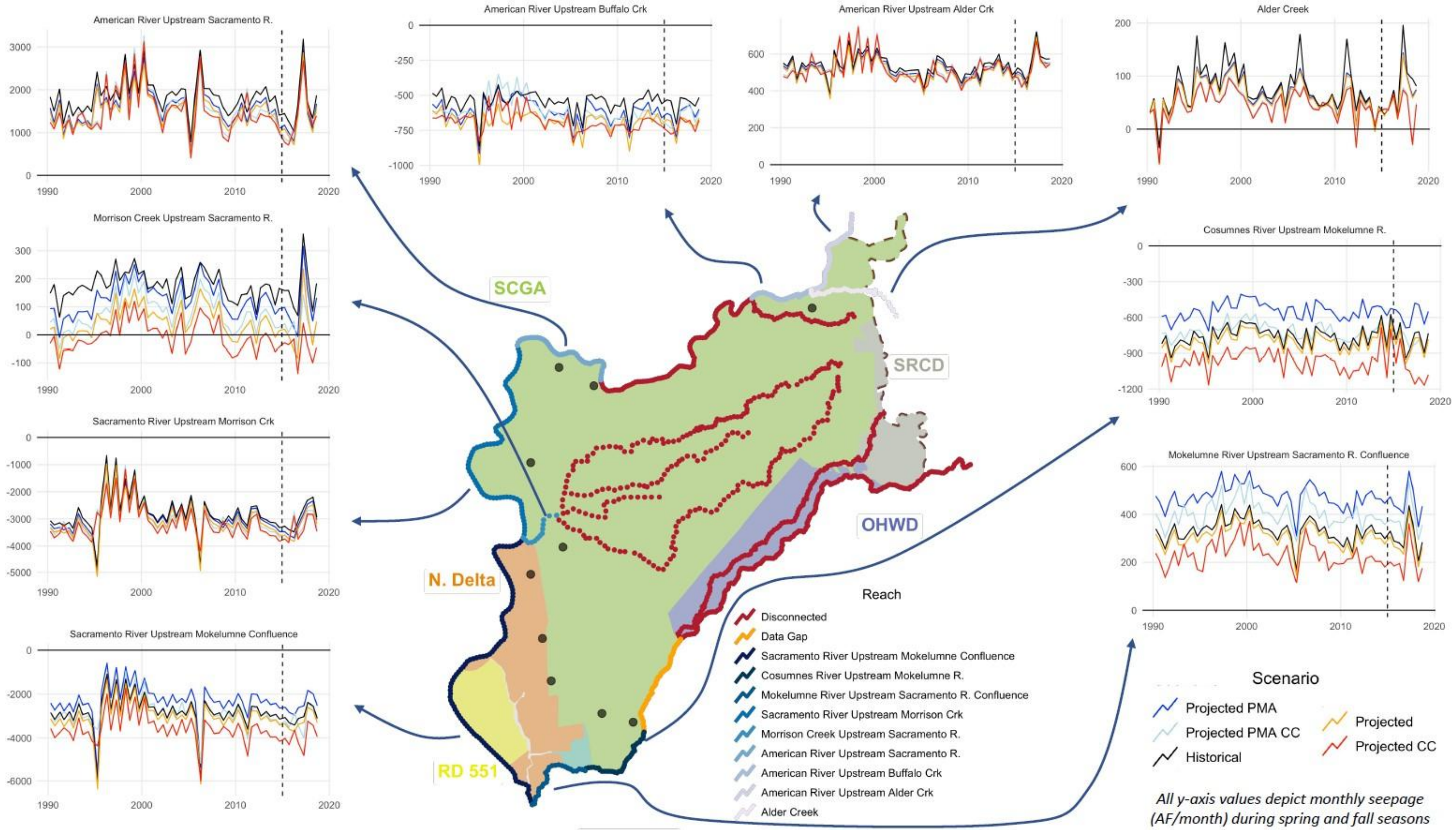


Figure 3-10: Seasonally averaged monthly seepage estimated by CoSANA at ISW designated reaches
over the current conditions baseline model simulation is relatively constant. Negative numbers indicate losing stream conditions (stream loss to groundwater) and positive numbers indicate gaining stream conditions (stream gain from groundwater). Spring (February - April) and fall (August - October) depletion rates are averaged per month in each 3-month seasonal window. A black vertical dashed line at 2015-01-01 is drawn for reference, and a black solid horizontal line at y = 0 indicates the transition from gaining to losing conditions. Most scenarios have little impact on seepage. The Cosumnes and Mokelumne gain more under projected conditions, even with climate change. Morrison Creek loses more in all scenarios.

Notably, reaches of the Cosumnes River approximately between Deer Creek and Twin Cities Road are disconnected on an average seasonal timescale, but evidence of short-term, flashy, sub-seasonal connection has been found. The role of these short-term connection events, and the prevalence of significant subsurface heterogeneity and perched zones make this region difficult to model and monitor. Thus, these reaches of the Cosumnes are considered a data gap for planning purposes, and more research and inter-basin coordination is needed to determine the nature of surface and groundwater interactions in this region. It is expected that by the next plan update (2027), a revised determination of ISW in this area will be developed (**Section 3.5.5**).

GSAs in the Basin are committed to cooperative, multi-benefit projects in coordination with land trusts, resource conservation agencies, neighboring basins, and other stakeholders to anticipate and mitigate impacts to ISW – and the beneficial users they support – that directly result from unsustainable groundwater management.

Impacts to adjacent basins: MTs were developed in coordination with the neighboring North American Subbasin and Cosumnes Subbasin. GSAs in these three basins will continue to coordinate the details of their Plans to model and evaluate the impact of MTs, and more broadly, MOs and project and management actions (PMAs) on achieving joint sustainability goals. No significant and unreasonable impacts resulting from management actions in the SASb are noted in adjacent basins.

3.3.1.3 Developed Minimum Thresholds

Figure 3-11 Figure 3-11 shows the conceptual relationship between MTs, Mos and IMs. As discussed in **Section 3.3.1**, developed minimum thresholds for chronic lowering of groundwater levels (**Table 3-4**) are based on a consideration of analyses that find the absence of significant and unreasonable dewatering of vulnerable wells (e.g., domestic, agricultural, and public wells), depletions of ISW, impacts to GDEs, and impacts to adjacent basins. The Basin's developed minimum thresholds are expressly designed with beneficial users of groundwater in mind. They represent groundwater levels which, if reached across the entire basin would result in significant and unreasonable impacts to these beneficial users. However, the identification of Undesirable Results which occurs when 25% of monitoring wells exceeds MTs for 3 consecutive years is also designed to be conservative: analyses of impacts to beneficial users assume 100% of the Basin reaches the MT surface. Thus, the impacts actually experienced if criteria to identify Undesirable Results are observed are likely to be less severe than analyses suggest (25% versus 100% of RMPs exceeding MTs). **Table 3-5** lists eight wells that have been moved from SGMA representative wells to SGMA wells because of their locations in or near the Aerojet and Mather super funds and because the GSAs have no control over the management in superfund site areas.

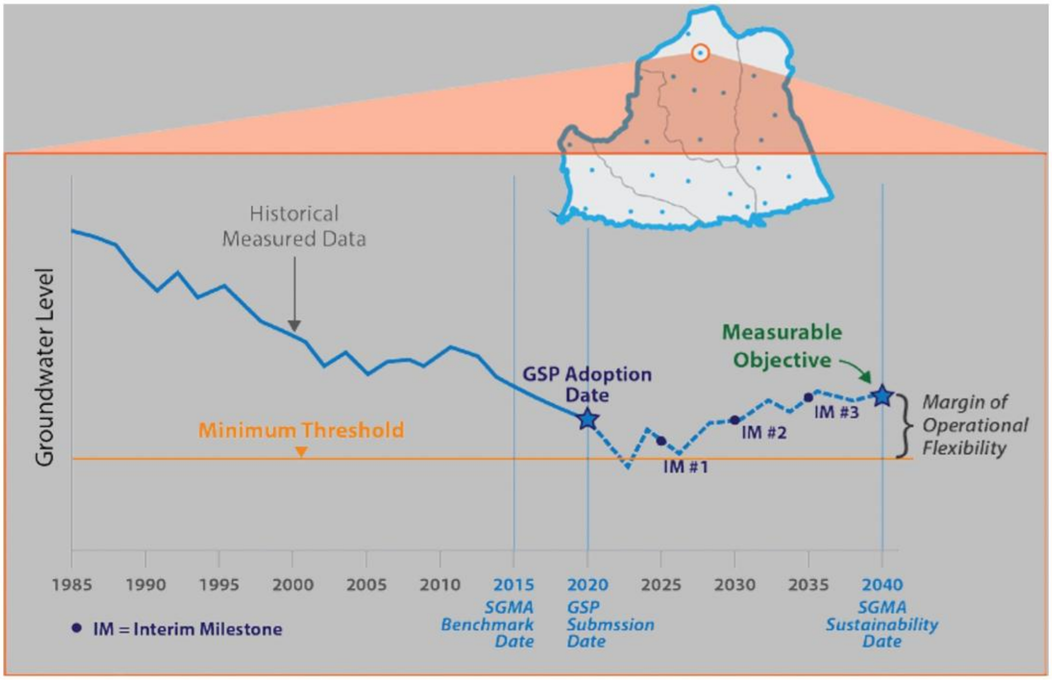


Figure 3-11: Minimum threshold, measurable objective, interim milestones, and operational flexibility at an example representative monitoring point drawn from DWR Best Management Practices (CA-DWR, 2017).

Importantly, some RMPs are in critical monitoring locations, but may lack historical data or perforation interval information. These data gaps will be addressed during the Plan implementation by collecting monitoring data and performing field investigations (**Section 3.5.5**); thus, the MTs presented herein (**Table 3-4**) may change in the five-year Plan update pending new information.

To ease interpretation and implementation, MTs are rounded to the nearest integer value.

Table 3-4: Sustainable management criteria for groundwater level decline, storage, and ISW depletion.

All 35 RMP wells in the network are used to track groundwater level and storage sustainability indicators, and a subset of 8 wells is used to track ISW depletion ("ISW RMP" column). See **Appendix 3-B** for an RMP ID to SITE CODE key.

				Interim milestones (ft AMSL) [c]									
Well ID	MT (ft AMSL)	Date last measured	Last measured elevation (ft AMSL)	IM (2027)	IM (2032)	IM (2037)	MO (ft AMSL)	Operational flexibility (ft)	ISW RMP[d]	Depth (ft)	Perforated interval (ft)	Lng (NAD83)	Lat (NAD83)
RMP_01[a]	-3	10/8/25	-3	-2	-1	0	1	4		20	NA-NA	-121.467	38.2604
RMP_02	-29	12/2/25	-8	-18	-8	2	12	41	TRUE	334	NA-NA	-121.39	38.2939
RMP_03	-14	10/9/25	-3	-6	1	7	14	28		39.5	30-40	-121.382	38.2967
RMP_04	-46	10/8/25	-35	-36	-27	-19	-10	36	TRUE	165	NA-NA	-121.422	38.3009
RMP_05	-15	10/9/25	8	-3	8	20	31	46		43	38-43	-121.379	38.31263
RMP_06	-28	12/2/25	-11	-18	-9	0	9	37	TRUE	125	88-125	-121.474	38.327
RMP_07	-12	10/8/25	-10	-9	-7	-5	-3	9	TRUE	200	NA-NA	-121.483	38.361
RMP_08	-28	10/8/25	-24	-25	-23	-21	-19	9		200	NA-NA	-121.455	38.3728
RMP_09	-3	10/17/25	12	5	12	19	26	29		97	57-97	-121.31944	38.379167
RMP_10	-11	10/8/25	-8	-9	-8	-8	-7	4	TRUE	175	135-175	-121.495	38.4125
RMP_11	-33	12/9/25	-15	-30	-27	-25	-22	11		NA	125-250	-121.324	38.415
RMP_12	-41	10/7/25	-27	-38	-37	-35	-34	7		508	NA-NA	-121.374	38.4202
RMP_13	-37	10/14/25	-21	-32	-28	-24	-20	17		119	90-119	-121.2396	38.4322723
RMP_14	-18	10/8/25	-12	-16	-16	-15	-14	4	TRUE	170	NA-NA	-121.462	38.4343
RMP_15	-34	10/15/25	26	-17	-1	15	31	65		121.5	73-113	-121.25129	38.439918
RMP_16	-42	10/7/25	-25	-39	-37	-35	-33	9		210	NA-NA	-121.303	38.4425
RMP_17	-47	10/7/25	-30	-44	-42	-40	-38	9		300	NA-NA	-121.286	38.4532
RMP_18	5	10/13/25	8	7	8	9	10	5		111.5	70-111.5	-121.20294	38.471742
RMP_19	-23	12/5/25	-12	-21	-20	-18	-17	6		382	149-375	-121.425	38.4738
RMP_20	-17	10/17/25	-8	-14	-12	-10	-8	9		NA	130-655	-121.231	38.478
RMP_21[b]	-54	10/9/25	-41	-49	-45	-41	-37	17		340	NA-NA	-121.261	38.4798
RMP_22	14	10/17/25	37	20	25	30	35	21		135	68-135	-121.18	38.493
RMP_23	-34	10/14/25	-32	-32	-31	-30	-29	5		216	196-206	-121.31398	38.500392
RMP_24[a]	-12	10/8/25	-5	-10	-9	-8	-7	5	TRUE	172	NA-NA	-121.495	38.5021
RMP_25	4	10/7/25	11	6	8	9	10	6		130	NA-NA	-121.22	38.5038
RMP_26	-34	10/7/25	-25	-32	-30	-29	-28	6		425	132-140	-121.302	38.519
RMP_27	-50	10/7/25	-34	-45	-41	-38	-34	16		164	132-164	-121.363	38.5223
RMP_28	-21	10/14/25	-20	-18	-17	-15	-14	7		420	275-420	-121.25873	38.527911
RMP_29	-5	10/8/25	19	-3	-1	0	1	6		72	NA-NA	-121.428	38.5343
RMP_30[a]	-41	10/7/25	-13	-37	-34	-31	-29	12		236	150-231	-121.339	38.5469
RMP_32[a]	-16	12/5/25	-4	-13	-10	-8	-6	10		125	63-125	-121.32401	38.558
RMP_33[a]	-5	10/30/25	7	-3	-3	-2	-1	4	TRUE	215	27-47	-121.43028	38.5637222
RMP_34[a]	-6	10/30/25	5	-4	-3	-2	-1	5		215	185-205	-121.42397	38.5671944
RMP_35[a]	-8	10/30/25	3	-6	-5	-5	-4	4		310	175-195	-121.42581	38.5679444
RMP_38	15	10/7/25	26	17	18	18	19	4		85	NA-NA	-121.317	38.5849
RMP_44	130	10/7/25	131	132	132	133	133	3		170	135-165	-121.188	38.6578
RMP_45	362	10/9/25	362	363	364	365	366	4		85	55-85	-121.117	38.6895

(a) These 6 RMPs have data gaps in historical groundwater levels and were reviewed with the additional information collected since 2021. All SMCs remained the same.

(b) The MT for this data point is based on the 2009 fall low due to a significant data gap between 2014 and 2019.

(c) When the operational flexibility, or difference between MOs and MTs is 3 feet or less, one or more IMs may be the same as MOs due to rounding of SMCs to integer values.

(d) When TRUE, this indicates the well is also used to monitor for ISW depletion in addition to groundwater level and storage sustainability indicators.

Table 3-5: Additional SGMA monitoring wells for groundwater level decline, storage, and ISW depletion.

Well ID	MT (ft AMSL)	Date last measured	Last measured elevation (ft AMSL)	ISW RMP(a)	Depth (ft)	Perforated interval (ft)	Lng (NAD83)	Lat (NAD83)
RMP_31	-22	10/7/25	-13		562	302-462	-121.259	38.5543
RMP_36	68	10/7/25	74		675	180-200	-121.187	38.5707
RMP_39	99	9/30/25	106		102	79-102	-121.2051	38.5889223
RMP_41	90	12/5/25	113		285	197-269	-121.162	38.592
RMP_42	102	10/1/25	109	TRUE	72	67-72	-121.20659	38.6260795
RMP_43	198	10/2/25	204		138	128-138	-121.17881	38.6358326

(a) When TRUE, this indicates the well is also used to monitor for ISW depletion in addition to groundwater level and storage

3.3.2 Minimum Threshold for Reduction of Groundwater Storage

23 CCR § 354.28. Minimum Thresholds

> *(c) Minimum thresholds for each sustainability indicator shall be defined as follows:*
> *(2) Reduction of Groundwater Storage. The minimum threshold for reduction of groundwater storage shall be a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results. Minimum thresholds for reduction of groundwater storage shall be supported by the sustainable yield of the basin, calculated based on historical trends, water year type, and projected water use in the basin.*
> *(d) An Agency may establish a representative minimum threshold for groundwater elevation to serve as the value for multiple sustainability indicators, where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual minimum thresholds as supported by adequate evidence.*

The minimum threshold for the reduction in groundwater storage is the rate or volume of groundwater which can be withdrawn from the Basin without leading to undesirable results. Groundwater storage change is not directly measurable. Rather, it is estimated by the CoSANA groundwater flow model, which depends on accurate groundwater levels and a robust HCM. Groundwater storage is the three-dimensional equivalent of groundwater level (two-dimensional) over a depth, and reduction of groundwater storage generally indicates (and is associated with) groundwater level decline.

Given that the MT for chronic lowering of groundwater (**Section 3.3.1**) protects beneficial uses and users of groundwater, and that groundwater level and storage are directly correlated, groundwater level MTs are used as a proxy for the reduction of groundwater storage sustainability indicator MTs.

The use of groundwater level as a proxy for the reduction of groundwater storage requires that “minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of [reduction in groundwater storage] will be prevented” according to CA-DWR Best Management Practices, (CA-DWR, 2017).

To demonstrate that SMC for the chronic lowering of groundwater level protect against significant and unreasonable reduction in groundwater storage, the change in groundwater storage under the current conditions baseline was compared to the change in storage implied under projected groundwater management and climate change scenarios **(Figure 3-12)**. In three of four scenarios evaluated, the lowest basin storage experienced occurs around simulation year 2065 (a repeat of 2015 hydrology), yet at this global minimum in the storage estimate, the basin storage still exceeds the fall 2015 low. The Basin has historically avoided overdraft, and through substantial investment in conjunctive use and recharge projects, is on track to avoid overdraft during and after Plan implementation. As before only currently implemented projects are considered in these storage projections (Harvest Water, OHWD recharge, regional conjunctive use).

Because groundwater level SMC are set based on spatially distributed modeled head differences which are then applied to observed groundwater level data, the spatial un-evenness of changes in groundwater storage are captured at RMPs, and it is unlikely that the Plan's groundwater level MTs would lead to significant and unreasonable reduction of groundwater storage. Hence, MTs for reduction of groundwater storage in the Basin are identical to those related to chronic lowering of groundwater level.

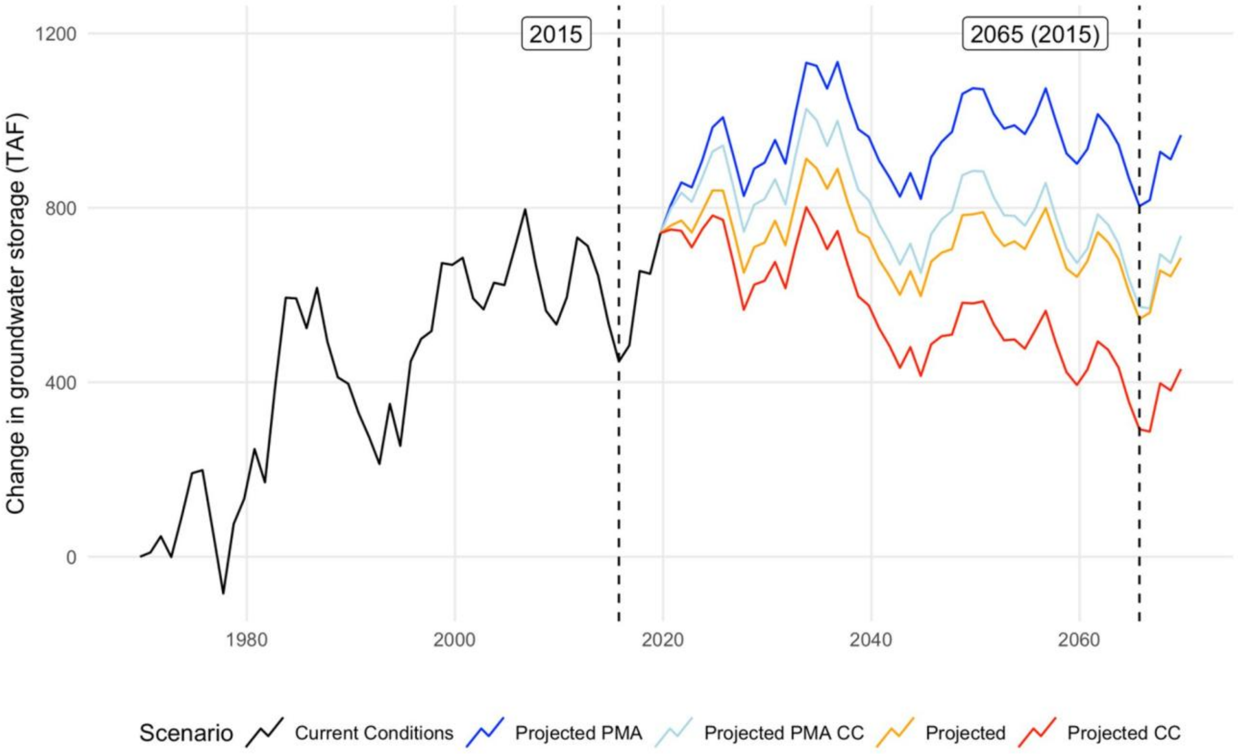


Figure 3-12: Cumulative change in groundwater storage under the current conditions baseline (black line), and the four scenarios (dark blue, light blue, orange, and red line) evaluated to aid in development of Basin SMC. Importantly, projects and management actions (PMA) increase storage, and climate change (CC) reduces storage. For consistency, all points represent September groundwater storage changes.

3.3.3 Minimum Threshold for Degraded Groundwater Quality

Minimum thresholds for groundwater quality in the Subbasin have been defined using existing groundwater quality data, beneficial uses of groundwater in the Subbasin, and existing pertinent water quality regulations, including water quality objectives defined under the Sacramento-San Joaquin Basin Plan, Title 22 Primary and Secondary MCLs, and consultation with the GSP Working Group members and stakeholders (see **Section 2.2.3**). As a result of this process, SMCs were developed for two of the constituents of concern in the Subbasin: nitrate and specific conductance. The selected minimum thresholds for the concentration of each of the constituents of concern and their associated regulatory thresholds are shown in **Table 3-6**. Significant and undesirable results for groundwater quality occur when the number of monitoring wells with exceedances is greater than the number of monitoring wells that had exceedances prior to May 22, 2020. Exceedances already exist at some monitoring wells, and these exceedances will likely continue into the future. The minimum threshold for the number of allowed exceedances is therefore equal to the number of monitoring wells that experienced exceedances prior to May 22, 2020 (two for nitrate, and two for specific conductance). The identification of Undesirable Results is therefore based on the number of monitoring wells to have exceedances for each nitrate and specific conductance, not necessarily the same monitoring wells..

Table 3-6: Constituents of concern and the associated minimum thresholds.
Minimum thresholds also include no more than two representative monitoring wells exceeding the minimum threshold listed here for nitrate or specific conductance.

Constituent	Minimum Threshold	Regulatory Threshold
Nitrate as Nitrogen	5 mg/L, trigger only 9 mg/L, trigger only 10 mg/L, MT	10 mg/L (Title 22 Primary MCL)
Specific Conductance	900 micromhos/cm, trigger only 1600 micromhos/cm, MT	900 – 1600 micromhos/cm (Title 22 SMCL)

Triggers

The GSAs will use concentrations of the identified constituents of concern (nitrate and specific conductance) below the minimum threshold as triggers for action in order to proactively avoid the occurrence of undesirable results. Trigger values are identified for both nitrate and specific conductance, as shown in **Table 3-6**. The trigger value for specific conductance is the recommended SMCL of 900 micromhos/cm. The trigger value for nitrate is 50% and 90% of the Title 22 MCL. Approaching or exceeding a trigger will be reported in the annual reports and the five-year evaluations.

Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

Two constituents of concern (nitrate and specific conductance) were identified due to measured exceedances of water quality standards or water quality objectives during the past 30 years and/or stakeholder input and prevalence as a groundwater contaminant of concern in California. A detailed discussion of the concerns associated with elevated levels of each constituent of concern is described in **Section 2.2.3**. Because the constituents of concern were identified using current and historical groundwater quality data, the list may be reevaluated during future GSP updates. In establishing minimum thresholds for groundwater quality, the following information was considered:

- Feedback about water quality concerns from stakeholders.
- An assessment of available current and historical groundwater quality data from production and monitoring wells in the Subbasin.
- An assessment of historical compliance with federal and state drinking water quality standards and water quality objectives.
- An assessment of trends in groundwater quality at selected wells with adequate data to perform an assessment.
- Information regarding sources, control options, and regulatory jurisdiction pertaining to constituents of concern.
- Input from stakeholders resulting from the consideration of the above information in the form of recommendations regarding minimum thresholds and associated management actions.

The current and historical groundwater quality data used in the effort to establish groundwater quality minimum thresholds are discussed in **Section 2.2.3**. Based on a review of these data, applicable water quality regulations, Subbasin water quality needs, and information from stakeholders, the GSAs reached a determination that the state drinking water standards (MCLs/SMCLs) are appropriate to define minimum thresholds for groundwater quality (**Table 3-6**). The established minimum thresholds for groundwater quality protect and maintain groundwater quality for existing or potential beneficial uses and users. Minimum thresholds align with the state standards for nitrate and specific conductance, and the Title 22 MCLs and SMCLs.

The evaluation of water quality in the Subbasin identified elevated concentrations of arsenic, iron, and manganese. These constituents were not assigned SMCs because their presence is impacted significantly by natural processes and local geologic conditions that are not controllable by the GSAs through groundwater management processes. Although SMCs are not assigned, the GSP will monitor these constituents to track any potential mobilization of elevated concentration or exceedances of the MCLs or SMCLs. Monitoring for these constituents will be carried out as part of the GSP monitoring network that is discussed in **Section 3.5.2**, as well as the Volunteer Monitoring Program that is described in **Section 4.7.1**. New constituents of concern may be added with changing conditions and as new information becomes available.

Method for Quantitative Measurement of Minimum Thresholds

Groundwater quality will be measured in representative monitoring wells as discussed in **Section 3.5**. Statistical evaluation of groundwater quality data obtained from available water quality data obtained from the monitoring network will be performed. The minimum thresholds for constituents of concern are shown in **Table 3-6.**

3.3.4 Minimum Threshold for Depletions of Interconnected Surface Water

Like reduction of groundwater storage, it is not possible to directly measure depletions of ISW. Rather, these depletions are estimated by the CoSANA integrated surface and groundwater flow model. Importantly, the depletion volume and rate depend on the hydraulic gradient, or relative elevation, between ISW bodies and groundwater.

As before, the use of groundwater level as a proxy for depletions of ISW requires that “minimum thresholds and measurable objectives for chronic declines of groundwater levels are sufficiently protective to ensure significant and unreasonable occurrences of [depletions of ISW] will be prevented” (CA-DWR, 2017).

As detailed in **Section 3.3.1**, MTs based on the fall 2015 low groundwater level and groundwater levels based on projected use do not suggest significant and unreasonable depletions of ISW or deviations in streamflow compared to the current conditions baseline. Groundwater level MTs (**Table 3-4**) arrest hydraulic gradients at the lower of post-2015 groundwater levels or projected low groundwater levels in the PMA CC scenario. ISW depletion rates assuming MTs are reached were evaluated and found to not appreciably differ from present day conditions. In fact, the lower Cosumnes River and Mokelumne River become more gaining over time due to benefits from the Harvest Water recharge site. Morrison creek becomes more losing in all projected scenarios due to increased pumping in the Sacramento urban area, but it remains interconnected, and the reduced baseflow from surrounding areas is not considered a significant and undesirable result.

Notably, the depletion rate may temporarily increase during wet years when surface water stage increases, which increases the hydraulic gradient and drives stream seepage into groundwater. The CoSANA model captures this hydrologic response during wet year types, but for the purposes of this Plan, which concerns the deleterious impact of groundwater extraction on stream depletion, monitoring of groundwater level measurements that indicate an expanding cone of depression are prioritized. Nonetheless, to better understand complex, sub-seasonal stream-aquifer interactions, high frequency (i.e., 15-minute interval) flow gauges have been installed in reaches immediately upstream of interconnected surface waters along the southern Cosumnes River.

There are currently no other state, federal, or local standards that relate to this sustainability indicator in the Subbasin.

3.3.5 Minimum Threshold for Land Subsidence

The minimum threshold for land subsidence in the Basin is set at no more than 0.1 foot [0.03 m] in any single year and a cumulative 0.5 foot [0.15 m] in any five-year period, resulting in no long-term permanent subsidence. Consistent with the subsidence BMP (DWR, 2026), the MT is set at the same magnitude as the estimated error in the InSAR data (+/- 0.1 foot [0.03 m]) in any single year and a cumulative 0.5 foot [0.15 m] in any five-year period as measured in at least a 5 square mile area of the Subbasin.

The minimum thresholds selected for land subsidence for the Basin area have been selected as a preventative measure to ensure the maintenance of current ground surface elevations and as an added safety measure for potential future impacts not currently present in the Basin and nearby basins. This avoids significant and unreasonable rates of land subsidence in the Basin, which are those that lead to a permanent subsidence of land surface elevations that impact infrastructure and agricultural production in the Basin and neighboring groundwater subbasins.

Given that the Basin is currently at the measurable objective and not expected to experience significant or unreasonable subsidence, the land subsidence MT will not likely have a significant effect on beneficial uses and users of groundwater or land uses and property interests.

There are currently no other state, federal, or local standards that relate to this sustainability indicator in the Basin.

Land subsidence in the Basin will be quantitatively measured by InSAR data (DWR-funded TRE Altamira or other similar data products).

The single CGPS (Continuous Global Positioning System) station in the Basin (UNAVCO station #P274) does not show significant and unreasonable inelastic subsidence during its period of record from 2005-2024 (see **Figure 2-91**) The CGPS station was discontinued in May 2024.The InSAR and CGPS data at the location of the CGPS station compare well with one another (see **Figure 2-91**), demonstrating that the InSAR data product is an adequate management tool for land subsidence in the Basin.

The minimum threshold applies to the entire Basin area.

3.4 Measurable Objectives and Interim Milestones (23 CCR § 354.30)

23 CCR § 354.30. Measurable Objectives

> (a) *Each Agency shall establish measurable objectives, including interim milestones in*
> (b) *increments of five years, to achieve the sustainability goal for the basin within 20 years of Plan implementation and to continue to sustainably manage the groundwater basin over the planning and implementation horizon.*
> (c) *Measurable objectives shall be established for each sustainability indicator, based on quantitative values using the same metrics and monitoring sites as are used to define the minimum thresholds.*
> (d) *Measurable objectives shall provide a reasonable margin of operational flexibility under adverse conditions which shall take into consideration components such as historical water budgets, seasonal and long-term trends, and periods of drought, and be commensurate with levels of uncertainty.*
> (e) *An Agency may establish a representative measurable objective for groundwater elevation to serve as the value for multiple sustainability indicators where the Agency can demonstrate that the representative value is a reasonable proxy for multiple individual measurable objectives as supported by adequate evidence.*
> (f) *Each Plan shall describe a reasonable path to achieve the sustainability goal for the basin within 20 years of Plan implementation, including a description of interim milestones for each relevant sustainability indicator, using the same metric as the measurable objective, in increments of five years. The description shall explain how the Plan is likely to maintain sustainable groundwater management over the planning and implementation horizon.*

> *(g) Each Plan may include measurable objectives and interim milestones for additional Plan elements described in Water Code Section 10727.4 where the Agency determines such measures are appropriate for sustainable groundwater management in the basin.*
>
> *(h) An Agency may establish measurable objectives that exceed the reasonable margin of operational flexibility for the purpose of improving overall conditions in the basin, but failure to achieve those objectives shall not be grounds for a finding of inadequacy of the Plan.*

Measurable objectives (MOs) are "specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted Plan to achieve the sustainability goal for the basin" (23 CCR § 351(s)). Interim milestones are "target value[s] representing measurable groundwater conditions, in increments of five years" (23 CCR § 351(q)) used to chart progress towards the Sustainability Goal quantified in the MOs.

Importantly, MOs provide a "margin of operational flexibility under adverse conditions" (23 CCR § 354.30(d)), quantified by the difference between MOs and MTs at each RMP. Operational flexibility is especially important in the Basin, as significant recharge-intensive projects and anticipated conjunctive use management actions require operational space to fill and drawn down the aquifer in wet and dry periods respectively.

Attainment of MOs not only ensures that the Basin avoids undesirable results for beneficial uses and users of groundwater, but also that the Basin is put on a long-term path of sustainable groundwater management. MOs developed herein achieve the Basin's stated Sustainability Goal.

3.4.1 Measurable Objective and Interim Milestones for Chronic Lowering of Groundwater Levels

Like MTs (**Section 3.3.1.1**), MOs were quantified following evaluation of historical groundwater levels at RMPs. MOs were defined as the average post-2015 groundwater level at RMPs, which can be interpreted as the average spring and fall groundwater level over a roughly present-day period (2015-2019), which contains 1 critical year, 2 below normal years, and 2 wet years. Moreover, if the MT was reduced because projected groundwater levels (in the PMA CC scenario) show a decline, the MO was also reduced by a proportional amount. Lastly, MOs were *increased* in 8 RMPs within or nearby the Harvest Water recharge project[31], where model simulations indicate groundwater levels will increase upwards of 25 feet in the main recharge zone. Increasing MOs near the Harvest Water recharge site reflects an aspirational goal of increasing groundwater levels in the southern SASb to provide multiple benefits: higher groundwater levels to exercise this portion of the Basin, increased baseflow to streams, and improved flows in the lower reaches of the Cosumnes River, and the Mokelumne and Sacramento Rivers.

Thus, MOs are generally near present-day groundwater levels: some MOs are greater than the last-measured value at RMPs, and others are less than the last measured value. Because MOs are established based on historically observed variation in groundwater elevation at RMPs, the operational flexibility, or difference between MTs and MOs (

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[31] The RMPs for which MOs were increased in and adjacent to the Harvest Water recharge area are: RMP_01, RMP_02, RMP_03, RMP_04, RMP_05, RMP_06, RMP_07, and RMP_08.

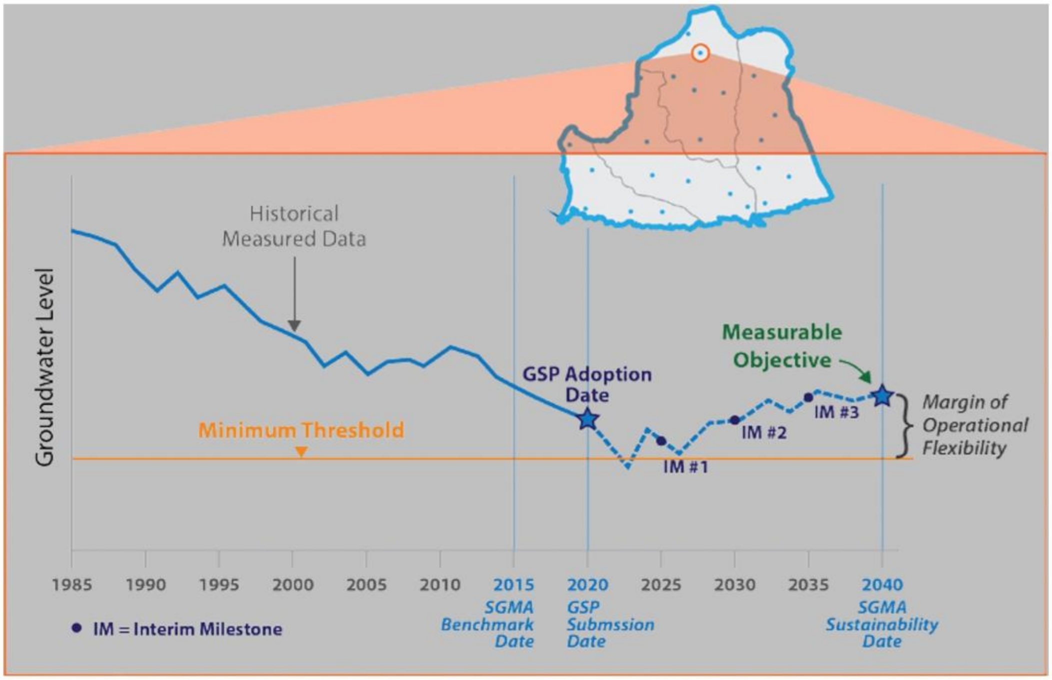

Figure 3-11: Minimum threshold, measurable objective, interim milestones, and operational flexibility at an example representative monitoring point drawn from DWR Best Management Practices (CA-DWR, 2017).

Importantly, some RMPs are in critical monitoring locations, but may lack historical data or perforation interval information. These data gaps will be addressed during the Plan implementation by collecting monitoring data and performing field investigations (**Section 3.5.5**); thus, the MTs presented herein (**Table 3-4**) may change in the five-year Plan update pending new information.

To ease interpretation and implementation, MTs are rounded to the nearest integer value.

a) also varies per RMP based on local site-specific conditions.

Three Interim Milestones (IMs) at five-year intervals were defined by dividing the range of operational flexibility between the MO and MT at each RMP into 4 regions, such that the Basin makes linear progress towards MOs in each five-year increment. For clarity, in five years following Plan submission (2027), it is projected that the Basin will make 25% progress towards MOs; in 10 years following Plan submission (2032), it is projected that the Basin will make 50% progress; in 15 years following Plan submission (2037) it is projected that the Basin will make 75% progress; and finally, in 20 years following Plan submission (2042), it is projected that the Basin will meet its long-term Sustainability Goal. Thus, the IMs in 2042 are equal to the MOs.

Importantly, the operational flexibility (difference between MT and MO) varies across sites. A small or large operational flexibility should not be misinterpreted as overly conservative or potentially damaging, but rather, based on observed groundwater elevation at that site. Differences in the range of groundwater elevation at a particular site are the result of hydrologic processes and geology (i.e., storage coefficient), and local water use (i.e., pumping, recharge, and other budget terms).

As before with MTs, the MOs and IMs in this Plan are rounded to the nearest integer value to ease interpretation. Measurable Objective and Interim Milestones for Reduction of Groundwater Storage

3.4.2 Measurable Objective and Interim Milestones for Reduction of Groundwater Storage

As before with MTs, chronic lowering of groundwater levels and reduction of groundwater storage are directly correlated, and groundwater level is used as a proxy for groundwater storage (**Section 3.3.2**). Thus, MOs and IMs for reduction of groundwater storage are identical to those set for chronic lowering of groundwater levels (

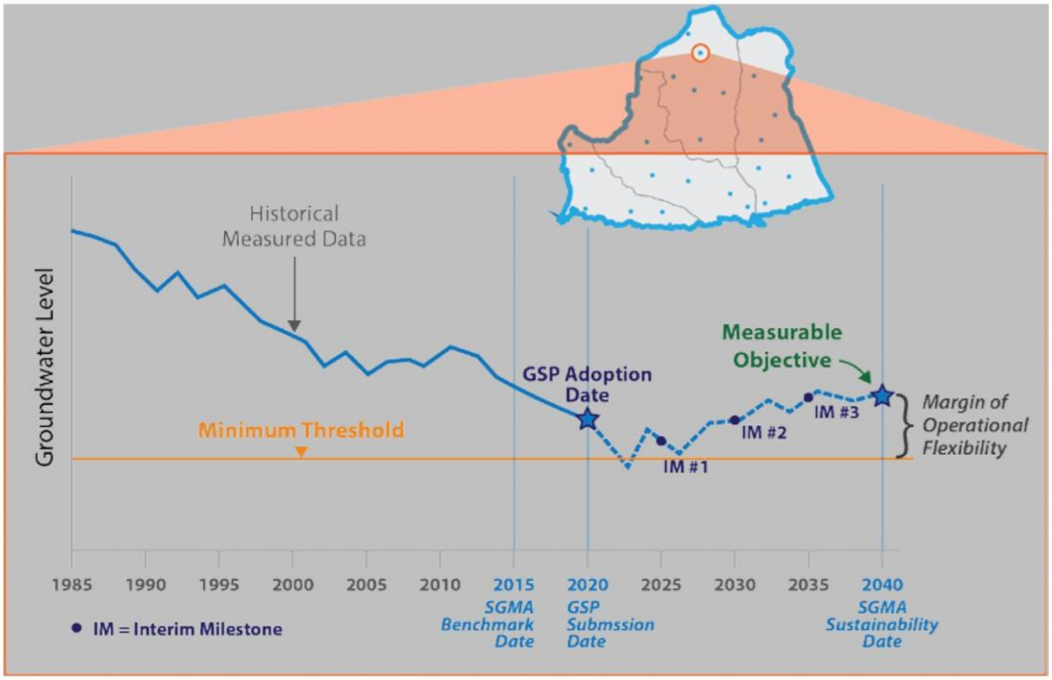

Figure 3-11: Minimum threshold, measurable objective, interim milestones, and operational flexibility at an example representative monitoring point drawn from DWR Best Management Practices (CA-DWR, 2017).

Importantly, some RMPs are in critical monitoring locations, but may lack historical data or perforation interval information. These data gaps will be addressed during the Plan implementation by collecting monitoring data and performing field investigations (**Section 3.5.5**); thus, the MTs presented herein (**Table 3-4**) may change in the five-year Plan update pending new information.

To ease interpretation and implementation, MTs are rounded to the nearest integer value.

a), and these values provide reasonable operational flexibility for the Basin.

3.4.3 Measurable Objective and Interim Milestones for Degraded Groundwater Quality

Within the Basin, the measurable objectives for water quality are established to provide an indication of desired water quality at levels that are sufficiently protective of beneficial uses and users. Measurable objectives are defined on a well-specific basis, with consideration of historical water quality data.

Description of Measurable Objectives

The groundwater quality MOs for nitrate and specific conductance for wells within the SASb monitoring network, where the concentrations of these constituents of concern historically have been below 90% of the minimum thresholds for water quality in recent years, is to continue to maintain concentrations at or below the range prior to May 22, 2020. For wells where the concentrations of constituents of concern have ever historically exceeded or been equal to 90% of the minimum thresholds, the measurable objective is 90% of the minimum threshold.

Specifically, for nitrate and specific conductance, the goal will be to meet MOs in a minimum of twenty of the twenty three groundwater quality monitoring wells (which corresponds to about 90% of wells monitored). The proposed MOs for nitrate and specific conductance at the selected wells within the Basin are listed in **Table 3-7**.

Path to Achieve Measurable Objectives

The SASb GSAs will support the protection of groundwater quality by monitoring groundwater quality conditions and coordinating with appropriate regulatory agencies with jurisdiction to regulate groundwater quality in the Basin. All future projects and management actions implemented by the GSAs will comply with state and federal water quality standards and Basin Plan water quality objectives, and will be designed to maintain or improve groundwater quality for all uses and users and avoid causing unreasonable groundwater quality degradation. The GSAs will review and analyze groundwater quality monitoring data as part of GSP implementation in order to evaluate any changes in groundwater quality. The need for additional studies on groundwater quality will be assessed through GSP implementation.

Using monitoring data collected as part of project implementation, the GSAs will develop information (e.g., time-series plots of water quality constituents) to demonstrate that projects and management actions are operating to maintain or improve groundwater quality conditions in the Basin and to avoid unreasonable groundwater quality degradation. Should the concentration of a constituent of interest meet or exceed its minimum threshold as the result of GSA project implementation, the GSA will implement measures to address such an occurrence.

Where the cause of an exceedance is unknown, the GSAs may choose to conduct additional or more frequent monitoring.

Interim Milestones

As existing groundwater quality data indicate that groundwater in the Basin generally meets applicable state and federal water quality standards for nitrate and specific conductance, the objective is to maintain existing groundwater quality. Interim milestones are therefore set to maintain groundwater quality equivalent to the measurable objectives established for nitrate and specific conductance, with the goal of maintaining water quality within the historical range of values.

Table 3-7: Measurable Objectives for Nitrate and Specific Conductance at Representative Monitoring Wells in the Degraded Water Quality Monitoring Network

Well ID	Well Type	Lat/Long	Top Depth of Screen (Ft)	Bottom Depth of Screen (Ft)	Aquifer Zone	Measurable Objective	
						Nitrate as Nitrogen (mg/L)	Specific Conductance (micromhos/cm)
CA3410020_009_009	Municipal	38.4675, -121.430556	91	164	Upper	3.8	492
CA3410029_002_002	Municipal	38.418056, -121.416667	176	236	Upper	3.0	470
CA3410029_016_016	Municipal	38.456944, -121.307222	150	286	Upper	1.1	246
CA3410029_029_029	Municipal	38.428056, -121.397222	153	183	Upper	2.0	494
CA3410033_006_006	Municipal	38.4923, -121.403458	127	152	Upper	7.2	520
L10005519750-MW-G(S)	Monitoring	38.5326864, -121.3851885	59	79	Upper	9.0 (3)	1,125 (1)
L10008601447-MW-13	Monitoring	38.4159214, -121.3540665	130	140	Upper	4.2	579 (1)
CA3400101_001_001	Municipal	38.367333, -121.518277	60	405	Upper	0.5	1,200
CA3410029_024_024	Municipal	38.415833, -121.479722	232	306	Upper	0.9	595
CA3410029_025_025	Municipal	38.429722, -121.457222	252	402	Upper	0.5	1,440 (3)
CA3901216_001_001	Municipal	38.333587, -121.56747	292	492	Upper	1.3	1,440 (3)
CA3400229_003_003 (2)	Municipal	38.304799, -121.422098	0	24	Upper	0.5	650
CA3410027_003_003 (2)	Municipal	38.561187, -121.210795	0	45	Upper	2.0	420
CA3410015_020_020	Municipal	38.574323, -121.293588	363	533	Lower	2.1	240
CA3410015_022_022	Municipal	38.618611, -121.264444	430	590	Lower	1.6	340
CA3410023_015_015	Municipal	38.512211, -121.444126	340	440	Lower	1.0	915
CA3410029_015_015	Municipal	38.464722, -121.362778	744	896	Lower	0.5	670
CA3410029_026_026	Municipal	38.410833, -121.346667	979	1219	Lower	0.5	232
CA3410029_027_027	Municipal	38.458889, -121.315556	720	794	Lower	0.5	230
CA3410704_001_001	Municipal	38.5400, -121.280556	300	520	Lower	0.5	170
L10007396297-MW-40B	Monitoring	38.5049953, -121.2016679	300	320	Lower	1.9	294 (1)
CA3410029_050_050 (2)	Municipal	38.396638, -121.424141	1167	1223	Lower	0.5	330
CA3410010_009_009 (2)	Municipal	38.552567, -121.339347	251	384	Lower	3.6	220

[1] MO value in the 2022 GSP determined from conversion of TDS to specific conductance using a conversion factor of 1.56 (UCANR, 2023); during 2027 Periodic Evaluation, historic specific conductance data was identified for this well and the MO value was determined using this data. Specific conductance data for this well is reported to GeoTracker and is not reported to GAMA.

[2] Well added to groundwater quality monitoring network during the 2027 Periodic Evaluation.

[3] The maximum historical value has been above the minimum thresholds, i.e., MCL or SMCL. Therefore, the MO has been set equal to 90% of the minimum thresholds

3.4.4 Measurable Objective and Interim Milestones for Depletions of Interconnected Surface Water

As before with MTs, chronic lowering of groundwater levels and depletions of ISW are interrelated in that reductions in groundwater elevation in the Basin that increase the hydraulic gradient between ISW bodies and groundwater also lead to increased stream depletion. Arresting groundwater level decline and maintaining groundwater levels above MTs ensures that ISW depletion volumes will not lead to significant and unreasonable outcomes for beneficial users of ISW (**Section 3.2.4**). Wells were carefully chosen to detect gradient changes associated with a potential expanding cone of depression to ISW depletion, and scenario analysis of ISW reach length, streamflow, and seepage at projected groundwater level thresholds was conducted to relate groundwater level conditions to ISW conditions. Groundwater level is thus used as a proxy for ISW depletion and MOs and IMs for reduction of stream depletion are identical to those set for chronic lowering of groundwater levels (

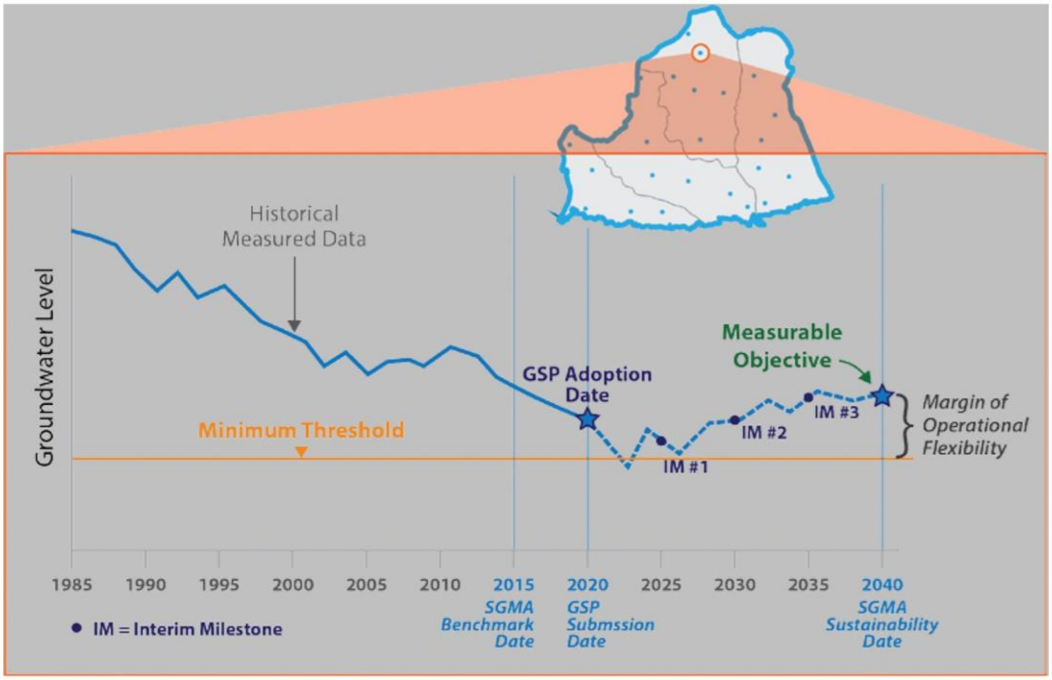

Figure 3-11: Minimum threshold, measurable objective, interim milestones, and operational flexibility at an example representative monitoring point drawn from DWR Best Management Practices (CA-DWR, 2017).

Importantly, some RMPs are in critical monitoring locations, but may lack historical data or perforation interval information. These data gaps will be addressed during the Plan implementation by collecting monitoring data and performing field investigations (**Section 3.5.5**); thus, the MTs presented herein (**Table 3-4**) may change in the five-year Plan update pending new information.

To ease interpretation and implementation, MTs are rounded to the nearest integer value.

a). These values provide reasonable operational flexibility for the Basin.

3.4.5 Measurable Objective and Interim Milestones for Land Subsidence

Land subsidence is not known to be significant in the SASb. Previous efforts to quantify land subsidence in the Basin have yielded results showing minor amounts of subsidence having occurred in the Basin. Such efforts have mainly been through leveling profiles studied between 1947 and 1966, a 2008 DWR- and the US Bureau of Reclamation-authorized subsidence project throughout the Sacramento Valley using GPS technology (Frame Surveying & Mapping, 2008), and DWR's Sacramento Valley 2017 GPS Survey program, all of which demonstrated that subsidence has been very minimal across the Basin.

Recent InSAR data provided by DWR (TRE Altamira) show no significant or unreasonable subsidence occurring during the period of June 2015 to April 2026 (**Figure 2-90**). Small fluctuations observed in these datasets are in the Sacramento-San Joaquin Delta area. The Delta area of the Basin is likely affiliated with subsurface organic deposit dynamics (CA-DWR, 1995).

The specific geology of the geologically older alluvial aquifer materials comprising the east side of the Basin is not known to contain the thicker clay confining units that typically exhibit inelastic subsidence due to excessive groundwater pumping (i.e., overdraft conditions). While the west side of the Basin contains more fine-grained materials susceptible to inelastic subsidence than the east side, it is more of a cause for awareness than concern for future subsidence impacts to infrastructure in the Basin.

The guiding MO of this GSP for land subsidence in the Basin is the maintenance of current ground surface elevations. This measurable objective avoids significant and unreasonable rates of land subsidence in the Basin, which are those that lead to a permanent subsidence of land surface elevations that impact infrastructure and agricultural production. As this subsidence measurable objective is essentially already met, the specific goal is to maintain this level of land subsidence (i.e., essentially at a similar magnitude to the InSAR data error) throughout the implementation period.

Land subsidence in the Basin is expected to be maintained throughout the implementation period via the sustainable management of groundwater pumping through the groundwater level measurable objectives, minimum thresholds, and interim milestones, as well as the fact that the aquifer geology is not very likely to be susceptible to significant and unreasonable subsidence, even under groundwater overdraft conditions.

The margin of safety for the subsidence MO was established by setting a MO to maintain current surface elevations and opting to monitor subsidence throughout the implementation period, even though there is no historical record of significant and unreasonable subsidence and a major portion of the aquifer is not deemed to be likely to succumb to inelastic subsidence. This is a reasonable margin of safety based on the past and current aquifer conditions and is more reasonable to the alternative action of simply setting the subsidence indicator as 'not applicable' in the Basin due to current and documented historical evidence.

As the current MO is set to maintain the present land surface elevations of the Basin, the interim milestones are set as check-in opportunities to review year-to-year subsidence rates from the previous five-year period to assess whether there are longer-period subsidence trends than what is observed in the annual reviews. The MOs and associated IMs apply to the entire Basin area.

3.5 Monitoring Network

23 CCR § 354.34(d)-(j):

> *(d) The monitoring network shall be designed to ensure adequate coverage of sustainability indicators. If management areas are established, the quantity and density of monitoring sites in those areas shall be sufficient to evaluate conditions of the basin setting and sustainable management criteria specific to that area.*
> *(e) A Plan may utilize site information and monitoring data from existing sources as part of the monitoring network.*
> *(f) The Agency shall determine the density of monitoring sites and frequency of measurements required to demonstrate short-term, seasonal, and long-term trends based upon the following factors:*
> *(1) Amount of current and projected groundwater use.*
> *(2) Aquifer characteristics, including confined or unconfined aquifer conditions, or other physical characteristics that affect groundwater flow.*
> *(3) Impacts to beneficial uses and users of groundwater and land uses and property interests affected by groundwater production, and adjacent basins that could affect the ability of that basin to meet the sustainability goal.*
> *(4) Whether the Agency has adequate long-term existing monitoring results or other technical information to demonstrate an understanding of aquifer response.*
> *(g) Each Plan shall describe the following information about the monitoring network:*
> *(1) Scientific rationale for the monitoring site selection process.*
> *(2) Consistency with data and reporting standards described in Section 352.4. If a site is not consistent with those standards, the Plan shall explain the necessity of the site to the monitoring network, and how any variation from the standards will not affect the usefulness of the results obtained.*
> *(3) For each sustainability indicator, the quantitative values for the minimum threshold, measurable objective, and interim milestones that will be measured at each monitoring site or representative monitoring sites established pursuant to Section 354.36.*
> *(h) The location and type of each monitoring site within the basin displayed on a map, and reported in tabular format, including information regarding the monitoring site type, frequency of measurement, and the purposes for which the monitoring site is being used.*
> *(i) The monitoring protocols developed by each Agency shall include a description of technical standards, data collection methods, and other procedures or protocols pursuant to Water Code Section 10727.2(f) for monitoring sites or other data collection facilities to ensure that the monitoring network utilizes comparable data and methodologies.*
> *(j) An Agency that has demonstrated that undesirable results related to one or more sustainability indicators are not present and are not likely to occur in a basin, as described in Section 354.26, shall not be required to establish a monitoring network related to those sustainability indicators.*

3.5.1 Description of Monitoring Network (23 CCR § 354.34)

Monitoring is fundamental to measure progress towards Plan management goals. The GSP monitoring network will characterize groundwater and surface water conditions in the Basin and evaluate hydrologic changes that occur during Plan implementation. This section explains the approach to develop the monitoring network for groundwater, storage, and the interconnection of surface water and groundwater, such that the network provides sufficient temporal frequency and spatial density to evaluate the effectiveness of the Plan.

Monitoring network data is used to evaluate impacts to beneficial uses and users of groundwater, monitor changes in groundwater conditions relative to sustainable management criteria (MOs, MTs, and IMs), and quantify annual changes in water budget components. Data from the network also provides an ongoing record for future assessments of groundwater conditions and informs adaptive management on the path to sustainability, thereby protecting against the Undesirable Results linked to, for example, the decline of groundwater level or the deterioration of groundwater quality. Ongoing monitoring during the plan implementation phase minimizes risk for exceeding minimum water quality thresholds and supports the GSAs in implementing timely projects and management actions.

The scientific rationale for assembling the GSP monitoring network for each sustainability indicator is based on a three-step approach (**Figure 3-13**). First, all existing wells in the Basin were reviewed. Second, a subset of these wells was selected based on selection criteria including well location, monitoring history, and well construction information. “Selected” wells were presented to the working group and subjected to a second set of selection criteria including site access. “Selected” wells with adequate site access are considered “Confirmed” monitoring points. “Confirmed” wells are the representative monitoring points at which SMC are defined (**Table 3-4**). These points are strategically selected to maximize lateral and vertical coverage, ensure historical and present-day data, and secure reliable site access during plan implementation.

Figure 3-13: General framework for monitoring site selection (Section 3.5).
To assess monitoring well suitability, all existing wells were reviewed according to selection criteria. Selected wells were then subjected to a second set of screening criteria including site access considerations. Wells that meet selection criteria and site

access considerations are considered “Confirmed” and are present in the GSP monitoring network.

The criteria (well location, monitoring history, well information, well access) used to confirm wells is discussed below:

Well Location

Strategic siting and design of a well network is important to ensure adequate spatial distribution, coverage, and well density. The well network must not only be laterally expansive but also span the vertical dimension and capture different depths of the principal aquifer that require monitoring. Beyond capturing general hydrologic trends, it is especially important to monitor areas within or adjacent to planned GSP projects and management actions at the appropriate temporal frequency, and areas where existing or legacy operations may threaten groundwater quality for beneficial uses and users. Where monitoring wells are not present, statistical methods are used to aid in extrapolating data from existing monitoring sites to the entire Basin.

Monitoring History

Wells with a long historical record provide valuable insight into trends and baseline conditions. Thus, candidate wells with current data, but also a historical record dating prior to 2005 were prioritized as monitoring candidates. Moreover, candidate wells with near present-day measurements were also prioritized.

Well Information

Beyond well location information and reliable site access, well construction information including well depth and depth of screened interval(s) are essential to interpret monitoring results and to ensure adequate vertical monitoring coverage of the principal aquifer. At a minimum, selected wells should have well depth information. Although perforation interval is not present for each well in the “Confirmed” monitoring network, it was essential to include these wells to provide adequate lateral coverage. Data gaps will be addressed in future field work during the GSP implementation period.

Well Access

Most monitoring wells in the Basin are on private land. The ability to access wells to collect data is a limiting factor in a successful monitoring network; thus, local agencies that collect monitoring data were consulted to confirm candidate wells with reliable site access.

3.5.2 Monitoring networks in the Basin

Based on the Basin’s historical and present-day conditions (**Section 2.3**), the groundwater level and storage, groundwater quality, and ISW are the main sustainability indicators to be monitored to evaluate progress towards the Basin’s sustainability goal. Land subsidence and seawater intrusion were not found in the Basin and thus do not have monitoring networks (23 CCR § 354.34(j)).

A general overview of the monitoring network associated with each of these sustainability indicators is discussed below. Additional network details are provided in each sustainability indicator's subsection.

Groundwater level is used as a proxy for reduction in storage and ISW depletion, thus the monitoring networks for level, storage, and ISW are complimentary; of the 45 wells in the level and storage network, 10 of those wells are in the ISW monitoring network. The water quality monitoring network is separate from the network for groundwater level, storage and ISW depletion. Each monitoring network is described below in greater detail.

Groundwater Elevation Monitoring Network

> *23 CCR § 354.34(c): Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(1) Chronic Lowering of Groundwater Levels. Demonstrate groundwater occurrence, flow directions, and hydraulic gradients between principal aquifers and surface water features by the following methods:*
>
> *(A) A sufficient density of monitoring wells to collect representative measurements through depth-discrete perforated intervals to characterize the groundwater table or potentiometric surface for each principal aquifer.*
>
> *(B) Static groundwater elevation measurements shall be collected at least two times per year, to represent seasonal low and seasonal high groundwater conditions.*

The groundwater elevation monitoring network is designed to demonstrate groundwater occurrence, level, flow directions, and hydraulic gradients between the principal aquifer and surface water features.

The initial list of groundwater level monitoring wells included 167 monitoring wells from:

- Department of Water Resources (DWR)
- Omochumne-Hartnell Water District (OHWD)
- University of California Davis (UCD)
- Sacramento State University (CSUS)
- Sacramento County
- Bureau of Reclamation
- Sacramento Central Groundwater Authority (SCGA)
- Historical calibration data in regional hydrologic models (SVSIM and SacIWRM)
- Aerojet

Next, these data were narrowed down by considering the following criteria:

- At least depth or perforated interval are present, preferably both;
- Measured water level data are available at least through 2019 (this criterion was relaxed in locations where spatial coverage is lacking);
- A preference is given to wells with data prior to 2005; and
- The well has at least five historical measurements.

Annual pumping in the Basin exceeds 10,000 acre-feet/year per 100 square miles, and thus, DWR Best Management Practices (CA-DWR, 2017) and Sophocleous (1983) suggest a density of 4 monitoring wells per 100 square miles to collect representative measurements. The surface area of the SASb is 388 square miles, which suggests a need for at least 16 monitoring wells and a lateral coverage of 24.25 square miles per well. The groundwater elevation monitoring network (**Figure 3-14**) uses 35 monitoring wells as SGMA representative wells. Eleven additional wells are designated as SGMA wells including eight wells within or near the Aerojet and Mather superfund sites and three wells that DWR is monitoring. Together the 46 SGMA and SGMA representative wells cover 89% of the Basin area according to spatial coverage estimates by Sophocleous (1983).

The Basin has one principal aquifer with most groundwater production occurring in the middle Laguna and Mehrten formations (**Section 2-2**). The monitoring network spans these formations and provides adequate vertical coverage across unconfined, semiconfined, and confined systems. Importantly, monitoring well density is appropriate to extrapolate seasonal groundwater elevation maps to support the shallow well protection analysis, GDE impact analysis, and to monitor seasonal changes in hydraulic gradients that indicate changes in ISW depletion.

Monitoring frequency is important to characterize groundwater and surface water dynamics. All wells will collect at least biannual measurements in spring (mid-March) and fall (mid-October) in line with DWR Best Management Practices (CA-DWR, 2017). Wells in or adjacent to the Harvest Water Recharge management zone will collect monthly measurements. All well IDs with the prefix “ACR”, “MW” and “SS” are within the vicinity of the Cosumnes and Sacramento Rivers and will collect high-frequency 15-minute interval data to improve understanding of stream-aquifer interactions. Specifically, these measurements will be paired with high-frequency 15-minute interval stream gauge data at two locations along the Cosumnes River to improve understanding in this important ecosystem.

Monitoring standards and conventions are consistent with 23 CCR § 352.4, which outline data and reporting standards for groundwater level measurements.

Groundwater Storage Monitoring Network

> *23 CCR § 354.34(c): Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(2) Reduction of Groundwater Storage. Provide an estimate of the change in annual groundwater in storage.*

Groundwater level is used as a proxy for groundwater storage (**Section 3.3.2**), thus the groundwater storage monitoring network is identical to the network for groundwater level. Observations obtained at the groundwater level monitoring network will directly inform integrated surface and groundwater modeling in the Basin as model calibration targets.

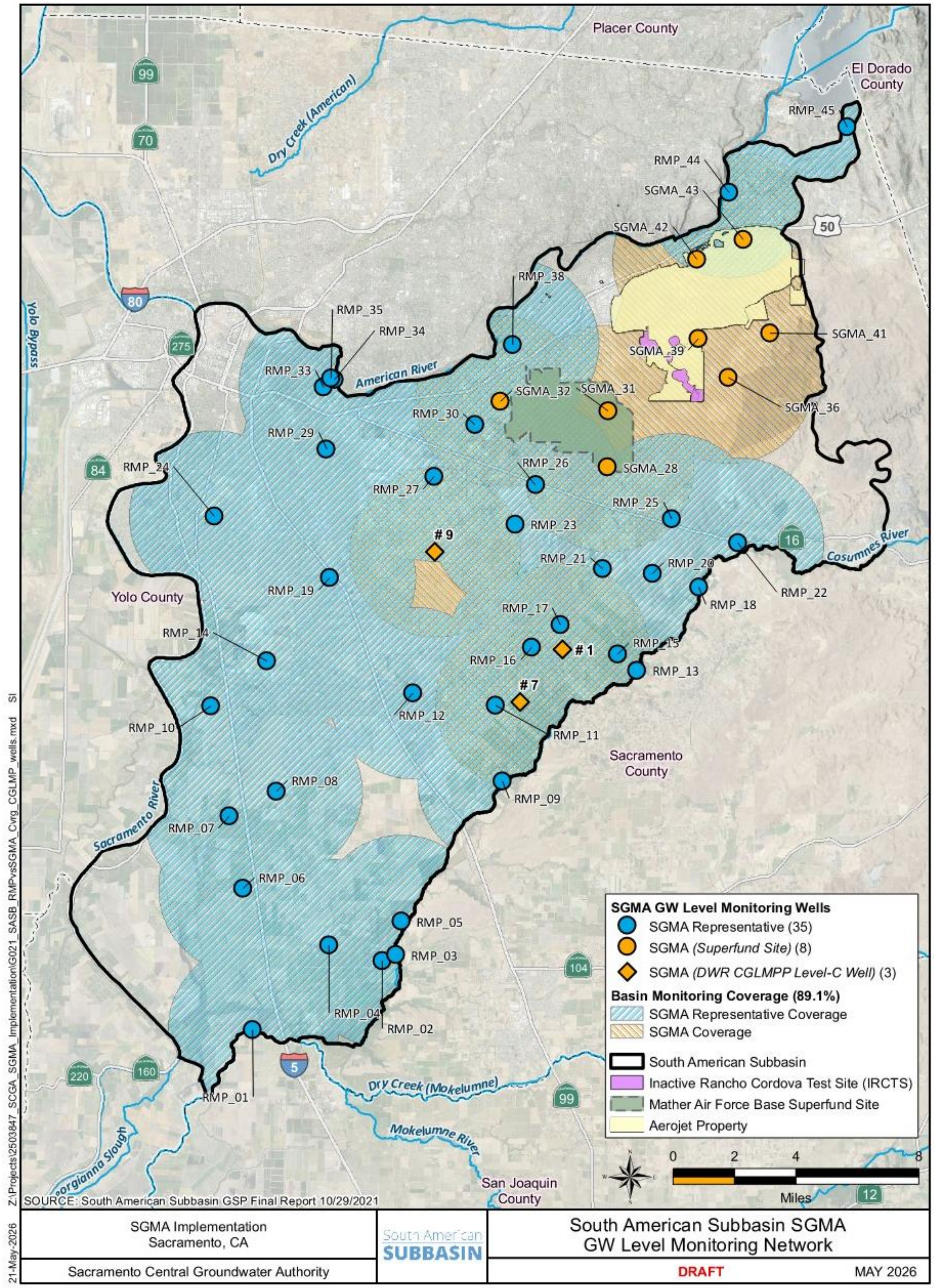

Figure 3-14. Monitoring network for groundwater level, storage ISW depletion sustainability indicators.

Groundwater Quality Monitoring Network

> *23 CCR § 354.34(c): Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(4) Degraded Water Quality. Collect sufficient spatial and temporal data from each applicable principal aquifer to determine groundwater quality trends for water quality indicators, as determined by the Agency, to address known water quality issues.*

The objective of the groundwater quality monitoring network design is to capture sufficient spatial and temporal detail to understand groundwater quality in the Basin. The data from the network will provide an ongoing water quality record for future assessments of groundwater quality. The spatial and temporal coverage of the groundwater quality monitoring network will be designed to allow the GSAs to take an effective and efficient adaptive management approach in protecting groundwater quality, to minimize the risk for exceeding *minimum* water quality thresholds, to support the GSAs in implementing timely projects and actions, and ultimately, to contribute to compliance with water quality objectives throughout the Basin.

Apart from groundwater quality problems associated with four contamination sites (Aerojet-General Corporation, Mather AFB, Union Pacific, and Inactive Rancho Cordova Test Site), the Basin currently maintains very good groundwater quality, as described in **Section 2.3.4**. Existing wells used for monitoring groundwater quality in the Basin include public water supply wells and monitoring wells at groundwater contamination sites. Coordination will be conducted between existing monitoring programs and the GSA to develop an agreement for data collection responsibilities, monitoring protocols, and data reporting. Wells in existing programs are almost exclusively located within and near the urban areas of the Basin.

Groundwater quality monitoring in the Basin in support of the GSP will rely largely on existing wells used for monitoring groundwater quality in the monitoring network. Groundwater quality samples will be collected and analyzed in accordance with the monitoring protocols outlined in **Section 3.5.3.2**. The monitoring network will use information from existing programs in the Basin that already monitor for specific constituents of concern, and from other programs where these constituents could be added as part of routine monitoring efforts in support of the GSP. New wells will only be incorporated into the network as necessary to obtain information that will fill spatial gaps in data gathered at existing wells.

As many of the wells in the Basin are used for public water supply, an extensive record of water quality data is available for most wells. Using the geographic location and screen elevation information of the municipal or monitoring wells with historical groundwater quality records, an initial list of existing wells with groundwater quality measurements was created for inclusion in the monitoring network. Water quality monitoring well locations and depths were intersected with the three-dimensional COSANA texture model (**Section 2.2.1**) to determine the geologic formations monitored by each well. Geologic formations were assigned to each well by aligning the depth ranges occupied by the formation and the screened interval or depth of the monitoring well at each well location. When present, the screened interval of the monitoring well was used to assign geologic formation; otherwise, the depth of the well was used.

The initial list of groundwater quality monitoring wells was created using data downloaded from the GAMA Groundwater Information System Data Download.[32] Data were downloaded for Sacramento County on May 22, 2020, and includes 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 (Electronic Deliverable Format (EDS) 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 (DOW)
- U.S. Geological Survey (USGS)

Additional data were obtained directly from GEI Consultants, Inc., which developed the Subbasin's 2016 Alternative Plan.

Evaluating these data, an initial list of groundwater quality monitoring wells with historical data for both nitrate and specific conductance was identified. The following criteria were considered to select the representative monitoring wells:

- Both nitrate and specific conductance are measured at the same well;
- Measured water quality data are available at least through 2018 (this criterion was relaxed especially in the lower aquifer to provide a better spatial coverage); and
- The well has at least five historical measurements.

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[32] http://geotracker.waterboards.ca.gov/gama/datadownload

Wells meeting these criteria are listed in Table A-1 in **Appendix 3-E** along with the name of their corresponding facility or water system, and the GSA within which the well is located. This list was further narrowed down to avoid inclusion of redundant monitoring wells that are within the proximity of each other. As shown in **Figure 3-15**, the final proposed groundwater monitoring network includes 13 wells screened within the upper aquifer layer (**Table 3-8**) and 10 wells screened through the lower aquifer layer (**Table 3-9**). As previously noted, SMCs are not set for arsenic, iron, or manganese, but these constituents will be monitored and evaluated as part of the GSP. Each constituent's period of historical monitoring data is presented for the selected monitoring wells in **Appendix 2-C**.

While there is no definitive rule for the appropriate density of groundwater monitoring points needed in a basin, Hopkins (1984) incorporates a relative well density based on the degree of groundwater use within a given area and suggests that basins pumping more than 10,000 acre-feet per year must have at least four monitoring wells per 100-square miles. This would suggest that each well roughly covers an area occupying 25-square miles. Using this well-density assumption, wells screened within the upper and lower layers of the aquifer would cover approximately 36% (**Figure 3-16**) and 47% (**Figure 3-17**) of the Basin area, respectively. These wells provide good coverage of mainly central portions of the Basin. Furthermore, Harvest Water Project, which covers approximately 10% of the Basin area in the southwest, plans to monitor groundwater quality within its project area. The GSA will continue to coordinate with the Harvest Water Project to evaluate the potential for incorporating additional monitoring wells within the project area. The northwestern portion of the Basin covers urban areas of the City of Sacramento with no issues related to nitrate or specific conductance. Therefore, monitoring concentrations of these constituents within the northern portions of the Basin is not necessary.

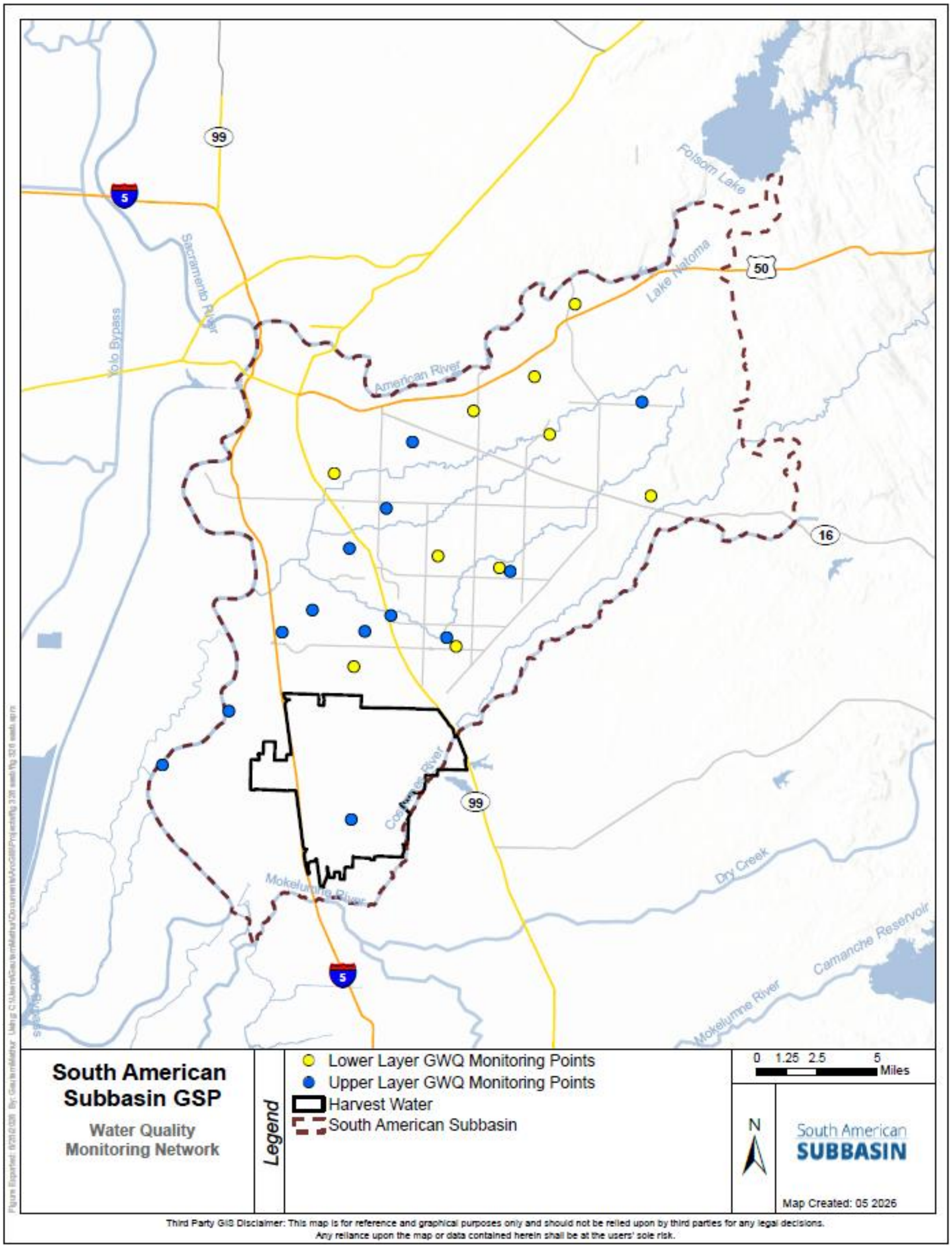


Figure 3-15: **Proposed groundwater quality monitoring networks within the upper and lower zones of the aquifer**

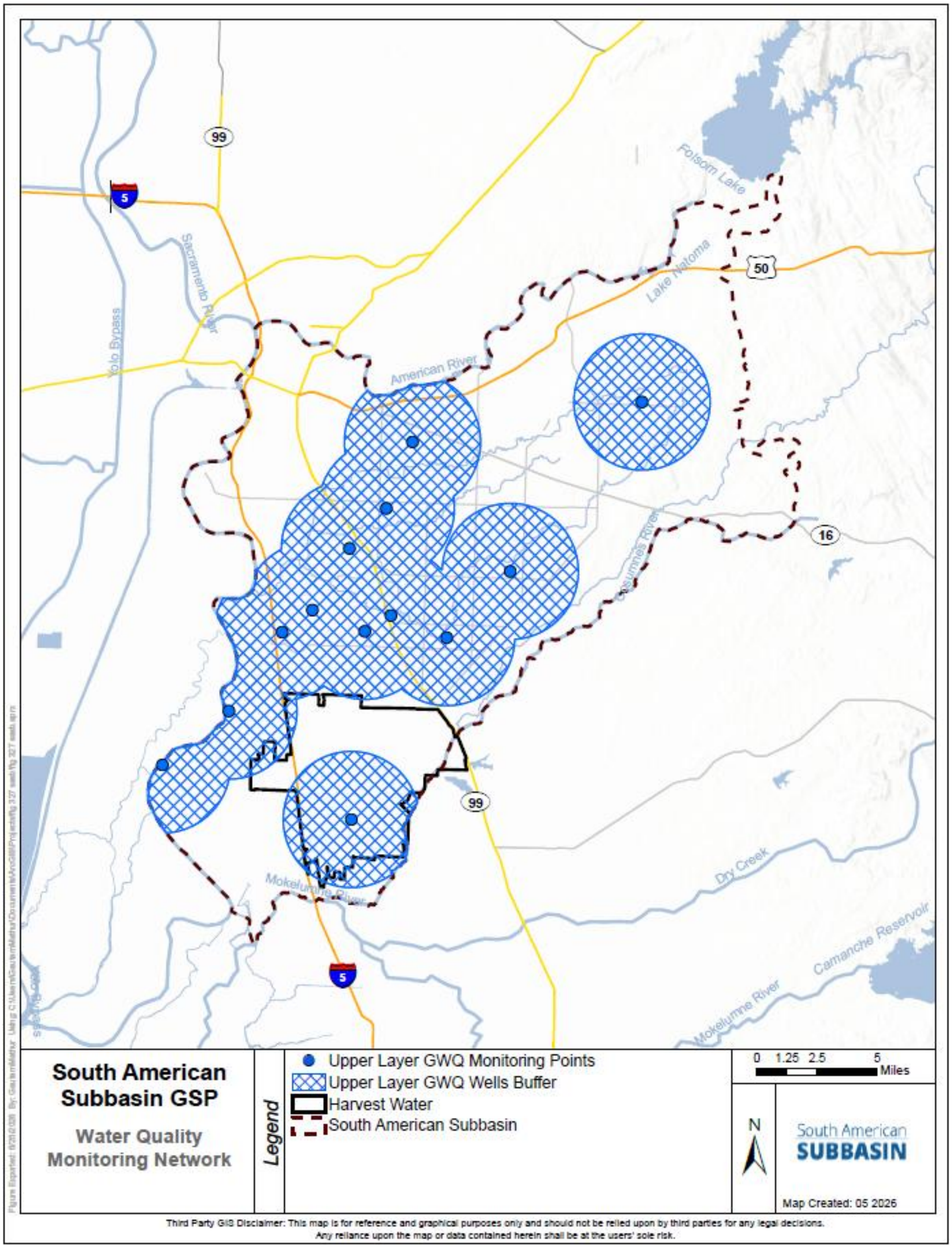


Figure 3-16: Upper aquifer layer groundwater quality monitoring wells covering approximately 49% of the Basin area

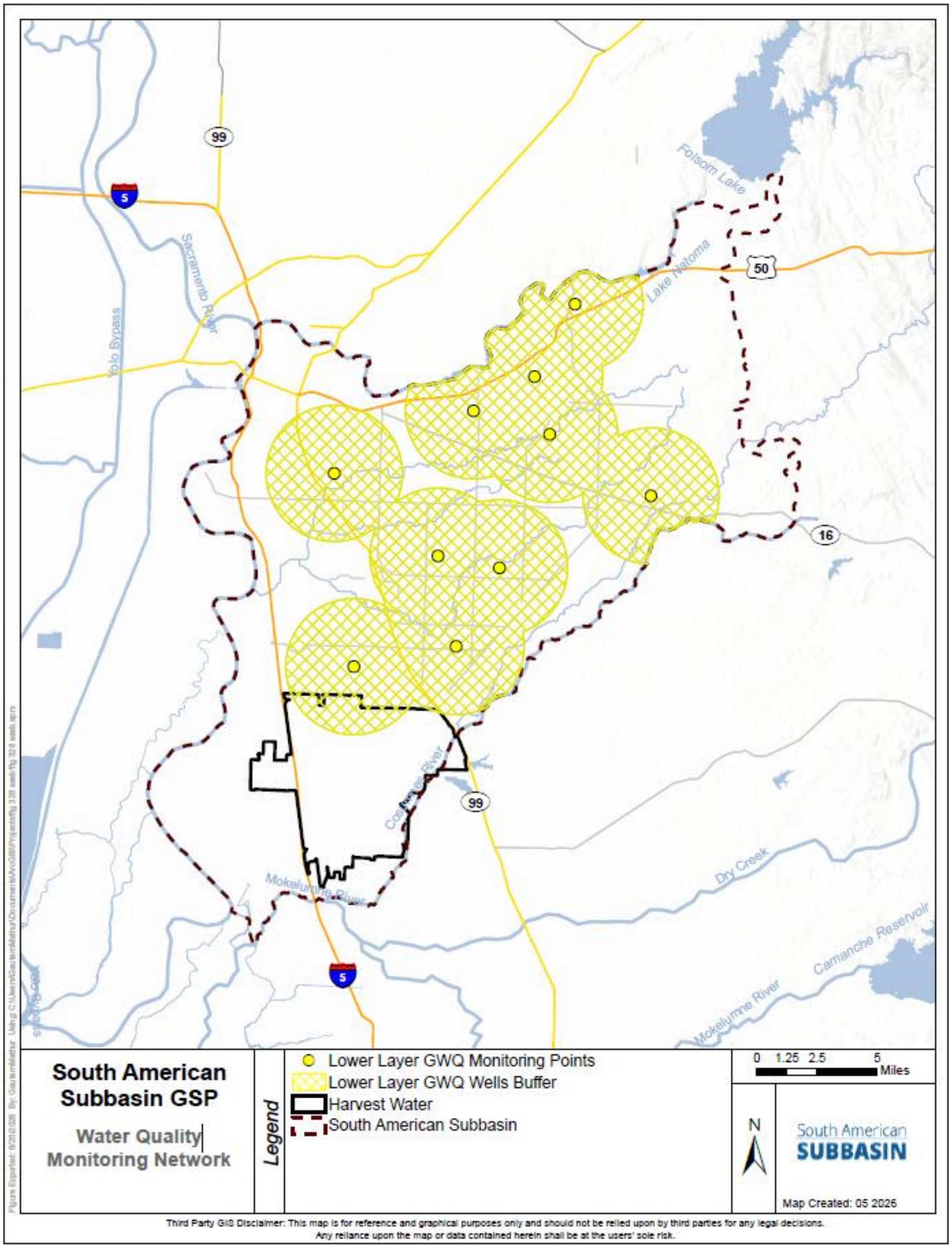


Figure 3-17: **Lower aquifer layer groundwater quality monitoring wells covering approximately 47% of the Basin area**

Table 3-8: Groundwater Quality Monitoring Wells in the Degraded Water Quality Monitoring Network's Upper Aquifer Zone

		Nitrate Measurements				Specific Conductance Measurements				
Well ID	**Facility or Water System Name**	**From**	**To**	**# of Records**	**Sampling Frequency**	**From**	**To**	**# of Records**	**Sampling Frequency**	**Logic for Selection**
CA3410020_009_009	City of Sacramento Main	1988	2024	31	Annual	1988	2023	15	Annual	Spatial representation Long monitoring records
CA3410029_002_002	SCWA - Laguna/Vineyard	1991	2024	32	Annual	1991	2023	16	Annual	Spatial representation Long monitoring records
CA3410029_016_016	SCWA - Laguna/Vineyard	1988	2024	31	Annual	1988	2023	15	Annual	Proximity to GWE monitoring wells; Long monitoring records
CA3410029_029_029	SCWA - Laguna/Vineyard	2001	2024	25	Annual	2001	2023	16	Annual	Spatial representation Long monitoring records
CA3410033_006_006	Florin County Water District	1990	2024	54	Annual	1990	2022	19	Triennial	Spatial representation Long monitoring records
L10005519750-MW-G(S)	Florin-Perkins Landfill	2014	2024	18	Semi-annual	2015	2025	20	Semi-annual	Proximity to GWE monitoring wells
L10008601447-MW-13	Elk Grove Class III Landfill	2014	2024	35	Semi-annual	2014	2025	33	Semi-annual	Proximity to GWE monitoring wells; Long monitoring records
CA3400101_001_001	Hood Water Maintenance Dist [SWS]	2001	2023	24	Annual	2002	2020	11	Annual	Spatial representation
CA3410029_024_024	SCWA - Laguna/Vineyard	2002	2023	23	Annual	2002	2023	10	Annual	Spatial representation
CA3410029_025_025	SCWA - Laguna/Vineyard	2001	2023	24	Annual	2001	2023	12	Annual	Spatial representation
CA3901216_001_001	Santos Ranch PWS #5-CSA #35	2002	2024	22	Annual	2002	2024	9	Annual	Spatial representation
CA3400229_003_003	Rio Cosumnes Correctional Center [Sws]	2006	2023	17	Annual	2006	2022	12	Annual	Spatial representation Long monitoring records
CA3410027_003_003	CAL AM - Security Park	1990	2024	37	Annual	1990	2024	20	Annual	Spatial representation Long monitoring records

Table 3-9: Groundwater Quality Monitoring Wells in the Degraded Water Quality Monitoring Network’s Lower Aquifer Zone

Well ID	Facility or Water System Name	Nitrate Measurements				Specific Conductance Measurements				Logic for Selection
		From	To	# of Records	Sampling Frequency	From	To	# of Records	Sampling Frequency	
CA3410015_020_020	Golden State Water Co. - Cordova	1986	2024	45	Annual	1986	2023	44	Annual	Proximity to GWE monitoring wells
CA3410015_022_022	Golden State Water Co. - Cordova	1993	2024	31	Annual	1993	2023	17	Annual	Spatial representation Long monitoring records
CA3410023_015_015	CAL AM - Fruitridge Vista	1991	2019	31	Annual	1991	2018	15	Annual	Spatial representation Long monitoring records
CA3410029_015_015	SCWA - Laguna/Vineyard	1988	2022	25	Annual	1988	2021	17	Annual	Spatial representation Long monitoring records
CA3410029_026_026	SCWA - Laguna/Vineyard	2001	2024	24	Annual	2001	2024	13	Annual	Spatial representation
CA3410029_027_027	SCWA - Laguna/Vineyard	2003	2024	22	Annual	2003	2022	11	Annual	Proximity to GWE monitoring wells Long monitoring records
CA3410704_001_001	SCWA Mather-Sunrise	1999	2024	25	Annual	2002	2024	56	Annual	Spatial representation
L10007396297-MW-40B	Kiefer Landfill	2014	2024	19	Semi-annual	2005	2025	41	Semi-annual	Proximity to GWE monitoring wells Long monitoring records
CA3410029_050_050	SCWA - Laguna/Vineyard	2002	2024	23	Annual	2002	2024	15	Annual	Spatial representation Long monitoring records
CA3410010_009_009	CAL AM - Suburban Rosemont	1992	2024	147	Annual	1992	2024	20	Annual	Spatial representation Long monitoring records

An assessment of the monitoring results for both spatial density and monitoring frequency suitability based on the proposed monitoring network will be performed to determine the need for expansion of the network with additional wells. This assessment is planned within the first five years of GSP implementation. Further evaluations of the monitoring network will be conducted on a five-year basis, particularly with regard to the sufficiency of the monitoring network in meeting the GSP's monitoring objectives. The monitoring network may be modified or expanded in the future based on an evaluation of the data collected or changes in land use.

Land Subsidence Monitoring Network

> *23 CCR § 354.34(c): Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(5) Land Subsidence. Identify the rate and extent of land subsidence, which may be measured by extensometers, surveying, remote sensing technology, or other appropriate method.*

The InSAR data provided by DWR (TRE Altamira) have spatial coverage for much of the Basin (considering the point data, while the rasters are interpolated for the entire subbasin area). These data are the only subsidence dataset currently available for the Basin and are consistent with the data and reporting standards outlined in 23 CCR § 352.4. The data have adequate temporal coverage for the Subbasin as well with annual rasters (beginning and ending on each month of the coverage year), cumulative rasters, and monthly time series data for each point data location.

The single CGPS station in the Subbasin (UNAVCO station #P274) is on the very edge of the Basin boundary, as well as near the larger subsidence subareas within the Basin (i.e., Delta and Elk Grove subareas). The InSAR and CGPS data at the location of the CGPS station compare well with one another demonstrating that the InSAR data product is an adequate management tool for land subsidence in the Basin.

As subsidence is not a significant concern for the Basin at present and likely not into the future, the InSAR data will be sufficient for the monitoring network..

The InSAR-based subsidence monitoring network allows sufficient monitoring both spatially and temporally to adequately assess that the measurable objective is being maintained.

The InSAR data provided by DWR (TRE Altamira) or equivalent InSAR satellite data products are sufficient to adequately resolve land subsidence estimates in the Subbasin spatially and temporally. While CGPS stations offer higher accuracy and frequency, satellite-based InSAR data are available monthly and are less accurate than CGPS data (although it is close enough for the management purposes of this GSP to be equivalent). However, InSAR data points are so many more times more numerous than are even feasible with CGPS stations (1,000s of individual points vs. a few stations) for a given basin that this is the preferable method given funding constraints. InSAR data can also be utilized to determine if and where future CGPS or ground-based elevation surveys should be sited.

The InSAR data provided by DWR (TRE Altamira) have adequate spatial coverage for the Basin (considering the point data, while the rasters are interpolated for the entire subbasin area). The data have adequate temporal coverage for the Basin as well, consisting of annual rasters (beginning and ending on each month of the coverage year), cumulative rasters for the full time period (2015-2026), and monthly time series data for each point data location. These temporal frequencies are adequate for understanding short-term, seasonal, and long-term trends in land subsidence.

Interconnected Surface Water Monitoring Network

> *23 CCR § 354.34(c): Each monitoring network shall be designed to accomplish the following for each sustainability indicator:*
>
> *(6) Depletions of Interconnected Surface Water. Monitor surface water and groundwater, where interconnected surface water conditions exist, to characterize the spatial and temporal exchanges between surface water and groundwater, and to calibrate and apply the tools and methods necessary to calculate depletions of surface water caused by groundwater extractions. The monitoring network shall be able to characterize the following:*
>
> *(A) Flow conditions including surface water discharge, surface water head, and baseflow contribution.*
>
> *(B) Identifying the approximate date and location where ephemeral or intermittent flowing streams and rivers cease to flow, if applicable.*
>
> *(C) Temporal change in conditions due to variations in stream discharge and regional groundwater extraction.*
>
> *(D) Other factors that may be necessary to identify adverse impacts on beneficial uses of the surface water.*

Groundwater level is used as a proxy for ISW depletion (**Section 3.2.4**). Thus, the surface water depletion monitoring network is complimentary with the network for groundwater level. The surface water depletion network consists of a subset of the wells which are strategically sited between ISW and pumping zones and in the upper zone of the principal aquifer (**Figure 3-18**). Observations obtained at these key locations in the groundwater level monitoring network will directly inform integrated surface and groundwater modeling in the Basin as model calibration targets.

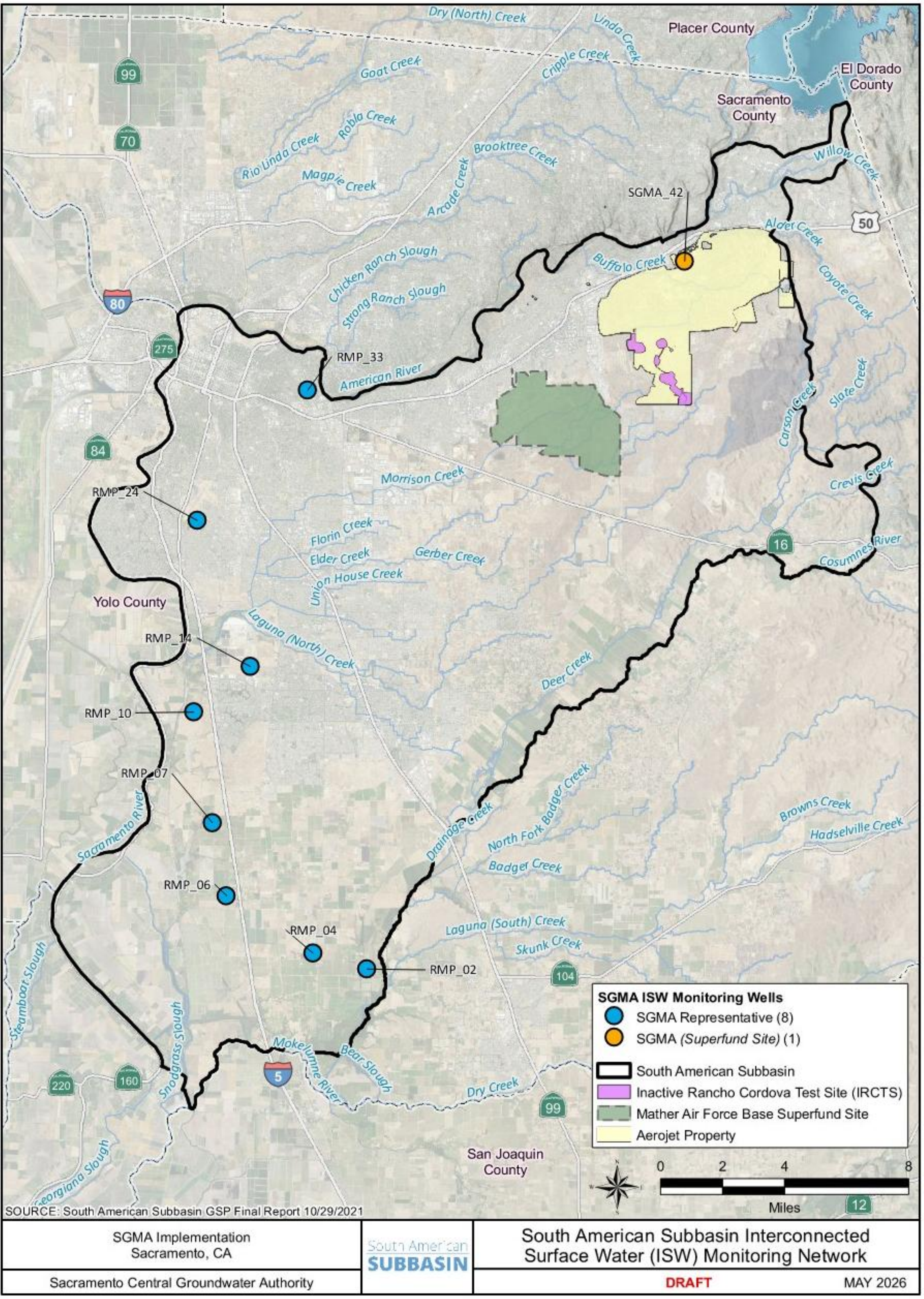


Figure 3-18: **Monitoring network for ISW depletion sustainability indicators.**

Moreover, through partnerships with GSAs and historical data availability, stream gauges that collect 15-minute interval data (**Table 3-10**) will be paired with 15-minute interval groundwater elevation data at specific locations along the American, Sacramento and Cosumnes Rivers. Paired observations will improve understanding of stream-aquifer exchange (via hydraulic gradient analysis) at a sub-seasonal timescale and inform sustainable and adaptive management of ISW in the Basin.

Table 3-10: Stream Gauge Monitoring Locations in the Basin

ID	Name	Latitude (NAD83)	Longitude (NAD83)
ACR_189	ACR_189	-121.32475	38.371660
ACR_181	ACR_181	-121.20423	38.466710
11335000	Michigan Bar	-121.04417	38.500278
SAMC1	H St	-121.42311	38.569014
11447650	Freeport	-121.50208	38.455775
MCNC1	McConnell	-121.34091	38.360702
11446500	Fair Oaks	-121.22667	38.635556

Data gaps along ISW reaches in the southern Cosumnes River and Sacramento River where 15-minute interval streamflow is available, but 15-minute groundwater elevation is not, will be addressed before the next Plan update by installing high-frequency monitoring sensors at existing biannually measured wells that will be paired with adjacent stream gauges.

3.5.3 Protocols for Data Collection and Monitoring (23 CCR § 352.2)

Establishment of monitoring protocols will ensure that collected data are accurate, representative, reproducible, and contain all required information. All groundwater elevation measurements, groundwater quality sample collection, and testing will follow the established protocols for consistency throughout the Basin and over time as outlined under each sustainability indicator's subsection.

3.5.3.1 Groundwater Level

Groundwater level data collection may be conducted remotely via telemetry equipment, or with an in-person field crew. The following section provides a brief summary of monitoring protocols for groundwater level collection. Establishment of protocols will ensure that data collected for groundwater elevation are accurate, representative, reproducible, and contain all required information. All groundwater level data collection in support of this GSP is required to follow the established protocols for consistency throughout the Basin and over time. These monitoring protocols will be updated as necessary and will be re-evaluated every five years.

All groundwater elevation measurements are referenced to a consistent elevation datum, known as the Reference Point (RP). For monitoring wells, the RP consists of a mark on the top of the well casing. For most production wells, the RP is the top of the well's concrete pedestal. The elevation of the (RP) of each well is surveyed to the National Geodetic Vertical Datum of 1929 (NGVD 29). The elevation of the RP is accurate to at least 0.5 foot.

Groundwater level measurements are taken to the nearest 0.01 foot relative to the RP using procedures appropriate for the measuring device. Equipment is operated and maintained in accordance with manufacturer's instructions, and all measurements are in consistent units of feet, tenths of feet, and hundredths of feet.

Groundwater elevation is calculated using the following equation:

$$GWE = RPE - DTW$$

Where GWE is the groundwater elevation, RPE is the reference point elevation, and DTW is the depth to water.

In cases where the official RPE is a concrete pedestal, but the hand soundings are referenced off the top of a sounding tube, the measured DTW is adjusted by subtracting the sounding tube offset from the top of the pedestal.

All groundwater level measurements must include a record of the date, well identifier, time (in 24-hour military format), RPE, DTW, GWE, and comments regarding factors which may influence the recorded measurement such as nearby production wells pumping, weather, flooding, or well condition.

Manual Groundwater Level Measurement

Groundwater level data collected by an in-person field crew will follow the following general protocols:

- Prior to sample collection, all sampling equipment and the sampling port must be cleaned. Manual groundwater level measurements are made with electronic sounders or steel tape. Electronic sounders consist of a long, graduated wire equipped with a weighted electric sensor. When the sensor is lowered into water, a circuit is completed and an audible beep is produced, at which point the sampler will record the depth to water. Some production wells may have lubricating oil floating on the top of the water column, in which case electric sounders will be ineffective. In this circumstance steel tape may be used. Steel tape instruments consist of simple graduated lines where the end of the line is chalked so as to indicate depth to water without interference from floating oil.
- All equipment is used following manufacturer specifications for procedure and maintenance.
- Measurements must be taken in wells that have not been subject to recent pumping. At least two hours of recovery must be allowed before a hand sounding is taken.
- For each well, multiple measurements are collected to ensure the well has reached equilibrium such that no significant changes in groundwater level are observed.
- Equipment is sanitized between well locations in order to prevent contamination and maintain the accuracy of concurrent groundwater quality sampling.

Data Logger Groundwater Level Measurement

Telemetry equipment and data loggers can be installed at individual wells to record continuous water level data, which is then remotely collected via cell phone towers to a central database which may be accessed in a web browser in the Stakeholder Data Portal. Installation and use of data loggers must abide by the following protocols:

- Prior to installation the sampler uses an electronic sounder or steel tape to measure and calculate the current groundwater level in order to properly install and calibrate the transducer. This is done following the protocols listed above.
- All data loggers installations follow manufacturer specifications for installation, calibration, data logging intervals, battery life, and anticipated life expectancy.
- Data loggers are set to record only measured groundwater level in order to conserve data capacity; groundwater elevation is calculated from these measurements, and knowledge of the cable length and ground surface elevation.
- In any log or recorded datasheet, site photographs, the well ID, transducer ID, transducer range, transducer accuracy, and cable serial number are all recorded.
- The sampler notes whether the pressure transducer uses a vented or non-vented cable for barometric compensation. If non-vented units are used, data are properly corrected for natural barometric pressure changes.
- All data logger cables are secured to the well head with a well dock or another reliable method. This cable is marked at the elevation of the reference point to allow estimates of future cable slippage.
- Data logger data is periodically checked against hand measured groundwater levels to monitor electronic drift, highlight cable movement, and ensure the data logger is operating correctly. This check occurs at least annually, typically during routine site visits.
- For wells not connected to a supervisory control and data acquisition (SCADA) system, transducer data is downloaded as necessary to ensure no data is overwritten or lost. Data is entered into the data management system as soon as possible. When the transducer data is successfully downloaded and stored, the data is deleted or overwritten to ensure adequate data logger memory. All wells in the Basin on continuous monitoring are on a SCADA system with the exception of Sacramento State wells (ID beginning with "SS").

3.5.3.2 Groundwater Quality

Sample collection will follow the USGS *National Field Manual for the Collection of Water Quality Data* (USGS 2015) and *Standard Methods for the Examination of Water and Wastewater* (Rice et al., 2012), as applicable, in addition to the general sampling protocols listed below.

The following section provides a brief summary of monitoring protocols for sample collection and analytical testing for evaluation of groundwater quality. Establishment of and adherence to these protocols will ensure that data collected for groundwater quality are accurate, representative, reproducible, and contain all required information. All sample collection and testing for water quality in support of this GSP are required to follow the established protocols for consistency throughout the Subbasin and over time. All testing of groundwater quality samples will be conducted by laboratories with certification under the California Environmental Laboratory Accreditation Program (ELAP). These monitoring protocols will be updated as necessary and will be re-evaluated every five years.

Wells used for sampling are required to have a distinct identifier, which must be located on the well housing or casing. This identifier will also be included on the sample container label to ensure traceability.

Event Preparation

- Before the sampling event, coordination with any laboratory used for sample analysis is required. Pre-sampling event coordination must include the scheduling of the laboratory for sample testing and a review of the applicable sample holding times and preservation requirements that must be observed.
- Sample labels must include the sample ID, well ID, sample date and time, personnel responsible for sample collection, any preservative in the sample container, the analyte to be analyzed, and the analytical method to be used. Sample containers may be labelled prior to or during the sampling event.

Sample Collection and Analysis

- Sample collection must occur at, or close to, the wellhead for wells with dedicated pumps and may not be collected after any treatment, from tanks, or after the water has travelled through long pipes. Prior to sample collection, the sample collector should clean all sampling equipment and the sampling port. The sampling equipment must also be cleaned prior to use at each new sample location or well.
- Sample collection in wells with low-flow or passive sampling equipment must follow protocols outlined in the EPA's *Low-flow (minimal drawdown) ground-water sampling procedures (*Puls and Barcelona, 1996) and USGS Fact Sheet 088-00 (USGS, 2000), respectively. Prior to sample collection in wells without low-flow or passive sampling equipment, at least three well casing volumes should be purged prior to sample collection to make sure ambient water is being tested. To ensure that ambient water is being tested, the sample collector should observe that field parameters have stabilized prior to sample collection. This method is outlined in the bullet below that discusses field parameters. If a well goes dry, this should be noted and the well should be allowed to return to at least 90% of the original level before a sample is collected.
- Sample collection should be completed under laminar flow conditions.
- Samples must be collected in accordance with appropriate guidance and standards and should meet specifications for the specific constituent analyzed and associated data quality objectives.
- In addition to sample collection for the target analyte (e.g., nitrate), field parameters, including temperature, pH, and specific conductance, must be collected at every site during well purging. Field parameters should stabilize before being recorded and before samples are collected. To ensure field parameters are stabilized, as the third or last well volume is purged, record the field measurements at regular time intervals (3 to 5 minutes apart). The following stabilization criteria should be met before final field parameters are collected: temperature is ± 0.2°C; conductivity (SC) is ± 3 percent; and pH is ± 0.1 to 0.2 pH units (allow ± 0.3 pH units if drifting persists). Field instruments must be calibrated daily and checked for drift throughout the day.
- Samples should be chilled and maintained at a temperature of 4° C and maintained at this temperature through delivery to the laboratory responsible for analysis.

- Chain of custody forms are required for all sample collection and must be delivered to the laboratory responsible for analysis of the samples to ensure that samples are tested within applicable holding limits.
- Laboratories must use reporting limits that are equivalent, or less than, applicable data quality objectives.

3.5.3.3 Land Subsidence

The DWR Groundwater Monitoring Protocols, Standards, and Sites BMP does not cite a standard approach for the monitoring of land subsidence but does provide various approaches to making determinations of land subsidence using varying data collection methods. The GSA will monitor all subsidence data annually. If any additional data become available, they will be evaluated and potentially incorporated into the GSP implementation. If the annual subsidence rate is greater than minimum threshold, further study will be needed.

Regarding the technical specifications of the DWR InSAR data (TRE Altamira) used in developing this SMC, the following text is from the California Natural Resources Agency (CNRA) data access webpage (https://data.cnra.ca.gov/dataset/tre-altamira-insar-subsidence):

> This statewide InSAR subsidence dataset was acquired as part of DWR's SGMA technical assistance to provide important SGMA relevant data to GSAs for GSP development and implementation. The dataset is formatted to support the production of maps and graphs that show the extent, cumulative total, and annual rate of land subsidence.
>
> Interferometric Synthetic Aperture Radar (InSAR) is a satellite-based remote sensing technique that measures vertical ground surface displacement changes at high degrees of measurement resolution and spatial detail. TRE processed Sentinel-1A InSAR data over the study area between January 1, 2015 and September 19, 2019 and calibrating them to data from 232 stations of the regional network of Continuous Global Positioning System (CGPS) stations. TRE provided the resulting time series data of vertical displacement values for point locations on a grid with 100 meter spacing, with values representing averages of vertical displacement measurements within the immediate 100 by 100 meter square areas of each point. Gaps in the spatial coverage of the point data are areas with insufficient data quality. The period of record for the point time series data varies by area, starting as early as January 1, 2015 and as late as June 13, 2015. TRE also provided 2 sets of GIS rasters; annual vertical displacement and total vertical displacement relative to the common start date of June 13, 2015, both in monthly time steps. An Inverse Distance Weighted (IDW) method with a maximum search radius of 500 meter was used to interpolate the rasters from the point data.
>
> Towill, Inc. (Towill), also under contract with DWR as part of DWR's SGMA technical assistance, conducted an independent study comparing the InSAR-based vertical displacement point time series data to data from 160 CGPS stations that were not used for calibrating the InSAR data, as well as 21 CGPS stations that were used for calibrating InSAR data in Northern California. The goal of this study was to ground-truth the InSAR results to best available independent data.
>
> The National Standard for Spatial Data Accuracy (NSSDA), developed by the Federal Geographic Data Committee (Document Number FGDC-STD-007.3-1998), offers a well-defined statistic and testing methodology for positional accuracy of geospatial data derived from various surveying methods including satellite remote sensing. The NSSDA is based on comparison of data from the tested dataset to values from an independent source of higher accuracy. For this study, variation in vertical displacement of California's ground surface over time, as measured from interferometric synthetic aperture radar (InSAR) satellites, was statistically compared to available ground based continuous global positioning systems (CGPS) data.

> Tested: 16 mm vertical accuracy at 95% confidence level.
>
> As tested by the processes described, this analysis provides statistical evidence that InSAR data accurately measured vertical displacement in California's ground surface to within 16 mm for the period January 1, 2015 through September 19, 2019. This statement of accuracy is based on the assumptions that the number, distribution, and characteristics of CGPS check point locations provide a representative sample of the entire study area and of the entire InSAR dataset, and that the CGPS data constitutes an independent source of higher accuracy. This statement of accuracy applies to the state-wide dataset and may vary for regional or localized area subsets.
>
> The Department of Water Resources makes no warranties, representations or guarantees, either expressed or implied, as to the accuracy, completeness, correctness, or timeliness of the information in this dataset, nor accepts or assumes any liability arising from use of these data. Neither the Department nor any of the sources of this information shall be responsible for any errors or omissions, or for the use or results obtained from the use of this information. A Groundwater Sustainability Agency is not required to use these data, and their use does not guarantee the adequacy of a Groundwater Sustainability Plan that relies on such data. (CNRA)

3.5.4 Reporting Monitoring Data to the Department (23 CCR § 354.40, § 352.4)

Monitoring data will be stored in the data management system and a copy of the monitoring data will be included in each Annual Report submitted electronically to the DWR. All reporting standards and information shall follow the guidelines outlined in 23 CCR § 352.4.

3.5.5 Assessment and Improvement of the Monitoring Network (23 CCR § 354.38)

The GSP and each five-year assessment report will include an evaluation of the monitoring networks, including a determination of uncertainty and whether there are data gaps that could affect the ability of the Plan to achieve the sustainability goal for the basin. Evaluation of data gaps must consider whether the spatial and temporal coverage of data is sufficient and whether monitoring sites are providing reliable and representative data. The description of identified data gaps will include the location and basis for determining data gaps in the monitoring network as well as local issues and circumstances that limit or prevent monitoring. These data gaps will be addressed by describing steps that will be taken to fill data gaps before the next five-year assessment, including the location and purpose of newly added or installed monitoring sites.

Data gaps to be filled (**Figure 3-19**) before the next Plan update will improve and expand SMC (**Table 3-4).** These data gaps fall into 3 main categories: information improvement, monitoring expansion, and SMC revision.

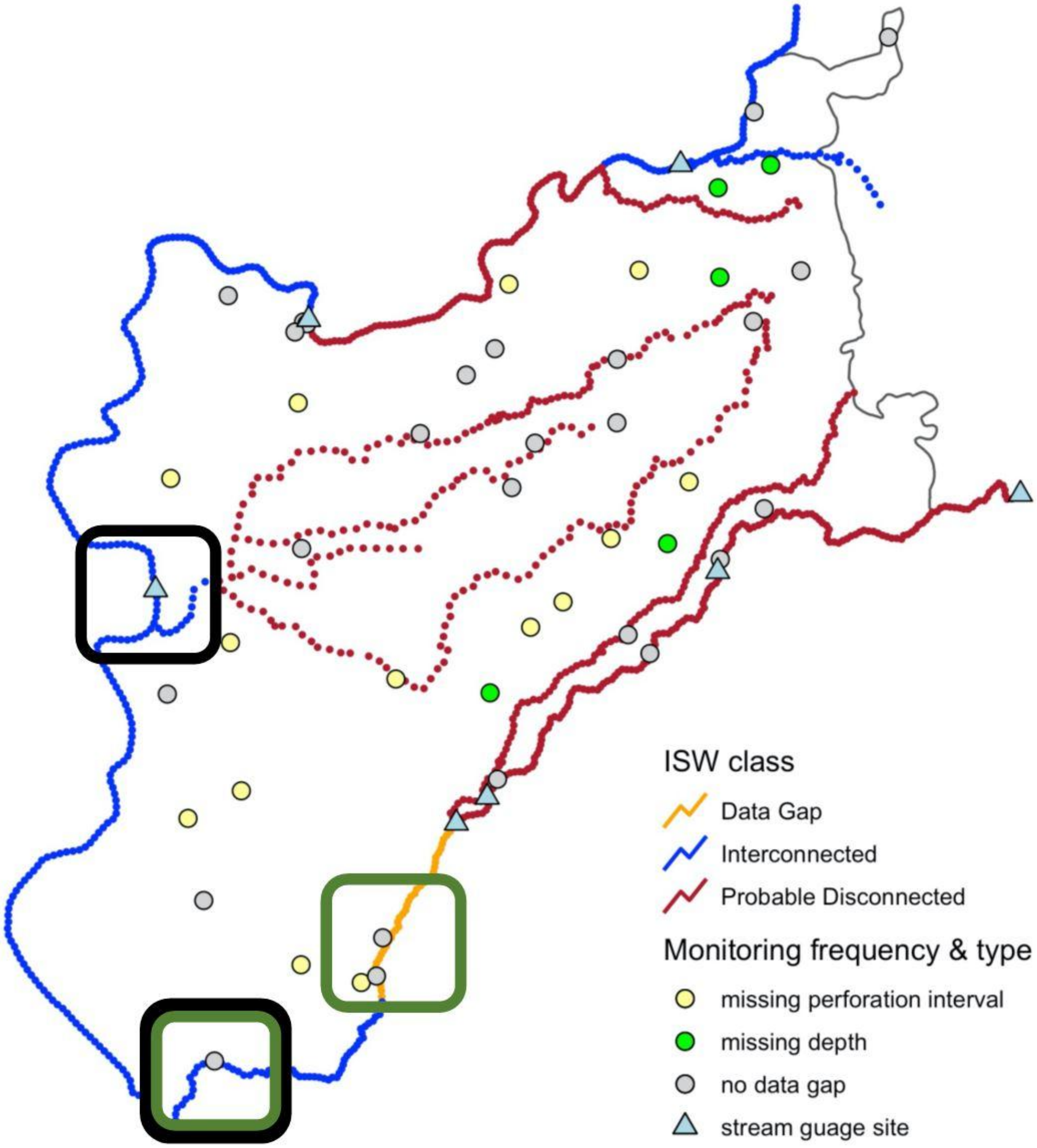


Figure 3-19: Data gaps to be addressed

Information Improvement

Not all monitoring points in the monitoring network contain construction information. After a thorough review of well completion reports and available information in the Basin, 5/45 wells are missing a total completed depth, and 15/45 wells are missing a description of the perforated interval (Error! Reference source not found., red and purple dots). No wells are missing both depth and perforated interval, as selection criteria mandates that at least one of these is present to understand vertical extent covered by the well. These data gaps will be addressed before the five-year Plan update in 2027. During field visitations to the monitoring sites, cameras and measuring tapes will be used to determine total completed depths and screened intervals depths.

Streamflow projections demonstrate significant reductions in all climate change scenarios, especially along the Sacramento and American rivers. More modeling is required to assess the impact of climate change on ISW and will be completed by the next 5 year plan update (2027).

A data gap along the Cosumnes River between Deer Creek and Twin Cities Road will be further investigated in terms of surface and groundwater interaction. Short term, sub-seasonal interaction is observed, but the reach remains disconnected on a seasonal average basis. It is unclear if short term interconnections events play an important role in the maintenance of habitat, species, or other beneficial uses and users. To address these data gaps, additional stream gage and continuous monitoring will be installed in the area, and GSAs will coordinate the Cosumnes subbasin GSAs and other stakeholders and technical experts to assess ISW presence/absence in the area. This data gap will be addressed before the next 5 year plan update (2027).

Streambed elevation is used to determine if a reach interconnects to adjacent groundwater by a comparison of their relative elevations. High resolution elevation mapping of ISW and other surface water bodies that provide ecological and recreational benefits can directly inform improved models and analyses of surface and groundwater interaction. Present day elevation data is likely sufficient to delineate ISW reaches but may be improved in the Cosumnes River.

Monitoring Expansion

The network needs two more stream gauges in the southern reaches of the Cosumnes River both above and below the point where analysis suggests ISW is present (Error! Reference source not found., green boxes). One stream gauge will be installed near an existing 15-minute interval groundwater monitoring site, and the second should be installed along the Mokelumne River upstream of the Sacramento River Confluence.

The network needs two more 15-minute interval monitoring wells (**Figure 3-19**, black boxes), which may be achieved by outfitting existing monitoring wells in the network with sensors and telemetry. These wells will be paired with 15-minute interval stream gauge stations and enable high-resolution monitoring of complex stream-aquifer interactions. Computed hydraulic gradients will improve understanding of sub-seasonal river-aquifer exchange.

GSAs in the Basin will coordinate with the adjacent Cosumnes Subbasin in order to strategically locate these high-frequency flow gauges and monitoring wells.

SMC Revision

Eight (8) representative monitoring points are in critical monitoring locations, but data is only available after 2018. Thus, data gaps in the historical record cause MTs and MOs to be set close to, or at present day, levels because the historical record only contains relatively wet water year types from 2018 onward. These eight wells were reviewed and the MTs, MOs, and IMs for these points (**Table 3-4**) remained unchanged. They will be reviewed again in the five-year Plan update as more information becomes available at these sites. Moreover, 5/8 these sites are high-frequency, 15-minute interval stations what will provide valuable insight into stream-aquifer interactions.

Section 4: Projects and Management Actions

To achieve the sustainability goal for the South American Subbasin (SASb) by 2042, and to avoid undesirable results over the remainder of a 50-year horizon, as required by SGMA regulations, multiple projects and management actions (PMAs) have been identified and considered by the SASb Groundwater Sustainability Agencies (GSAs) in this Groundwater Sustainability Plan (GSP).

4.1 History and Context

The projects and management actions described in this section build upon a long effort that started prior to the adoption of the Sustainable Groundwater Management Act (SGMA). Efforts to manage the SASb groundwater resources started as early as 1972 and became quite intensive in the 1990s. During that decade, a collaborative process involving a wide array of stakeholders resulted in a basin-wide agreement to manage both surface waters and groundwater and set a sustainable yield metric for the Basin. The timeline of these efforts is provided below.

1. Formation of the Sacramento County Water Agency (SCWA) by a special legislative act and creation of countywide groundwater policies – 1952.
2. Adoption of policies by the County of Sacramento recognizing that groundwater should be conserved, managed, and protected – 1972.
3. Voluntary groundwater elevation (spring and fall) monitoring as part of State Well Monitoring Program and development of groundwater elevation contour maps utilized by the State and local agencies to monitor groundwater use – 1974.
4. Partnerships with DWR in Bulletin 118 studies to specifically characterize the region's aquifer and local groundwater conditions – 1975.
5. Adoption of a master plan, creation of a benefit zone (i.e., Zone 40 of SCWA), establishing a fee structure to implement conjunctive use programs to support all new growth within groundwater impacted areas – 1986.
6. Adoption of county-wide water policies limiting new development's use of groundwater and requiring that alternative supplies be identified to offset increased water demands – 1990.
7. Development of the Sacramento County Integrated Groundwater and Surface water Model (SacIGSM), which was renamed the Sacramento Integrated Water Resources Model (SacIWRM), along with corresponding analyses of groundwater quality conditions – 1993.
8. Development of current and projected water demands for Water Forum planning models (*The Estimate of Annual Water Demand within the Sacramento Metropolitan Area*) – 1995.
9. Delivery of first increment of surface water as part of the SCWA Zone 40 conjunctive use program – 1995.

10. Quantitative impacts analysis of undesirable effects and groundwater modeling to support Water Forum negotiations – 1995.
11. Establishment of a stakeholder process and significant education to define Sacramento County groundwater management areas and acceptable sustainable yields (Water Forum Process) – 1994-2000.
12. Self-imposed and locally financed consensus-based stakeholder process leading to a quantitative threshold-based groundwater management plan identified as the Central Sacramento County Groundwater Management Plan (GMP) in accordance with the provisions of SB-1938 and a proposed governance structure – 2000-2006.
13. Development of GMP, along with the corresponding hydrologic database management system, which implemented a monitoring program for groundwater levels and groundwater quality with thresholds to manage the basin within the sustainable conditions as set forth by the Water Forum Agreement – 2002-2006.
14. Establishment of a Joint Powers Authority Governance Structure creating the Sacramento Central Groundwater Authority (SCGA) and adoption of the GMP – 2006.
15. Development of the California Statewide Groundwater Elevation Monitoring (CASGEM) program for the SASb, per State requirements – 2009.
16. Voluntary groundwater management activities through SCGA and member agencies and stakeholders who represent all subbasin groundwater use sectors – 2006-Present.
17. Completion of the Freeport Intake and associated pipelines by Freeport Regional Water Authority (SCWA and East Bay Municipal Utility District (EBMUD)) to deliver surface water supplies to users within the SASb - 2007.
18. Completion of the Vineyard Surface Water Treatment Plant by SCWA to produce potable water for the communities of eastern Sacramento County – 2011.
19. Completion of Regional Water Reliability Plan prepared for Regional Water Authority – 2019.

A key output of the pre-SGMA planning efforts was the development of a sustainable yield value of 273,000 AF per year for the SASb. This sustainable yield metric has served as the basis for agreements on land and water use planning in the region and is referenced explicitly in planning documents produced by land use management entities and water purveyors in the SASb, including the 2006 GMP, which serves as the overarching groundwater management document for the SASb.

4.2 Project and Management Actions Under SGMA

For the SGMA process, a description of PMAs that will contribute to the achievement of the sustainability goal in the SASb is provided in accordance with §354.42 and §354.44 of the SGMA regulations. “Projects” generally refer to structural features whereas “management actions” refer to non-structural programs or policies (e.g., designed to incentivize reductions in groundwater pumping or optimize management of the subbasin). PMAs discussed in this section will support the sustainability goal in the context of the measurable objectives and minimum thresholds to avoid undesirable results identified for the Basin in **Section 3: Sustainable Management Criteria**.

At the outset, it is important to distinguish between projects that will be directly funded and implemented by the GSAs in the SASb, as opposed to projects that are currently sponsored and planned and will be implemented by specific entities within the SASb, in coordination with the respective GSAs. This GSP takes such planned projects into account to evaluate whether additional projects will be needed in the future to reach the sustainability goal. An evaluation of the impact of various planned projects on groundwater levels and storage volumes is provided in this Section through the use of scenarios developed with stakeholder input and modeled using the CoSANA model.

It is also important to acknowledge that the basin's beneficial uses and users will receive significant benefits from PMAs that provide multiple benefits and embrace innovation and new technologies. This Plan prioritizes multi-benefit PMAs that stress the utilization of natural infrastructure, including the basin itself for storage and its waterway floodplains as recharge areas. The Plan emphasizes coordination among users and neighboring basins to improve the region's groundwater condition. For example, the multi-benefit Harvest Water program (described in detail later in this section) will provide recycled water, which is treated to the tertiary level, to agricultural water users in the southwestern area of the basin in lieu of groundwater use, resulting in recovery of groundwater levels. The Cosumnes River is expected to gain water by this rise in groundwater levels which will also provide ecosystem benefits in southern parts of the Subbasin. This recycled water is currently discharged to the Sacramento River.

The PMAs identified in this Section will be periodically assessed during the GSP implementation period. The PMAs are in various stages of development so complete information is not uniformly available on construction requirements, operations, costs, permitting requirements, and other details. A conceptual description of the operation of PMAs as part of the overall GSP is provided in this section and in **Section 5: Plan Implementation**.

Each individual project proponent will manage the permitting and other specific implementation oversight for its own projects. Inclusion of PMAs in this GSP does not forego any obligations regarding individual project implementation under local, state, or federal regulatory programs. While the GSAs do have an obligation to oversee progress towards groundwater sustainability, they are not necessarily the primary regulator of land use, water quality, or environmental compliance. It is the responsibility of the implementing agencies of planned projects to ensure compliance with all applicable laws and regulatory requirements. The GSAs will collaborate with project proponents to track progress and support project implementation. The implementation of PMAs will be enhanced by the development of clear policy and guidance by the GSAs that lay out sustainable management criteria for the SASb (as described in **Section 3: Sustainable**

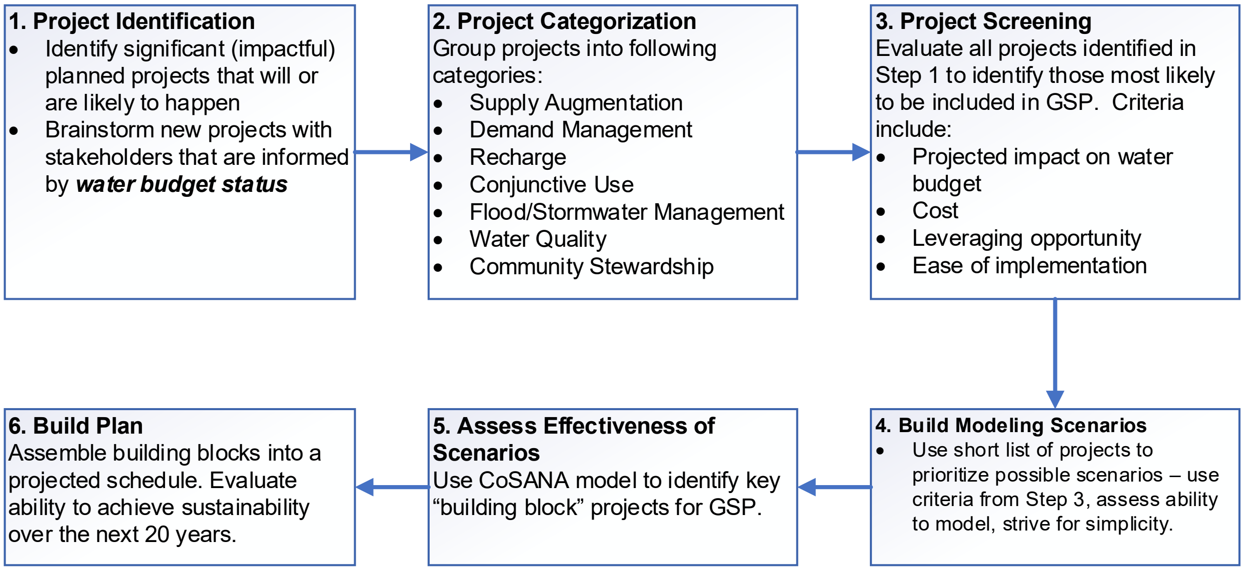
Management Criteria) as well as the monitoring and reporting framework that serve to protect the Subbasin and ensure it achieves and maintains sustainability. The GSP includes a management action to coordinate implementation of each of the key planned projects in such a way that the Subbasin sustainability is achieved in a collaborative environment among the GSAs and the project proponents and sponsors.

The process of identifying, screening and selecting PMAs for detailed consideration in this GSP is illustrated in **Figure 4-1**. Existing and planned projects were first identified from available reports, documents, and websites including:

- American River Basin IRWMP Database
- SCGA Basin Management Plan
- City of Sacramento Urban Water Master Plan (UWMP) and Groundwater Master Plan
- Northern Division Sacramento District UWMP
- Regional Water Authority Regional Water Reliability Plan

New projects were also identified through brainstorming sessions with GSPWG members and other stakeholders, including representatives from the following entities with jurisdictional responsibility in the South American Subbasin:

- Sacramento Central Groundwater Authority
- City of Sacramento
- City of Folsom
- Sacramento County Water Agency
- Sacramento County
- Sloughhouse Resource Conservation District
- Omochumne-Hartnell Water District (OHWD)
- Elk Grove Water District
- Sacramento Regional County Sanitation District
- Golden State Water Company
- California American Water Company
- Northern Delta Groundwater Sustainability Agency
- Sacramento Area Flood Control Agency
- Regional Water Authority
- Cosumnes Coalition
- Environmental Coalition of Sacramento (ECOS)
- The Nature Conservancy



1. Project Identification
- Identify significant (impactful) planned projects that will or are likely to happen
- Brainstorm new projects with stakeholders that are informed by ***water budget status***

2. Project Categorization
Group projects into following categories:
- Supply Augmentation
- Demand Management
- Recharge
- Conjunctive Use
- Flood/Stormwater Management
- Water Quality
- Community Stewardship

3. Project Screening
Evaluate all projects identified in Step 1 to identify those most likely to be included in GSP. Criteria include:
- Projected impact on water budget
- Cost
- Leveraging opportunity
- Ease of implementation

4. Build Modeling Scenarios
- Use short list of projects to prioritize possible scenarios – use criteria from Step 3, assess ability to model, strive for simplicity.

5. Assess Effectiveness of Scenarios
Use CoSANA model to identify key "building block" projects for GSP.

6. Build Plan
Assemble building blocks into a projected schedule. Evaluate ability to achieve sustainability over the next 20 years.

Figure 4-1: The Process of Identifying, Screening, Evaluating and Selecting PMAs

Identified projects are summarized in **Appendix 4-A** and have been grouped into seven categories: Recharge, Flood/Stormwater Management, Water Quality, Supply Augmentation, Demand Management, Community Stewardship, and Conjunctive Use. Projects in each category were evaluated to identify those with the highest potential to impact groundwater conditions and sustainability indicators within the SASb.

The projects identified from the list in **Appendix 4-A** and the stakeholder interviews were then categorized into three groups:

> **Group 1 –** Existing PMAs currently being implemented and expected to continue to be implemented, as needed, to support achievement of the sustainability goal. These PMAs are considered as baseline conditions in the groundwater modeling projections described in this section and in **Section 2: Plan Area and Basin Setting**.
>
> **Group 2 –** PMAs already planned for near-term implementation by individual entities, which may, individually or in aggregate, contribute to achieving sustainability in the SASb over the implementation horizon.
>
> **Group 3 –** Supplemental PMAs that are in conceptual stages which may be implemented in the future and would provide additional benefit in improving groundwater conditions and/or adapting to changes in future conditions.

From this list of projects and management actions, those that had adequate information to allow a modeling evaluation, that were deemed likely to be implemented, and are projected to have a significant impact on groundwater conditions in the SASb were chosen as components for modeling scenarios. Some multi-benefit projects that are described in this Section were not included in the modeling scenarios due to lack of adequate information (e.g., the SAFCA project) but are included herein based on widespread support from GSP Working Group members and local stakeholders. Other projects that have been identified as part of the PMA research effort are listed in **Appendix 4-B**.

Using the CoSANA model, the effectiveness of the different PMA scenarios were assessed to determine the range of impacts of the selected scenarios on sustainability of the Subbasin based on sustainability indicators in the SASb (Groundwater levels, Groundwater storage, and Inter-connected surface water). The projects included in the modeling scenarios and described in detail below fall in Group 2, as described above. These projects would ultimately be implemented by individual entities, in coordination with the GSAs in the SASb, and are therefore not considered as an obligation of the GSAs as part of this GSP. The results of the model scenario runs are provided in **Section 4.7** below.

4.3 Group 1: Existing Projects

In response to the recognized need to diversify water supplies, water management entities in the SASb have historically implemented and continue to implement projects to achieve this goal. Below is a partial list of those actions focusing on the larger efforts that are included in the CoSANA Baseline modeling scenario.

20. The 2005 Zone 40 Water Supply Master Plan recommended the Freeport Regional Water Project as the preferred alternative, which resulted in the collaboration of SCWA and EBMUD to jointly construct the 185 MGD diversion on the Sacramento River, completed in 2007. As part of the recommendation, SCWA also constructed the 50 MGD Vineyard Surface Water Treatment Plant (Vineyard WTP), completed in 2011.
21. 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, SCWA, and the Golden State Water Company.
22. The City of Sacramento Groundwater Master Plan was developed in 2017 to address an extensive well replacement program (as the majority of their wells are near or at the end of their useful life) and to analyze the fiscal implications of well replacement in comparison with surface water treatment expansion. The City has firm water rights on the Sacramento and American Rivers and has historically relied on groundwater from the wells north of the American River. Nevertheless, the City developed a plan to utilize groundwater in both their north and south service areas, as part of the City-wide conjunctive use program to increase water supply reliability for retail and wholesale water supplies in the City. This Groundwater Master Plan includes rehabilitation and/or replacement of wells in the north service area, and installation of new wells in the south service area (i.e., the SASb).

4.4 Group 2: Near-term Planned Projects

Near-term projects are in the planning or design phase and are expected to be operational within the next five (5) years. For these projects, details are provided for implementation, in addition to their expected impact on the groundwater basin.

4.4.1 Harvest Water

4.4.1.1 Project Description

Sponsored by the Sacramento Regional County Sanitation District (Regional San), Harvest Water will provide a safe and reliable supply of disinfected tertiary-treated recycled water for agricultural uses. This project is expected to reduce groundwater pumping, support habitat protection efforts, enhance groundwater dependent ecosystems, and provide near-term benefits to the SASb and the Sacramento-San Joaquin Delta. The project will support efforts at maintaining sustainability indicators for groundwater storage, groundwater levels, and depletions of interconnected surface water in the SASb.

The project will use the upgraded Sacramento Regional Wastewater Treatment Plant (scheduled to be completed in 2023) to deliver up to 50,000 acre-feet per year (AFY) of drought-resistant recycled water to irrigate more than 16,000 acres of permanent agriculture and habitat conservation lands near the Cosumnes River and Stone Lakes Wildlife Refuge (**Figure 4-2**).

Physical construction of the project is scheduled for completion in 2026, with an anticipated start of operation in 2027.

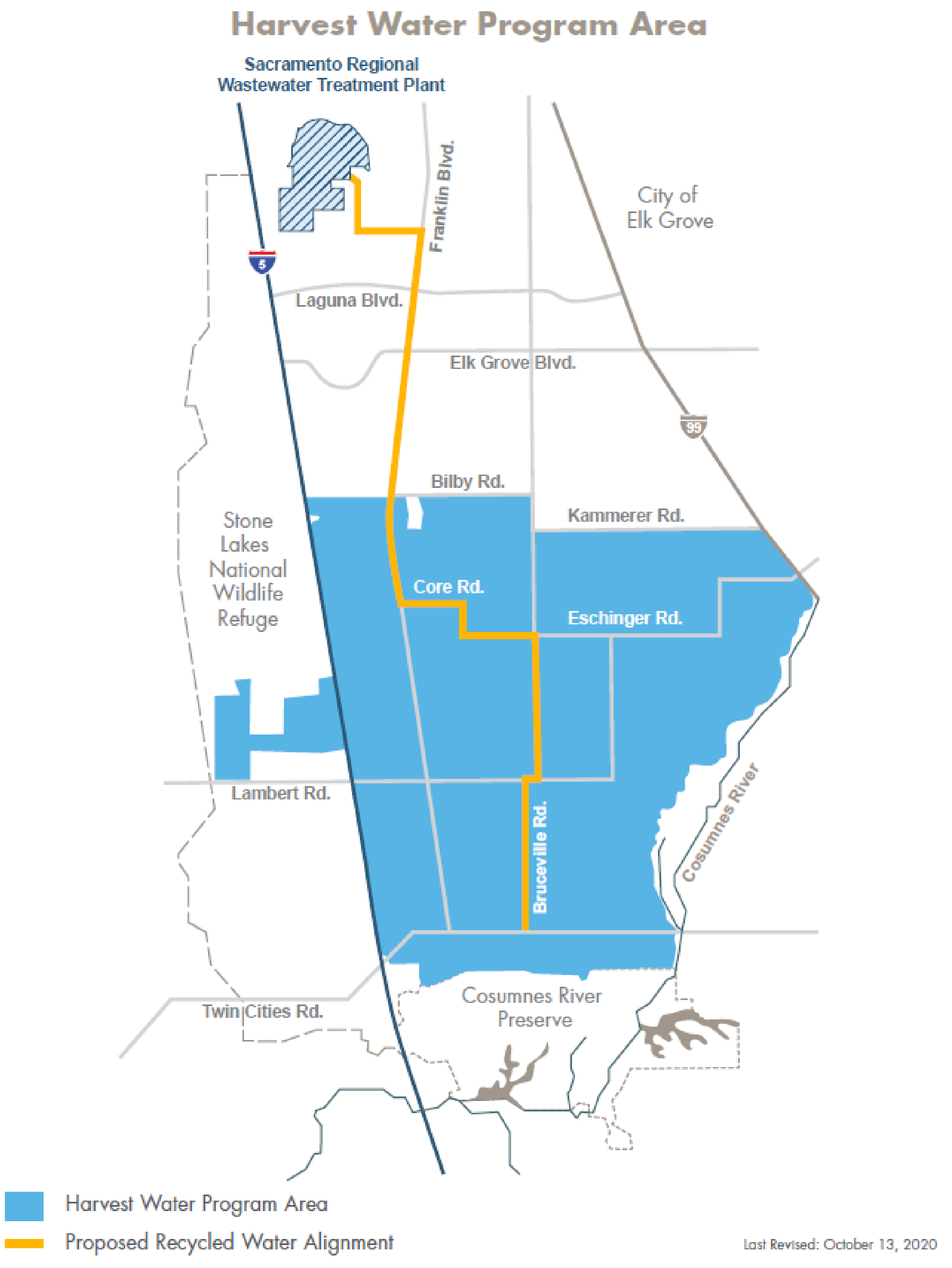


Figure 4-2: Map of Proposed Recycled Water Pipeline Alignment and Program Area

4.4.1.2 Public Noticing

Regional San is in the process of fulfilling public noticing and disclosure requirements under CEQA for Harvest Water and has conducted an extensive public outreach effort and will fulfill all additional public notifications to support implementation of the project.

4.4.1.3 Permitting and Regulatory Process

Regional San is in the process of fulfilling all permitting requirements for the construction and operation of the Harvest Water.

4.4.1.4 Status

This project is currently in the construction phase.

4.4.1.5 Expected Benefits

- Provides up to 50,000 AFY of recycled water to irrigate more than 16,000 acres of agricultural and habitat lands.
- Increases regional and state water supply reliability through in-lieu groundwater recharge which will increase groundwater in storage via this conjunctive use process.
- Improves water quality by increasing groundwater levels and in-stream flows in the Cosumnes River.
- Restores low groundwater levels up to 35 feet within 15 years and helps advance GSP goals of basin sustainability.
- Increases volume of groundwater in storage by approximately 245,000 AF within 10 years, and approximately 450,000 AF in 40 years.
- Supports and increases riparian and wetland habitat on over 5,000 acres.
- Supports a variety of special status species, such as Swainson’s Hawk, Sandhill Cranes and Giant Garter Snake.
- Increases frequency of Cosumnes River instream flows to support fall-run Chinook Salmon.
- Supports the State and U.S. Bureau of Reclamation goals of increased use of recycled water.
- Provides reliable agricultural water supplies, and drought resiliency.

4.4.1.6 Implementation

The project will be implemented by the Regional San in coordination with the local GSAs and consistent with this GSP.

4.4.1.7 Legal Authority

Regional San is in the process of establishing its legal authority for the project, including obtaining a recycled water permit.

4.4.1.8 Estimated Costs and Funding Plan

The total project cost is expected to be $444.2 million. This total includes:

- $257.4 million for recycled water infrastructure construction
- $76.7 million for ecological program
- $86 million for planning, design, permitting, construction management and other program implementation elements
- $24.1 million for construction and program contingencies

To date, the project has been awarded $287.5 million in grant funds by the California Water Commission from the Water Storage Improvement Program and $4.2 million in grant funds from US Bureau of Reclamation's Water Infrastructure Improvements for the Nation (WIIN) Act. Regional San continues to pursue additional funding opportunities and will finance the balance of capital costs through cash reserves and user rate revenues.

4.4.1.9 Management of Groundwater Extractions and Recharge

The project will provide recycled water from the Sacramento Regional Wastewater Treatment Plant. The recycled water is derived from wastewater originating in the SRWTP service area, which includes the Cities of Sacramento, Rancho Cordova, Folsom, Elk Grove, West Sacramento, Citrus Heights, and unincorporated areas of Sacramento County. During the growing season, this water will be delivered to growers that currently rely on groundwater for irrigation, thereby reducing groundwater pumping in the project service area (**Figure 4-2**). Recycled water is also planned to ultimately be delivered to the Stone Lakes National Wildlife Refuge to further reduce the need for groundwater pumping. Approximately 20 years after recycled water deliveries begin, once the groundwater levels recover and the basin is in sustainable excess, groundwater stored in the basin could be available in the future for potential groundwater accounting partners, such as growers and local municipalities to use in dry years instead of surface water. Through an extensive monitoring well system, Regional San will track progress toward realizing project benefits associated with increased groundwater levels and evaluate conjunctive use operations, as they occur.

4.4.2 Omochumne-Hartnell Water District Groundwater Recharge Project and Groundwater Monitoring

4.4.2.1 Project Description

The Cosumnes River is the last major undammed river draining the western slope of the Sierra Nevada. The river experiences an intermittent and perennial cycle of large peak flows in the winter and low flows in the summer. Historically, the Cosumnes River has had a physical connection to the underlying groundwater basin, which helped improve the flow within the river for fish migration and other beneficial uses. However, the installation of levees in the 1940s which reduced the river flooding that recharged the basin and years of groundwater pumping have lowered groundwater levels and severed the basin’s interconnectivity with surface water in some reaches, reducing the viable times for migration of Chinook salmon and other fish.

In 2011, OHWD received funding to implement a groundwater banking project through a Proposition 84 Integrated Regional Water Management (IRWM) grant submitted by the

Regional Water Authority (RWA). That project was re-designed as an off-season irrigation project to enhance recharge to the underlying aquifer in the South American and Cosumnes subbasins. A revised Proposition 84 grant proposal, including detailed scope and budget, was submitted to the Department of Water Resources (DWR); the proposal received project approval by DWR.

The grant funding has been used to construct pipelines and other facilities to divert up to 4,000 AF per year of surface water from the Cosumnes River to a 1,168-acre area between the Cosumnes River and Deer Creek (**Figure 4-3**). In the future, up to 6,000 AFY are planned to be diverted from the Cosumnes River.

OHWD has operationalized the project under a temporary State Water Resources Control Board permit (granted in WY 2023), allowing diversion of up to 2,444 AF during eligible winter high-flow events, with plans to expand capacity to 4,000 AFY. Moving forward, OHWD will continue operating under the temporary permit while exploring applying for a standard diversion permit.

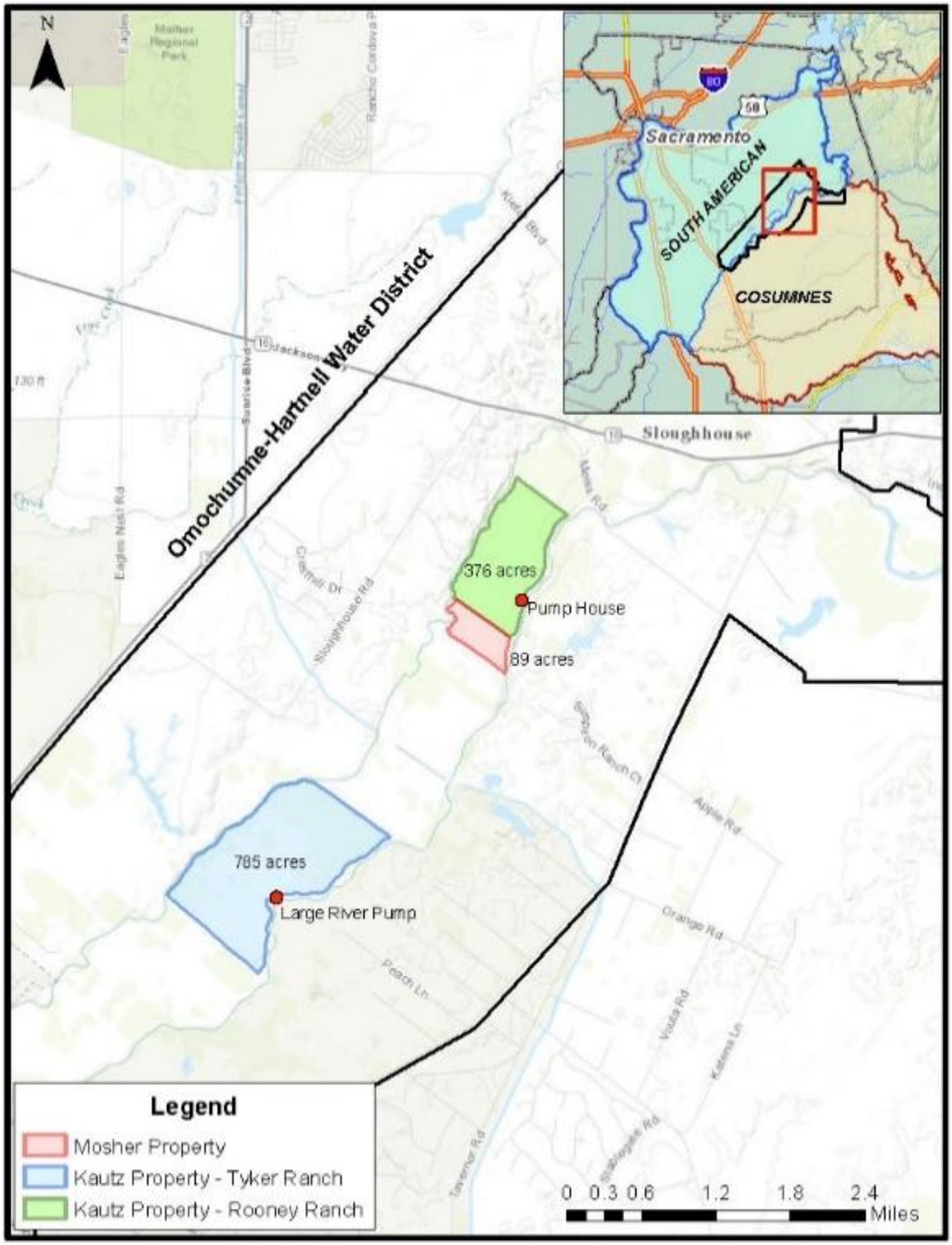


Figure 4-3: Location of Omochumne-Hartnell Water District Groundwater Recharge Project

The project, when fully operational, will help alleviate groundwater overdraft in both the South American and Cosumnes subbasins. The project will also support efforts at maintaining sustainability indicators for water table elevations, and depletion of interconnected surface water.

4.4.2.2 Public Noticing

OHWD satisfied all public noticing and disclosure requirements under CEQA for the existing pilot project. OHWD will fulfill all additional public notifications to support implementation of the final project.

4.4.2.3 Permitting and Regulatory Process

On September 18, 2018, OHWD adopted a final Mitigated Negative Declaration approving the Pilot Project and determining that the Project's environmental impacts will be less than significant with mitigation.

In Phase 1 of the pilot study, a temporary diversion permit was obtained from the State Water Resources Control Board allowing diversions from the Cosumnes River during periods of high flow from December 1, 2020 to February 15, 2021. This permit allowed for pumping at two locations at a rate of 2000 gallons per minute (gpm) and 5000 gpm, totaling 16 cubic feet per second (cfs).

A second Phase of the pilot study will upgrade the pumping and conveyance systems to allow a maximum diversion rate of 50 cfs and total diversion to underground storage of 6000 AF during wet years. This phase will require a new temporary permit.

Ultimately, the plan is to apply for the right to divert a portion of the peak winter flows in the Cosumnes River to allow permanent implementation of the second phase of the pilot study, i.e., a 6,000-AFY diversion during wet years for groundwater recharge, with extraction of this recharged volume during the next growing season to offset groundwater pumping demands.

OHWD will fulfill all permitting and regulatory requirements prior to implementation of the second Phase of the pilot study and the final project.

4.4.2.4 Status

In WY 2023, OHWD obtained a five-year temporary groundwater recharge permit from the State Water Resources Control Board authorizing diversion of up to 2,444 AF during qualifying flow events between December 1 and March 15. The permit includes operational requirements, such as installation of fish screens and adherence to minimum flow criteria, to protect environmental resources.

Future expansion of the project, including increased diversion capacity, will require additional permitting. OHWD is currently evaluating options to apply for a long-term diversion permit to support continued and expanded recharge operations.

4.4.2.5 Expected Benefits

- The project will facilitate sustainable groundwater management by increasing recharge, utilizing the available groundwater storage capacity, and thereby increasing the safe yield available to overlying users.
- If OHWD's efforts are successful in restoring groundwater/surface water connectivity, use of 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 flow window for the Cosumnes River is extended, the local ecosystem will be enhanced by the project.

Due to the heterogeneity of the local geology, there is some difficulty in predicting the degree to which these benefits will be realized. For that reason, a data collection program has been designed to capture hydrologic data that will assist managers in determining the impact of the project. The data collection program builds on OHWD's streamflow and temperature monitoring program between Rancho Murieta and State Highway 99 and adds instrumentation for the monitoring of levels and quality in numerous groundwater wells in the floodplain.

4.4.2.6 Implementation

The project has been implemented by OHWD, and Phase 1 is now complete. As described earlier, OHWD obtained a temporary permit and is recharging water according to permit terms when it is available.

4.4.2.7 Legal Authority

The Omochumne-Hartnell Water District is a California Water District formed under the California Water District Act in 1953; it is located in both the South American and Cosumnes Subbasins. OHWD works to manage surface water flows in the Cosumnes River and groundwater supply in these subbasins to facilitate its landowners' exercise of their own water rights.

4.4.2.8 Estimated Costs and Funding Plan

Estimated costs for the final project are not yet available.

4.4.2.9 Management of Groundwater Extractions and Recharge

An extensive monitoring program has been established to monitor the amount of water recharged and the amount of water extracted. Additionally, some existing wells have been outfitted with instrumentation to monitor groundwater levels in real time to ensure that extraction does not exceed recharge, as indicated by a drop in groundwater levels.

4.4.3 Regional Conjunctive Use Program / Water Bank

4.4.3.1 Project Description

This project is a comprehensive regional conjunctive use program that will increase conjunctive use among both NASb and SASb municipal and industrial (M&I) water purveyors, including California American Water Company, Citrus Heights Water District, City of Lincoln, City of

Sacramento, Golden State Water Company, SCWA, and Sacramento Suburban Water District. The project will utilize existing infrastructure and leverage ongoing planning processes to use available surface water through water transfers, groundwater recharge projects, wholesale agreements, or wheeling agreements (**Figure 4-4**). The goal is to provide long-term basin benefits through additional surface water supplies during wet years which would result in reduction of groundwater use. In addition, the program includes groundwater recovery operations by select entities during dry years. It is anticipated that project implementation will be heavily integrated with the Regional Reliability Program (RWA, 2018) and, ultimately, the future Sacramento Regional Water Bank, to track and manage the usage of water.

Development efforts for the Sacramento Regional Water Bank are progressing. Agencies completed the Water Bank governance document, advanced modeling improvements, started California Environmental Quality Act (CEQA) documentation, evaluated benefits of previously banked water, and developed water accounting system that is being piloted. The program is expected to be completed in the next few years.

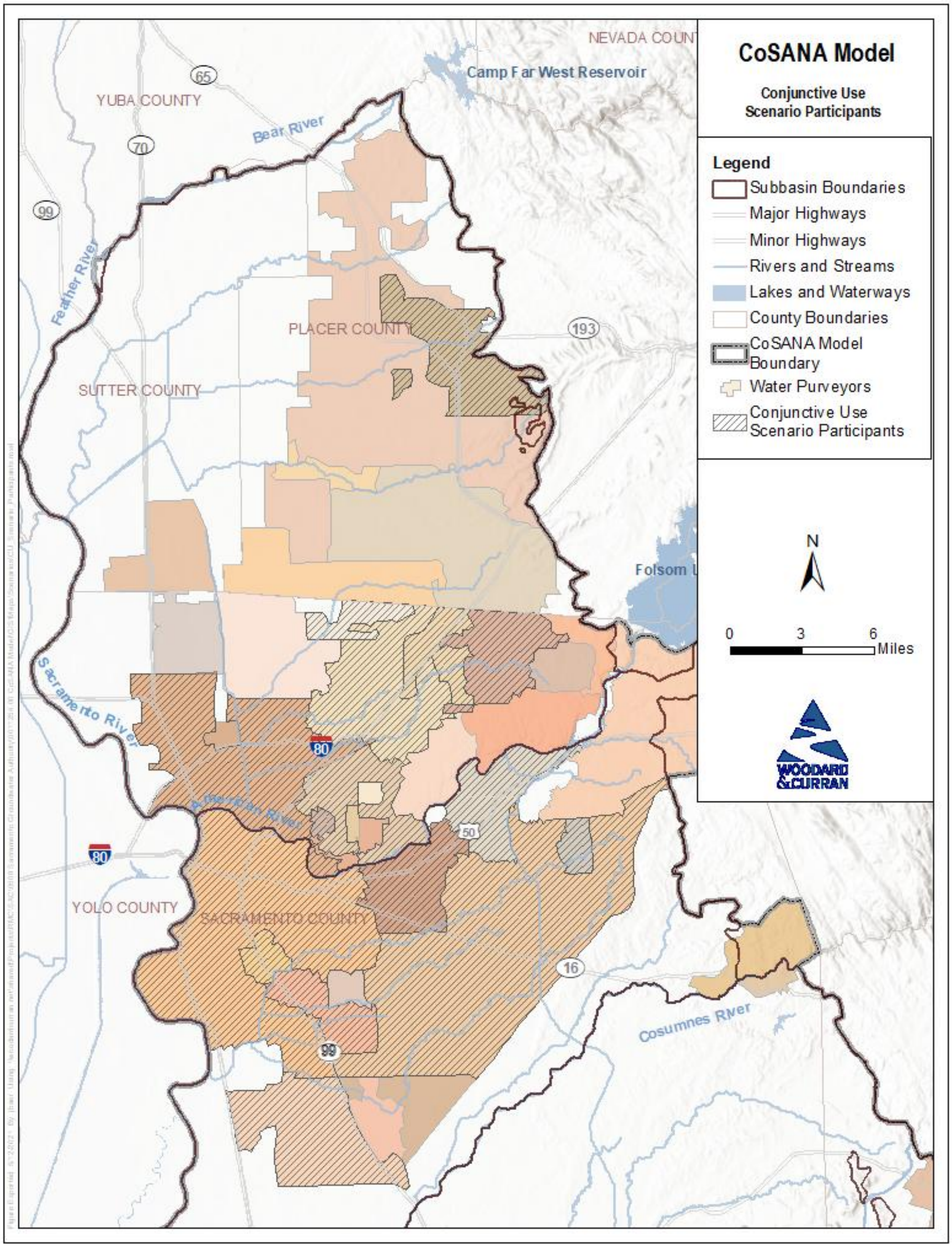


Figure 4-4: Map of Participating Conjunctive Use Program Agencies

The project will allow participating agencies to increase surface water usage during wet years, during short-duration periods such as storm events, or during other year types when surface water is available to be transferred. 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. This project is estimated to yield an average annual benefit of about 7,200 AF/year based on CoSANA model output. The program, as currently defined, includes surface water supplies and groundwater pumping reduction as shown in **Table 4-1**.

Table 4-1: Regional Conjunctive Use Program

Entity	Projected Demand	Wet Year Additional SW Supply	Wet Year GW Pumping Reduction	Long-Term (50-Yr) Avg. Annual Pumping Reduction	Dry Year GW Pump Back
California American WC – Parkway	16,604	5,351	5,351	1,819	0
California American WC – Suburban Rosemont	13,227	6,902	6,885	2,341	0
California American WC – Fruitridge Vista	6,609	0	0	0	0
California American WC – Security Park	97	0	0	0	0
Golden State WC – Cordova	19,752	6,177	6,108	2,077	0
City of Sacramento – South	101,306	1,000	1,000	340	0
Sacramento County Water Agency – Laguna Vineyard	72,423	1,000	1,000	612	0
Subtotal SASb	***230,018***	***20,431***	***20,344***	***7,189***	***0***

4.4.3.2 Public Noticing

The agencies sponsoring this project will meet applicable public noticing and CEQA requirements.

4.4.3.3 Permitting and Regulatory Process

The agencies sponsoring this project will obtain necessary permits and meet regulatory requirements.

4.4.3.4 Status

A defined schedule for implementation of this project does not currently exist.

4.4.3.5 Expected Benefits

On a long-term average annual basis, approximately 7,200 AF/year of groundwater would be left in the basin, which would provide both environmental benefits as well as provide long-term water reliability for the water agencies. Benefits include:

- Increased regional and state water supply reliability through groundwater storage and conjunctive use.
- Improved water quality by restoring groundwater levels and increasing in-stream flows in the Cosumnes River.
- Increased reliability of local water supplies, enhanced groundwater storage opportunities, and drought resiliency.

4.4.3.6 Implementation

The project will be implemented through cooperation between the seven agencies listed in **Table 4-1**. The project will require that any direct or in-lieu groundwater recharge precedes groundwater extractions and that a percentage of the recharged volume will be left in the aquifer to account for losses and groundwater storage mitigation.

4.4.3.7 Legal Authority

The entities sponsoring this project have the legal authority to implement this project.

4.4.3.8 Estimated Costs and Funding Plan

The current budget estimate is provided below.

- $0.5 million for interconnection upgrade between Golden State Water Company and California American Water Company
- $0.5 million for interconnection upgrades between Golden State Water Company and Sacramento County Water Agency
- $0.5 million to upgrade the interconnection between Golden State Water Company and the City of Folsom (would upgrade a temporary interconnection into a permanent interconnection)
- Unknown cost for a possible interconnection between the City of Folsom and OHWD at the Folsom South Canal
- Unknown cost for ASR wells for Sacramento County Water Agency
- $663 million for 75 MGD surface water expansion of the City of Sacramento River Water Treatment Plant. Planning has been completed, project in in design phase.
- $30-$40 million for a 36”-54” pipeline along Power Inn Road to move surface water from the City of Sacramento EA Fairbairn surface water treatment plant to southern portions of the American River Place of Use (ARPOU) – Planned

4.4.3.9 Management of Groundwater Extractions and Recharge

The project will require that any direct or in-lieu groundwater recharge precedes groundwater extractions and that a percentage of the recharged volume will be left in the aquifer to account for losses and groundwater storage mitigation.

4.4.4 Flood Diversions for Groundwater Recharge Project

4.4.4.1 Project Description

The County of Sacramento is actively developing a Flood Diversions for Groundwater Recharge Annex to the County's Emergency Operation Plan that is aligned with Water Code Section 1242.1[33], which allows parties to divert flood waters for groundwater recharge without a water right if in compliance with certain requirements. Executive Order N-16.25, issued in January 2025, suspended the requirement to have the Emergency Operations Plan Annex in place to make diversions, as long as other code requirements are met. Following this Executive Order, the County of Sacramento issued a Proclamation of Local Emergency in February 2025 and worked with Rancho Murieta Community Service District to divert flood flows from the Cosumnes River for groundwater recharge. Water was conveyed through an existing ditch system and then applied to agricultural fields for recharge.

Looking ahead, the County of Sacramento intends to continue exploring opportunities under Water Code Section 1242.1 in future years, including 1) final adoption of a Flood Diversion for Groundwater Recharge Annex to the County's Emergency Operation Plan and 2) expanding the sites prepared to divert flood waters.

Figure 4-5: Map of Flood Diversion Point and Recharge Areas

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[33] More information on Water Code Section 1242.1: https://www.waterboards.ca.gov/waterrights/water_issues/programs/groundwater-recharge/recharge-diversions.html

4.4.4.2 Public Noticing

The agencies sponsoring this project will meet applicable public noticing and CEQA requirements.

4.4.4.3 Permitting and Regulatory Process

The agencies sponsoring this project will obtain necessary permits and meet regulatory requirements.

4.4.4.4 Status

The project is ready to be implemented when the flow is above the flood diversion threshold established by Sacramento County.

4.4.4.5 Expected Benefits

- In WY 2025, diversions occurred for ~12 hours in February (2/13 – 2/16 in the volume of 112 AF) and ~12 hours in March (3/17 – 3/18, volume of 112 AF), resulting in a total volume of 224 AF of flood water diverted.
- In future years, diversions will depend on the length of time the flow is above the flood diversion threshold established by Sacramento County and land area available for recharge.

4.4.4.6 Implementation

The project will be implemented by Sacramento County in coordination with the local GSAs and consistent with this GSP.

4.4.4.7 Legal Authority

Sacramento County has the legal authority to implement this project.

4.4.4.8 Estimated Costs and Funding Plan

The project uses existing infrastructure so costs are minimal and will be borne by the participating agencies and individuals.

4.4.4.9 Management of Groundwater Extractions and Recharge

The goal is to reduce flooding and provide Subbasin benefits through recharge of surface water supplies during high flow events. The water recharged would benefit the Subbasin.

4.5 Group 3: Supplemental Projects

Supplemental projects are still in the conceptual stage and not expected to be operational within the next 10-15 years, and therefore, have less detailed information related to project implementation. These projects would be beneficial to the attainment of the sustainability goal in the SASb.

4.5.1 SAFCA Flood-MAR

4.5.1.1 Introduction

This project is part of the Sacramento Area Flood Control Agency's (SAFCA) response to climate driven changes in precipitation patterns and recent advances in meteorological forecasting. Recent research in atmospheric rivers has found that 30-50% of precipitation on the West Coast is due to atmospheric rivers. Using modern forecasting techniques, it is now feasible to more intensively operate flood control reservoirs and structures to capture flood flows and utilize them for various purposes, including groundwater recharge. This project includes modifications to the outlet works of the three largest non-federal dams in the American River Basin so that these facilities can be operated to create reservoir storage space for flood control when extreme atmospheric rivers are forecasted to occur in the American River Basin. In combination with ongoing improvements to Folsom Dam and the downstream levee system, these modifications will allow the flood system to safely contain floods with a 1-in-500 annual probability of occurrence. To secure the broadest level of public support and funding for these improvements, the SAFCA project also includes measures to conserve water for environmental, agricultural, and urban use. These measures include allowance of conditional storage of winter runoff in space normally designated for flood control in Folsom Reservoir; use of the Folsom South Canal and other existing water conveyance facilities to convey this stored water to groundwater infiltration sites for storage in the aquifers underlying the South American and Cosumnes subbasins (**Figure 4-6**); and use of the stored water to improve flow and temperature conditions along the American and Cosumnes rivers, sustain agricultural productivity in South Sacramento County and meet urban water needs during drought conditions.

While not specifically analyzed as a project scenario in this GSP, it is clear that this project, if implemented, will improve groundwater levels and storage volumes in the SASb, and would enhance the attainment of the sustainability goal in the SASb.

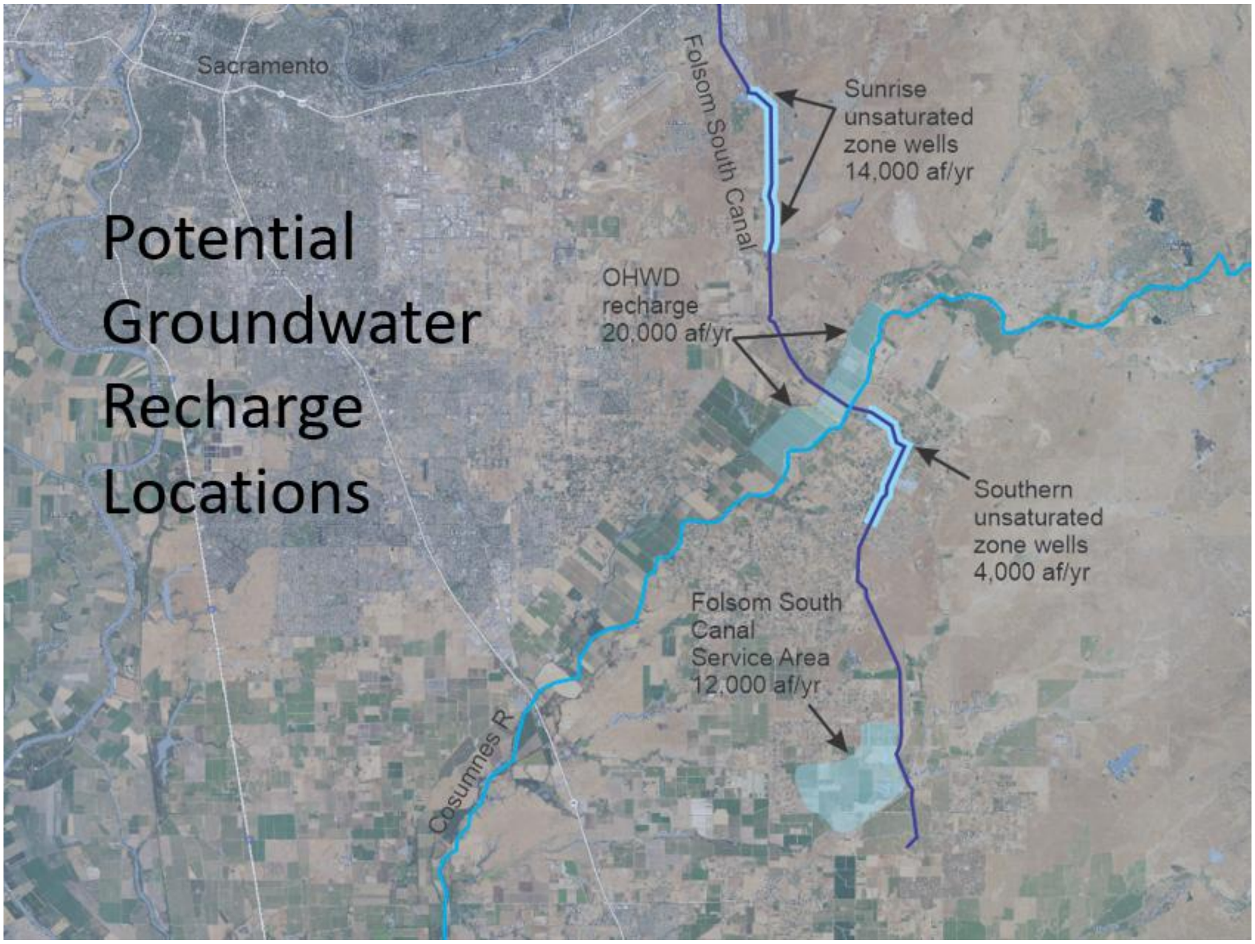


Figure 4-6: Map of Potential Recharge Areas for Water Delivered by the Folsom South Canal

4.5.1.2 Stakeholder Outreach

As project conceptualization continues, the SAFCA leadership team has created a stakeholder outreach and engagement plan. The focal points of this effort are:

- Water Forum Agreement Updates
- South American Subbasin Groundwater Sustainability Plan
- Cosumnes Subbasin Groundwater Sustainability Plan
- Sacramento Regional Water Bank
- American River Basin Study

As this effort proceeds, stakeholder outreach tasks will be addressed and will include:

- Identification of a facilitation team
- Development of a program webinar
- Incorporation of stakeholder technical information
- Creation of a stakeholder partner advisory group

Currently, the expected list of stakeholders include:

- Regional Water Authority
- Sacramento Water Forum
- US Bureau of Reclamation
- Environmental NGOs
- Environmental justice entities
- Water agencies and GSAs
- Landowners and growers
- Resource Conservation Districts
- Native Tribes
- California Department of Water Resources

The stakeholder outreach and engagement plan will be modified as needed in the future as this project develops.

4.5.1.3 Technical Analyses/Pilot Projects

To date, project proponents at SAFCA have articulated an overall vision for the implementation of the project and are now working on specific components. It is projected that the needed institutional and infrastructure improvements will be in place for excess floodwater from the American River to be delivered down the Folsom South Canal by 2027. Recent and ongoing efforts are discussed below:

4.5.1.3.1 Technical analyses

Initial analyses have been completed by MBK Engineers to estimate the volume of available water. That analysis found that surplus flood water will be available in many years and could be used to support an average annual volume of 50,000 AF for managed aquifer recharge. That analysis found that approximately 125,000 AF per year will be available in four out of every ten years.

4.5.1.3.2 Identification of recharge sites

Promising recharge sites have been identified based on proximity to the Folsom South Canal and due to hydrogeologic analyses conducted by UC Davis. The locations are shown in **Figure 4-6**.

One other potential recharge location is a gravel pit just south of Florin Road and adjacent to the Folsom South Canal. Elk Grove Water District has completed preliminary modeling that confirmed benefits from direct recharge in the gravel pit.

4.5.1.3.3 Well demonstration project

In 2021-2022, project proponents are conducting an unsaturated zone well demonstration project in the SASb at locations along the Folsom South Canal where recharge can occur. In 2021, boreholes will be drilled to evaluate the local geology. Concurrently, the necessary permits for CEQA compliance, water transfers, well drilling, and use of the Folsom South Canal will be obtained. In 2022, two wells will be constructed for a demonstration project.

In this area, just north of Kiefer Blvd and adjacent to the Folsom South Canal, the boreholes were drilled in 2022 to support interpretation of the tTEM data. The results were that there was "no apparent conductive pathways for fast transmission to saturated zone."

4.5.1.3.4 Farmland recharge demonstration project

In 2021-2022, a farmland recharge demonstration project will be conducted on land in the SASb portion of the OHWD (**Figure 4-6**) using water conveyed in the Folsom South Canal. In 2021, permits will be obtained, and a pipeline will be constructed to the recharge area. In 2022, the recharge demonstration project will be operated.

4.5.2 Wilton Road Floodplain Reconnection Project

4.5.2.1 Project Description

The Wilton Road Floodplain Multi-Benefit Project, led by the County of Sacramento, provides an opportunity to enhance the Cosumnes River watershed's health and resilience. The project is located within the OHWD GSA area at 10865 Wilton Road, Elk Grove, CA 95624, between the Cosumnes River and Deer Creek. Conceptually, the project involves modifying floodplain elevations to connect two gravel pits (locally referred to as the "Hanford Gravel Pits") to the Cosumnes River and Deer Creek at lower flows. An initial project report was finalized in September 2025.Primary project goals are to:

- Reduce flood risk: Implement innovative flood management strategies to lower flood elevations and minimize property damage.
- Enhance groundwater recharge: Restore natural recharge opportunities to support agricultural production, drinking water supplies, and ecosystem functions.
- Improve habitat: Reconnect the river to its floodplain to provide critical habitat for native vegetation, fish, and wildlife.

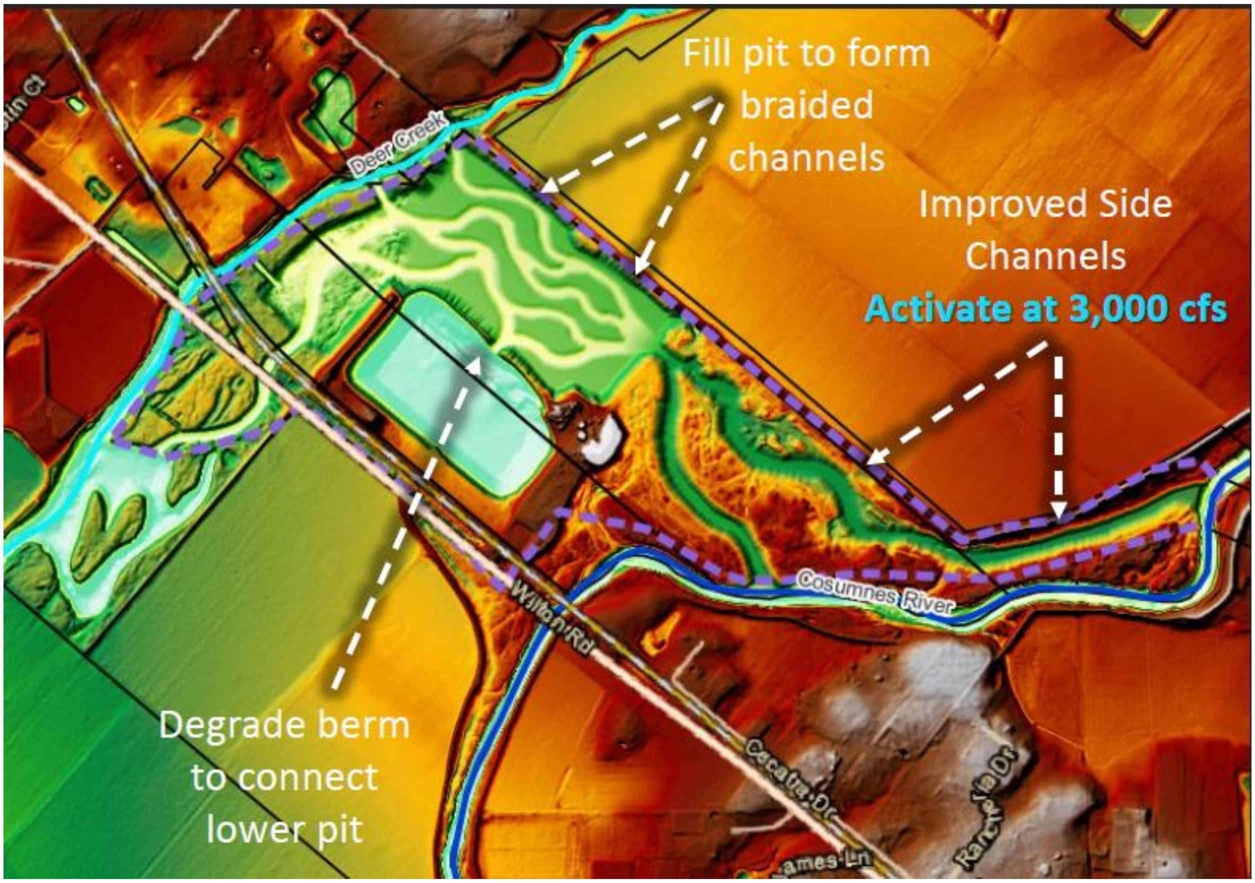


Figure 4-7: Map of Proposed Floodplain Reconnection Project

4.5.2.2 Public Noticing

The agencies sponsoring this project will meet applicable public noticing and CEQA requirements.

4.5.2.3 Permitting and Regulatory Process

The agencies sponsoring this project will obtain necessary permits and meet regulatory requirements.

4.5.2.4 Status

Project concept report completed. Engineering and design work will be completed before the project implementation.

4.5.2.5 Expected Benefits

- Recharge: 2,700 AF of additional recharge per average water year
- Flood: Flood elevation reduction by over 1 foot in Wilton area
- Habitat: Increase of over 10,000 acre-days per year of aquatic/riparian habitat

4.5.2.6 Implementation

The project will be implemented by the County of Sacramento in coordination with the local GSAs and consistent with this GSP.

4.5.2.7 Legal Authority

The agencies sponsoring this project have the legal authority to implement this project.

4.5.2.8 Estimated Costs and Funding Plan

Preliminary costs are estimated to be between $8-24 million, depending on the scale of the project. Project proponents are actively searching for funding to finalize engineering/design work on the project. Proposition 4 funding for SGMA and watershed resiliency are two possibilities.

4.5.2.9 Management of Groundwater Extractions and Recharge

Goals are to reduce flooding, improve habitat, and provide basin benefits through recharge of surface water supplies during high flow events. Water recharged would benefit the Subbasin.

4.6 Results of Model Scenarios

To evaluate the potential effects of proposed projects and management actions in meeting the sustainability goal of the SASb GSP, the Group 2 (near-term) projects described above have been analyzed using the Cosumnes-South American-North American (CoSANA) model, the fully integrated surface and groundwater flow model that covers the entire South American Subbasin as well as the adjoining North American and Cosumnes Subbasins. The CoSANA model is described in greater detail in the water budget section of this GSP (**Section 2**). The

CoSANA model has been used to develop the water budget estimates for historical, current, and projected conditions, as well as basin groundwater levels, streamflows, and inter-connected surface water bodies under baseline and various project conditions.

The analysis below considers the proposed projects using the Projected Conditions Baseline in CoSANA without climate change. The Projected Conditions Baseline applies future land and water use conditions and uses the 50-year hydrologic period of WY 1970-2019 as a planning period for purposes of the GSP. A total of ten scenarios were analyzed, three of which constitute baseline conditions, and seven of which represent additional PMA scenarios (see **Table 4-2** below).

Table 4-2: Projects and Management Actions Analyzed Using CoSANA Model

				Demand Reduction				
Scenario	**Current Condition Baseline**	**Projected Condition Baseline**	**Projected Condition Baseline with Climate Change**	**5% Ag 10% Urban**	**10% Ag 10% Urban**	**Harvest Water**	**OHWD Recharge**	**Regional Conjunctive Use Program**
CCBL	✓							
PCBL		✓						
PCBL - CC			✓					
1		✓		✓				
2					✓			
2a			✓		✓			
3		✓				✓	✓	
4		✓						✓
4a			✓					✓
5		✓				✓	✓	✓
5a			✓			✓	✓	✓

Specific assumptions used for the modeling scenarios are included here.

Demand Reduction scenarios:

- Scenario 1 assumes a 5% reduction in agricultural demand and 10% reduction in urban demand (and corresponding reductions in pumping) relative to the Projected Conditions Baseline Scenario
- Scenario 2 assumes a 10% reduction in agricultural demand and 10% reduction in urban demand (and corresponding reductions in pumping) relative to the Projected Conditions Baseline Scenario

Harvest Water:

- Harvest Water is designed to improve groundwater conditions to benefit groundwater conditions, wildlife and ecosystems.
- Harvest Water includes delivery of approximately 41,250 AFY of recycled water from the Sacramento Regional Wastewater Treatment Plant, providing an in-lieu net recharge of approximately 22,500 AFY and winter delivery of approximately 8,750 AFY to enhance

wildlife habitat. This water is delivered to farmland within the Harvest Water Project area. Ultimately, Harvest Water is intended to deliver 50,000 AFY to the project area.

- Harvest Water also includes a potential extraction component. The extraction component, if implemented, would not be implemented until certain benefit triggers (e.g., groundwater level increases) have been met, which is expected to take approximately 20 years. The extraction component is conceptualized to allow up to 30% of the recycled water recharge to be extracted, with the remaining 70% of recycled recharge and all winter application assumed not to be extracted. Any extractions, if performed, would be done in a manner to preserve key program benefits to wildlife and ecosystems and to meet SMC and the sustainability goal of this GSP.
- Modeling performed for this GSP has used a net recharge approach that recognizes a future extraction component that has not yet been specified or finalized. Rather than delivering 100% of the recycled recharge water and then extracting 30% of that water, the net recharge approach simulated delivery of 70% of the recycled supply for application in the growing season. This effectively accounts for the extraction of up to 30% of this water without a need to define extraction details that are currently unknown. All winter application is modeled as not being extracted.

OHWD Recharge Project:

- The project assumes a diversion of 6,000 AFY from the Cosumnes River.
- The maximum diversion is assumed to be 50 cfs, which occurs during the period of December 1 through February 28 in any year where adequate peak flows occur in the Cosumnes River.
- Water is applied to 1,168 acres between Cosumnes River and Deer Creek (Rooney Ranch and Teichert Ranch)
- The project is expected to enhance groundwater levels along the Cosumnes River resulting in the river running for longer periods during the spring and summer, with flows beginning earlier in the fall.

Regional Conjunctive Use Program:

- The program is a comprehensive Regional Conjunctive Use Program, with participation by both NASb and SASb urban entities, including California American Water Company, Citrus Heights Water District, City of Lincoln, City of Sacramento, Golden State Water Company, SCWA and Sacramento Suburban Water District.
- Existing infrastructure and planning are assumed to remain in place.
- The program will be integrated with the Regional Water Reliability Program (RWA, 2018).
- Project operations include delivery of wet year surface water supplies to reduce groundwater use and dry year groundwater recovery operations by select entities.

Note that while the SAFCA project was included in the list of supplemental projects above, it was not included in the modeling scenarios for the GSP because of significant uncertainties with respect to the recharge and extraction cycle, including location and fate of extracted water.

The following subsections describe the results of the modeled scenarios.

4.6.1 Results of Demand Reductions Scenarios (Scenarios 1 and 2)

Scenarios 1 and 2 include different potential combinations of reductions in groundwater pumping over the projected 50-year hydrologic period. These scenarios were run to assess the sensitivity of future conditions to potential reductions in demand. Scenario 1 is compared with the Projected Conditions Baseline, and Scenario 2 is compared with the Projected Conditions both without and with Climate Change.

Figure 4-8 and **Figure 4-9** shows groundwater hydrographs that result from Scenarios 1 and 2, respectively, in various locations throughout the subbasin, each compared to the Projected Conditions Baseline without climate change. Both demand reduction scenarios result in higher groundwater levels as compared to the Projected Condition baseline. Scenario 1 results in increases in groundwater levels ranging from 2-10 feet over the 50-year hydrologic period. The increases in groundwater elevations can potentially be greater in the vicinity of the agricultural areas in the southern portions of the subbasin in Scenario 2, with the overall changes ranging from 2-12 feet.

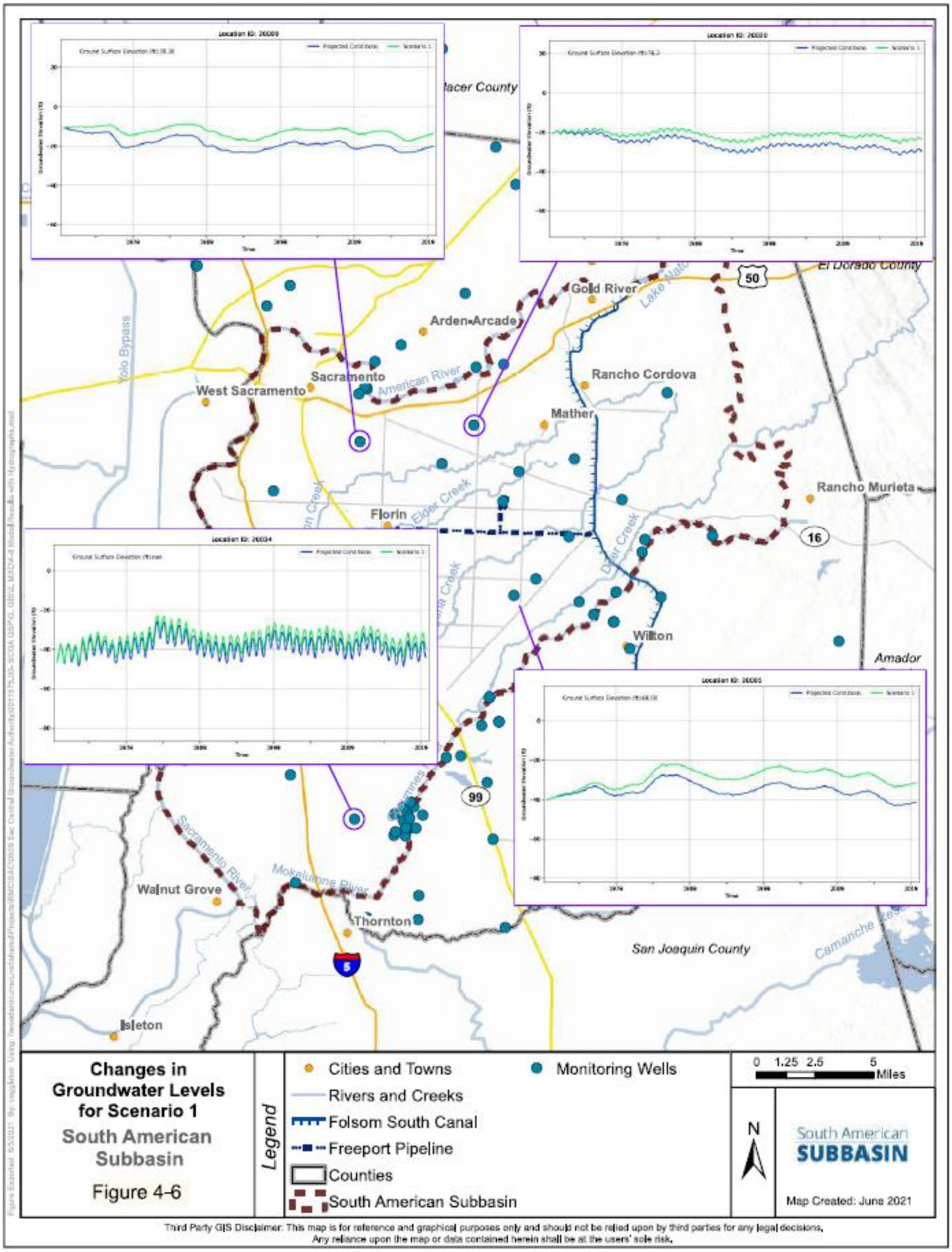


Figure 4-8: Changes in Groundwater Level Hydrographs from Scenario 1

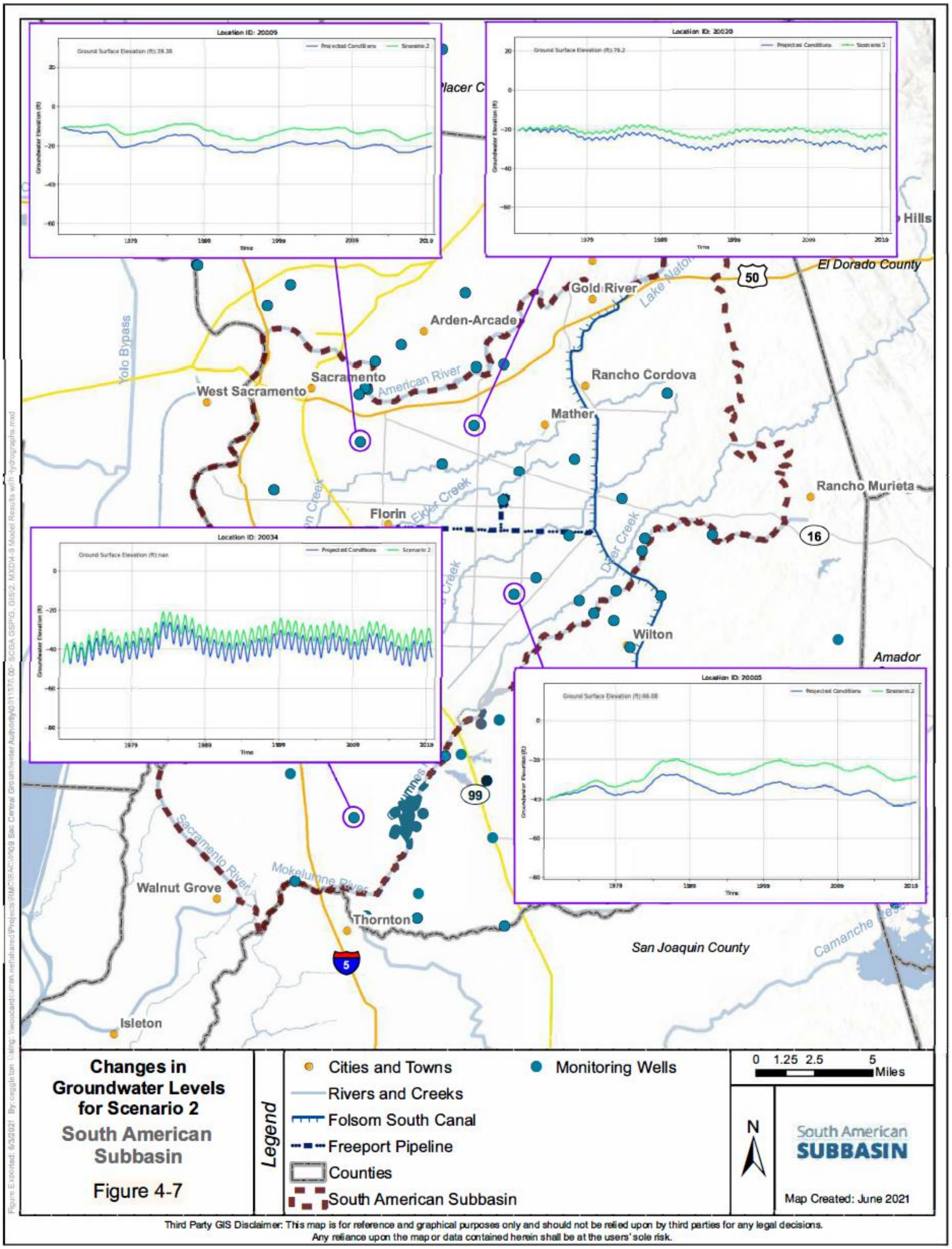


Figure 4-9: Changes in Groundwater Level Hydrographs from Scenario 2

Figure 4-10 shows the cumulative change in storage in Scenarios 1 and 2 as compared to the respective Projected Conditions Baseline over the 50-year projected hydrologic period. Both scenarios show a similar pattern of increase and decrease in overall storage during various hydrologic conditions over time. However, while the Projected Conditions Baseline indicates an average annual deficit in groundwater storage of about 1,100 AFY, both demand reduction scenarios have a storage surplus over the course of the 50-year hydrologic period. The average annual storage surplus is about 2,000 AFY in Scenario 1 and about 2,800 AFY in Scenario 2. This reflects the effects of reduction in groundwater pumping under each scenario.

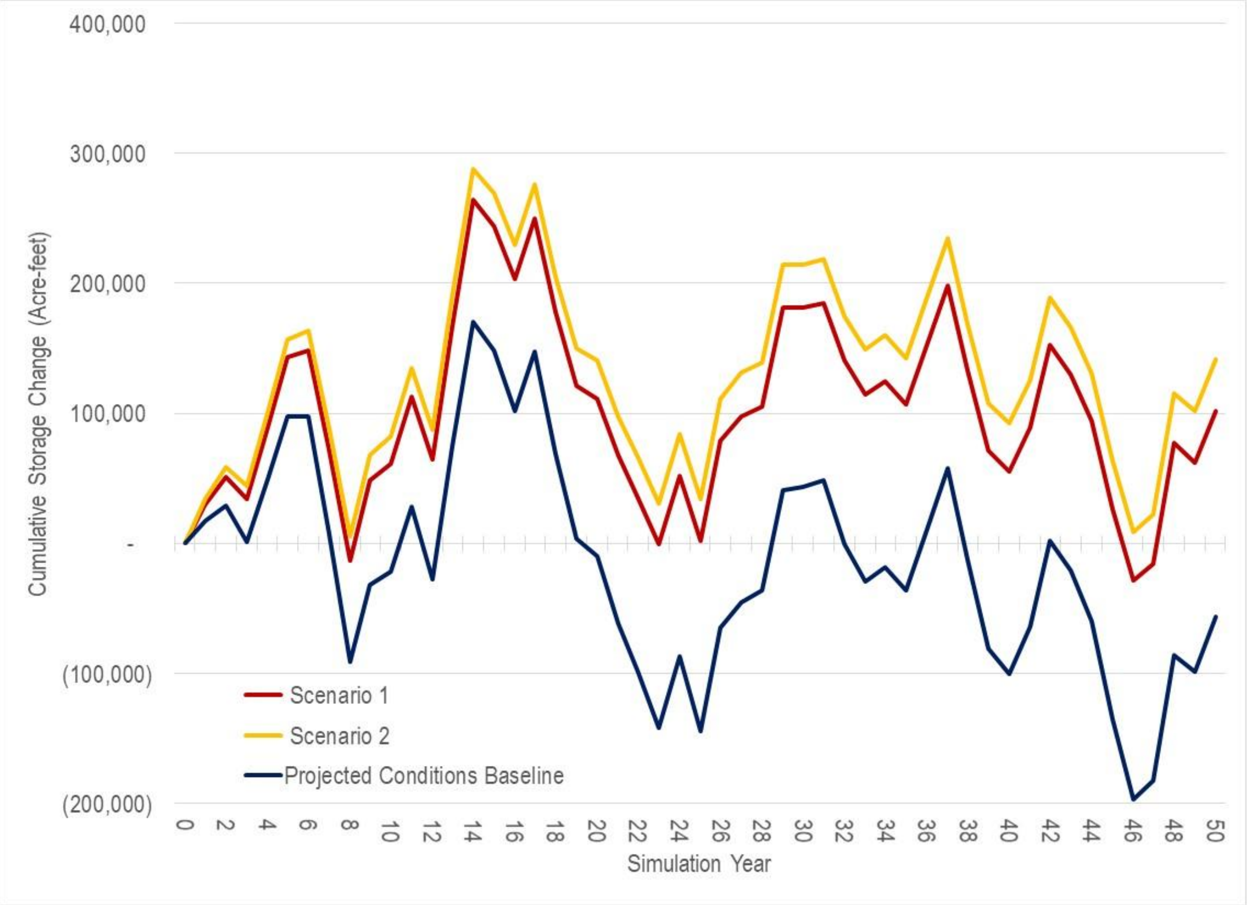


Figure 4-10: Cumulative Storage Change in Scenarios 1 and 2

Additionally, Scenario 2 was simulated using the Projected Conditions with climate change Baseline. **Figure 4-11** shows the cumulative storage change for the Projected Conditions Baseline and Scenario 2 with climate change over the course of the 50-year simulation period. With climate change, the Projected Conditions Baseline has an average annual reduction in storage of about 6,200 AFY. The average annual reduction in storage is about 1,500 AFY in Scenario 2. Therefore, implementation actions resulting in a total basin-wide demand reduction of 10% would be projected to bring the subbasin closer to balance but will not achieve sustainability under climate change.

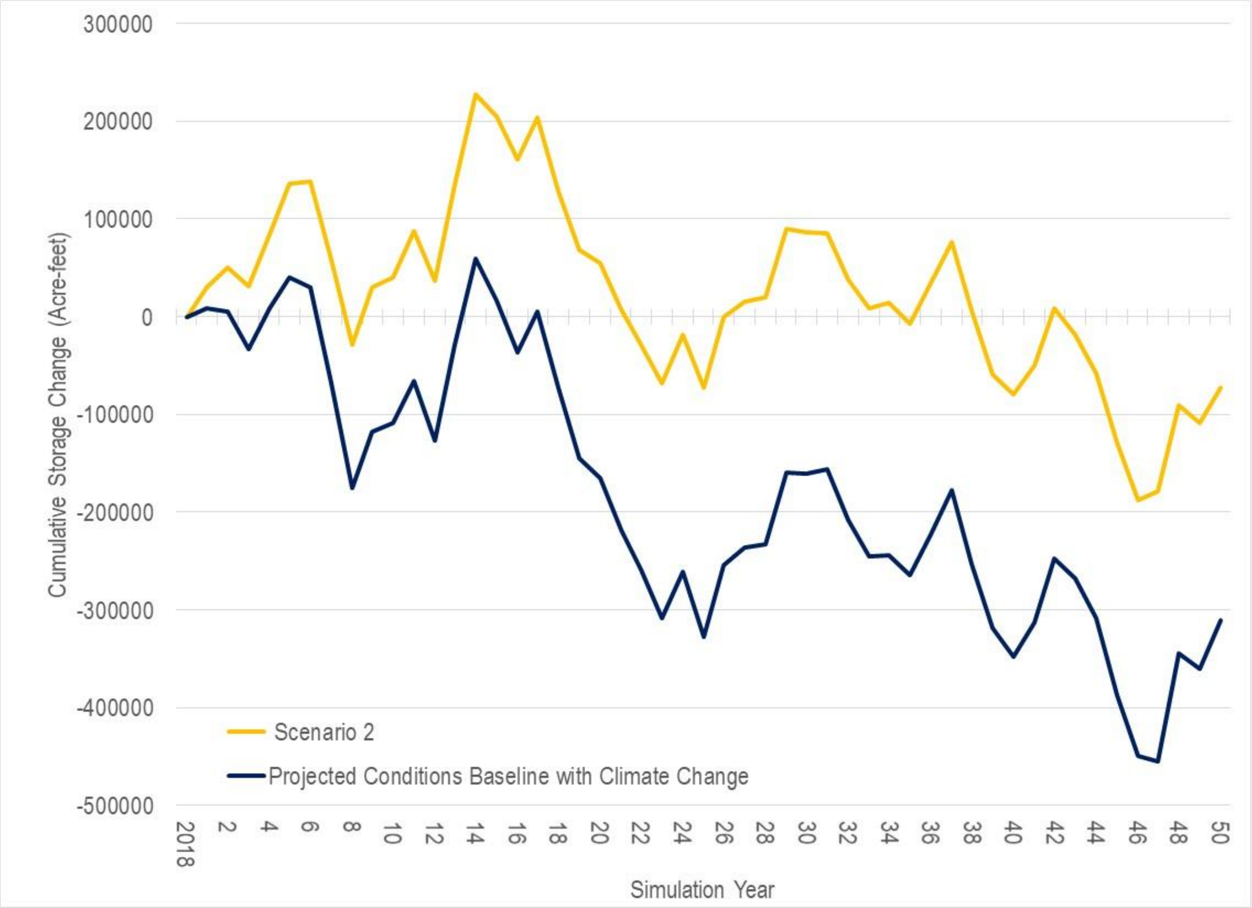


Figure 4-11: Cumulative Storage Change with Climate Change in Scenario 2

4.6.2 Results of Project Implementation Scenario 3

Scenario 3 includes implementation of Harvest Water and the OHWD recharge project over the projected 50-year hydrologic period. Modeling results are compared to the Projected Conditions Baseline without climate change.

Figure 4-12 shows the changes in groundwater hydrographs that result from Scenario 3. In Scenario 3, there is a significant increase in groundwater levels of about 30-40 feet in the vicinity of the Harvest Water project areas in the southwestern portion of the basin in southern Sacramento County. In the OHWD area along the Cosumnes River, there are more moderate increases in groundwater levels of about 10 feet in the southwestern portion of the OHWD GSA and about 5 feet near the intersection of the Folsom South Canal and the Cosumnes River. Note that both the Harvest Water and OHWD projects will provide benefits in the form of increased stream flow in the Cosumnes River and increased subsurface flows to the Cosumnes Subbasin due to the locations of these projects.

Figure 4-13 shows the cumulative change in storage in Scenario 3 as compared to the Projected Conditions Baseline over the 50-year simulation period. There is a similar pattern of increase and decrease in overall storage as the simulation moved through time. However, while the Projected Conditions Baseline has an average annual reduction in storage of about 1,100 AFY, Scenario 3 has a storage surplus of about 3,200 AFY over the course of the 50-year simulation period, reflecting a net benefit to the SASb of about 4,300 AFY. Scenario 3 will provide storage benefits to the Cosumnes Subbasin due to increased subsurface flows to that subbasin.

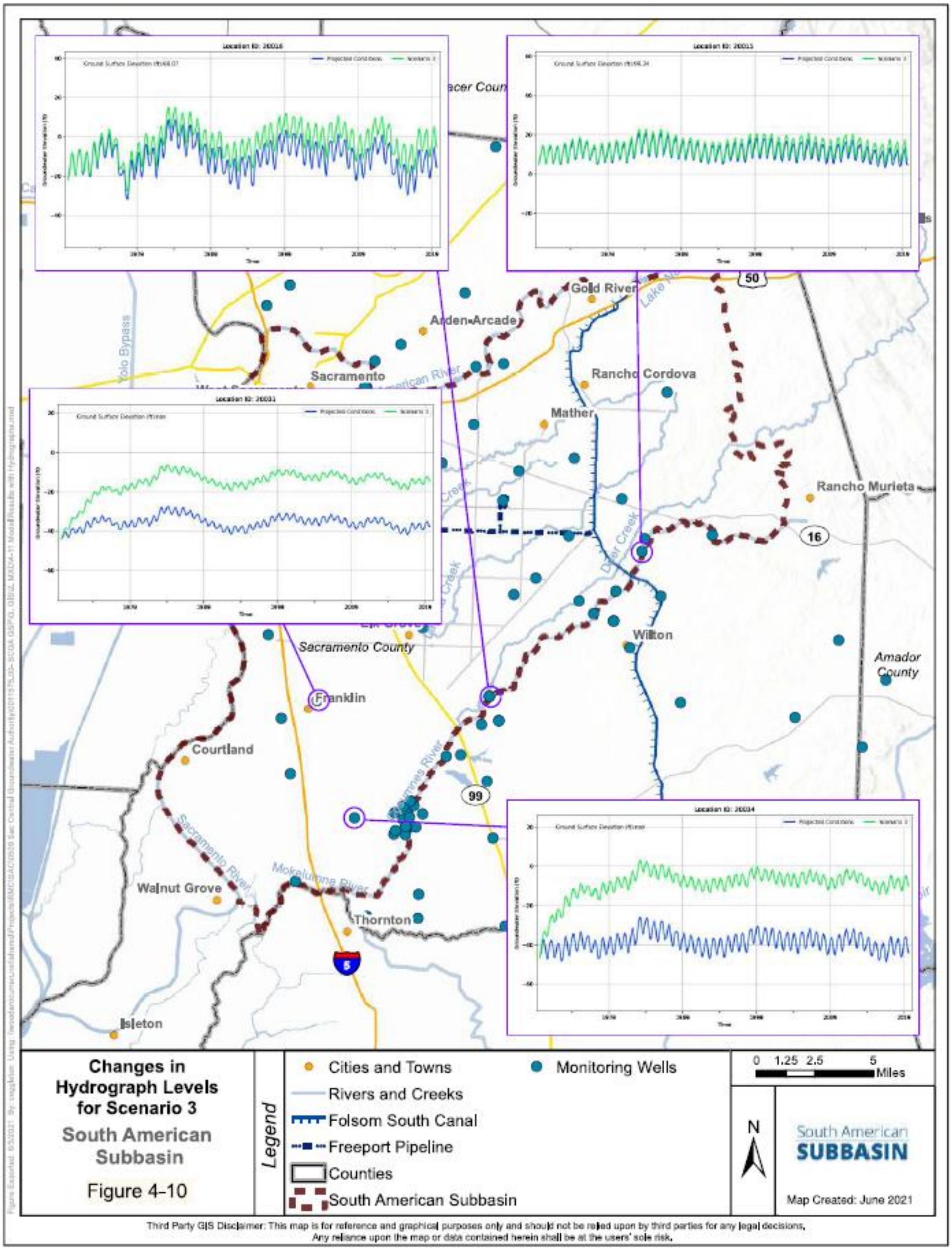


Figure 4-12: Changes in Groundwater Level Hydrographs from Scenario 3

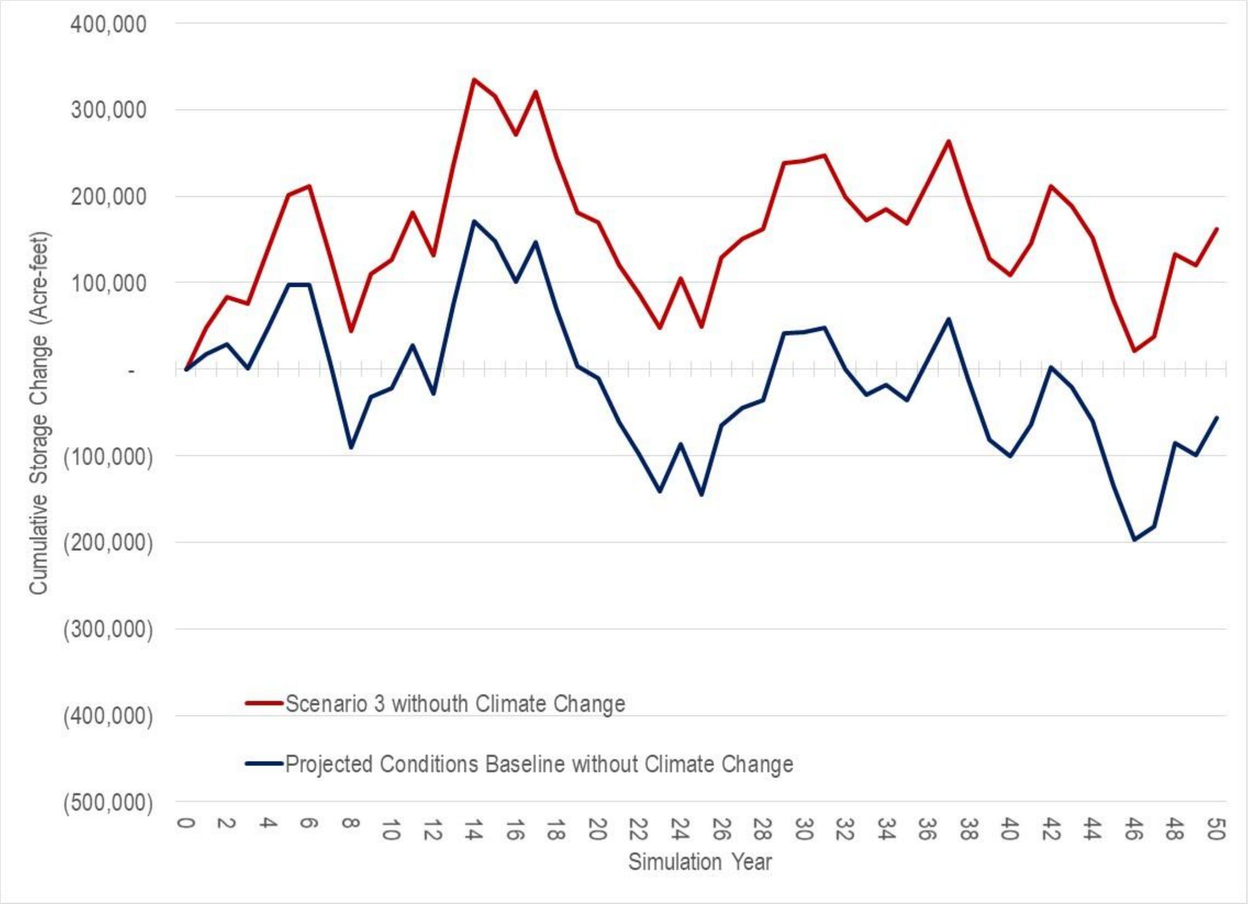


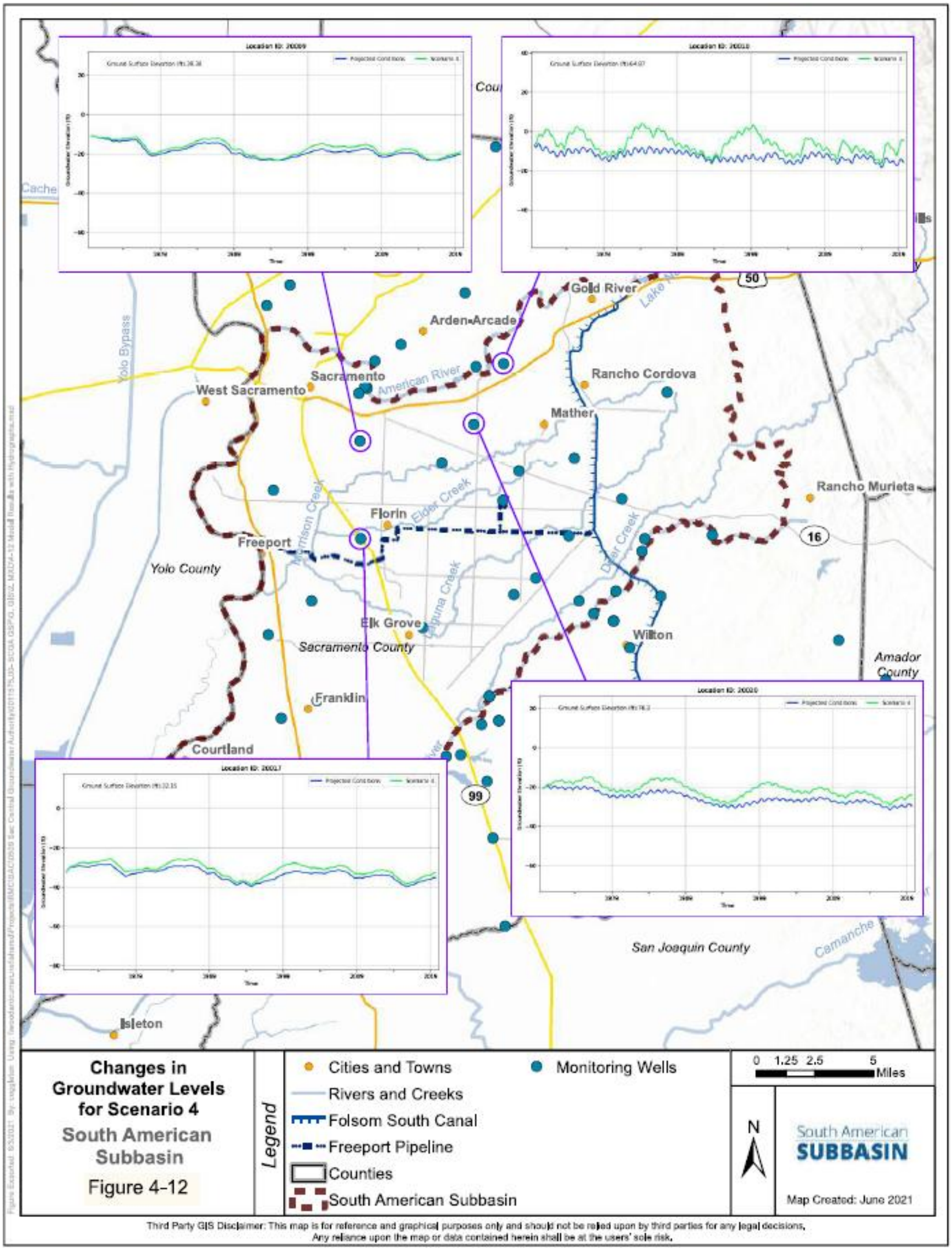
Figure 4-13: Cumulative Storage Change in Scenario 3

Results of Project Implementation Scenario 4

Scenario 4 include includes implementation of the M&I entities' regional conjunctive use program. Modeling results are compared to the Projected Conditions Baseline both without and with climate change.

Figure 4-14 shows the changes in groundwater hydrographs that result from Scenario 4 using the Projected Conditions Baseline without climate change. In Scenario 4, there are increases in groundwater levels over the 50-year simulation period ranging from 2-10 feet in the areas of recharge. This includes an increase of about 10 feet in the vicinity of the American River, which results in increased stream flow in the American River and increased subsurface flows to the North American Subbasin.

Figure 4-15 shows the cumulative change in storage in Scenario 4 as compared to the Projected Conditions Baseline both without and with climate change over the 50-year simulation period. While the Projected Conditions Baseline has an average annual reduction in storage of about 1,100 AFY without climate change, in Scenario 4 there is an average annual storage surplus of about 200 AFY. Similarly, while the Projected Conditions Baseline with climate change has an average annual reduction in storage of about 6,200 AFY, the average annual reduction in storage in Scenario 4 is about 4,800 AFY. Therefore, Scenario 4 provides an average annual storage benefit to the subbasin of about 1,300-1,400 AFY, in addition to storage benefits to the North American Subbasin.



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 4-14: Changes in Groundwater Level Hydrographs from Scenario 4

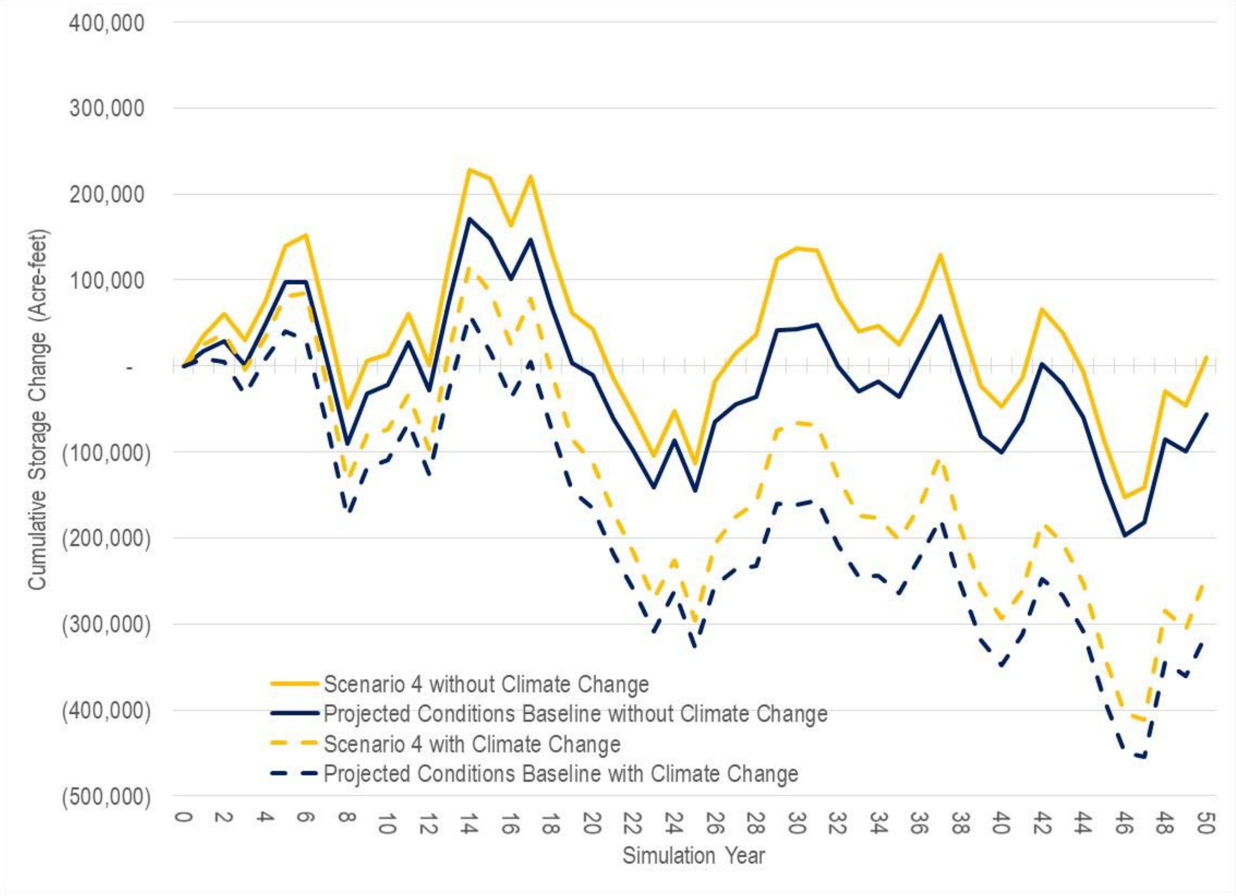


Figure 4-15: Cumulative Storage Change in Scenario 4

4.6.3 Results of Project Implementation Scenario 5

Scenario 5 includes all of the projects that were in Scenarios 3 and 4, which include implementation of Harvest Water and the OHWD recharge project, and implementation of the M&I entities' regional conjunctive use program. Modeling results are compared to the Projected Conditions Baseline both without and with climate change.

Figure 4-16 shows the changes in groundwater hydrographs that result from Scenario 5 using the Projected Conditions Baseline without climate change. Similar to Scenario 3, there is a significant increase in groundwater levels of about 30-40 feet in the vicinity of the Harvest Water project area in the southwestern portion of the basin in southern Sacramento County and more moderate increases in groundwater levels of about 10 feet along the Cosumnes River in the vicinity the OHWD GSA. Similar to Scenario 4, there are increases in groundwater levels over the 50-year simulation period ranging from 2-10 feet in the northern portion of the subbasin in the areas of recharge, including increases of about 10 feet in the vicinity of the American River. These relative groundwater level changes provide benefits to the American and Cosumnes Rivers in the form of increased streamflow and to the North American and Cosumnes Subbasins in the form of increased subsurface flows.

Figure 4-17 shows the cumulative change in storage in Scenario 5 as compared to the Projected Conditions Baseline, both without and with climate change over the 50-year simulation period. While the Projected Conditions Baseline has an average annual reduction in storage of about 1,100 AFY without climate change, in Scenario 5 there is an average annual storage surplus of about 4,500 AFY. Similarly, while the Projected Conditions Baseline with climate change has an average annual reduction in storage of about 6,200 AFY, the average annual reduction in storage in Scenario 5 is only about 100 AFY. Therefore, Scenario 5 provides an average annual net benefit to the subbasin in the range of 5,600 to 6,100 AFY, in addition to storage benefits provided to the North American and Cosumnes Subbasins. It is anticipated that planned demand management (as considered in either Scenario 1 or 2) resulting from implementation of future conservation measures (e.g., as described in 2020 Urban Water Management Plans) would offset the small storage deficit of 100 AFY predicted for Scenario 5 with climate change.

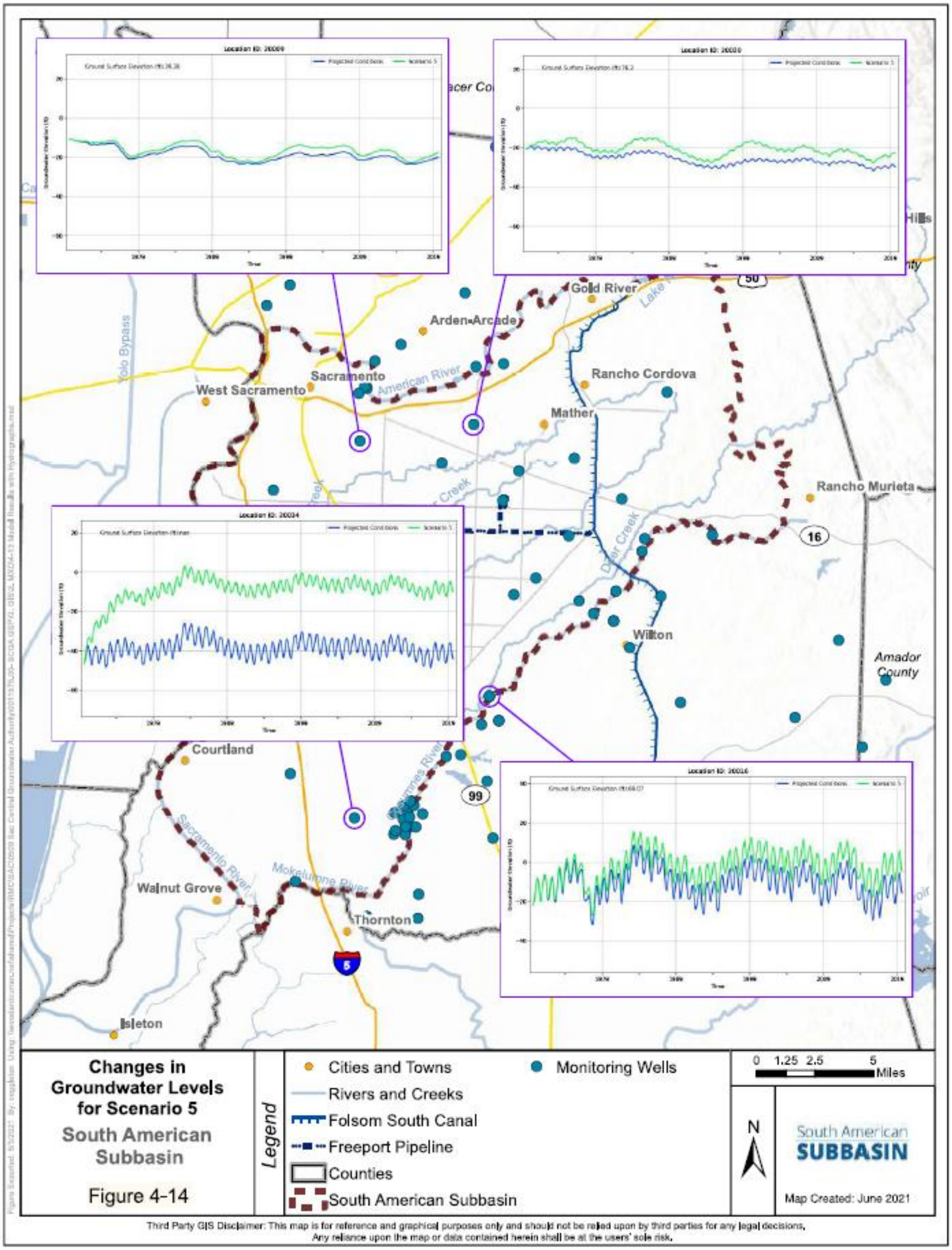


Figure 4-16: Changes in Groundwater Level Hydrographs from Scenario 5

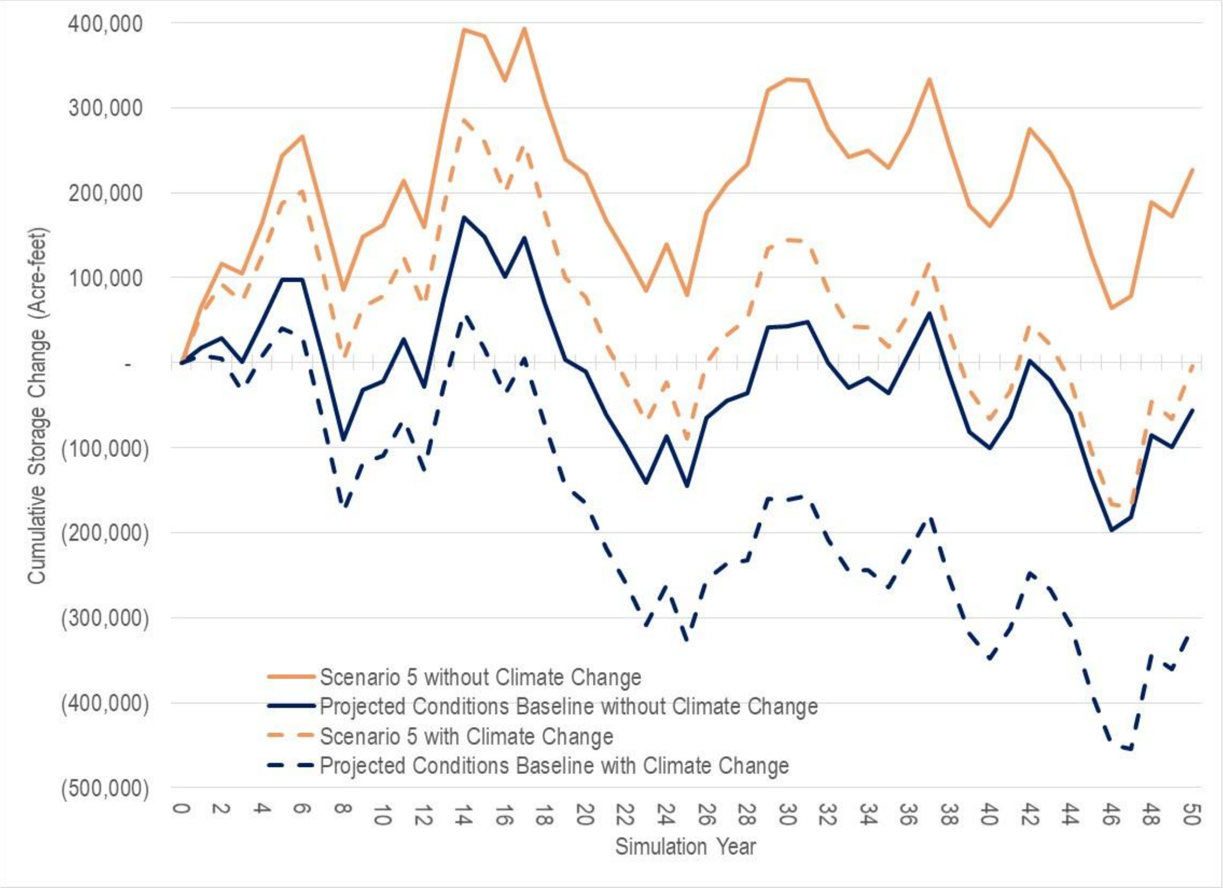


Figure 4-17: Cumulative Storage Change in Scenario 5

4.6.4 Summary of Project Management Scenario Results

The results of the project management scenarios are summarized for scenarios simulated without consideration of climate change in **Table 4-3** below and for the scenarios simulated with consideration of climate change in **Table 4-4** below. Both without and with climate change, all scenarios result in lower average annual groundwater pumping and an improvement in groundwater storage. Note that Scenarios 1 and 2 (Demand Reduction) were run separately from Scenarios 3, 4 and 5 (Projects) to assess the isolated benefit of either expected urban demand reductions or potential agricultural demand 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 can be achieved under any of the projected management scenarios if projected conditions without climate change were to occur. If, as anticipated, the projects that were included in Scenario 5 all occur as planned, and accounting for an expected planned reduction in demand, long-term groundwater basin sustainability will occur under the climate change conditions that have been modeled.

Table 4-3: Summary of Project Management Action Modeling Scenarios Without Consideration for Climate Change

CoSANA Model Scenarios	Description	Average Annual Groundwater Pumping (AFY)	Average Annual Groundwater Storage Condition (Inflows minus Outflows) (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	227,400	+200
Scenario 5	Harvest Water, OHWD Recharge & Regional Conjunctive Use	205,200	+4,500

Table 4-4: Summary of Project Management Action Modeling Scenarios With Consideration of Climate Change

CoSANA Model Scenarios	Description	Average Annual Groundwater Pumping (AFY)	Average Annual Groundwater Storage Condition (Inflows minus Outflows) (AFY)
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

4.7 Management Actions

In this subsection, proposed management actions to be taken by SASb GSAs as an element of GSP implementation are identified and described.

4.7.1 Shallow/Vulnerable Well Protection Program

The concept of a shallow/vulnerable well protection program has been discussed at numerous GSPWG meetings and public meetings. The purpose of the program would be to provide relief to users of shallow wells in the SASb impacted by declines in groundwater levels in the vicinity of their wells due to groundwater management activities associated with the GSP. Based on best available information, an analysis has been performed (**Appendix 3-C: Shallow Well Protection Technical Memorandum**) which indicates that the incidence of such impacts is projected to be low over the GSP planning horizon. However, uncertainty in measured and modeled groundwater elevations, the number of shallow/vulnerable wells in the SASb, well completion data, and age of active wells requires additional coordination, monitoring, and data collection to ensure ongoing protection of shallow and vulnerable wells. The creation of a shallow well protection program is intended to address the cases where such impacts may occur.

The development, implementation and funding of a shallow/vulnerable well protection program would be consistent with historical action in the SASb; a well protection program was previously considered by SCGA, as part of the Zone 40 Water Supply Master Plan and SCWA developed and implemented the North Vineyard Well Protection Program in the Sunrise-Douglas area within the City of Rancho Cordova. The new program would be developed with knowledge of the details of these previous efforts.

The Sacramento County Environmental Management Department Wells Program (Wells Program) is the entity with responsibility for oversight of well construction, modification, repair, inactivation, or destruction of wells in Sacramento County. Any water supply or monitoring well that is constructed in Sacramento County must first obtain a permit from the Wells Program. Therefore, the development of a shallow well protection program will be done in close coordination with the Wells Program.

An incremental approach to a well protection program is favored by the GSAs, with early emphasis on information gathering, outreach, program development and engagement. This includes formation of a shallow well advisory group (SWAG) comprised of local well owners and agency representatives, increased coordination, improved risk assessment based on additional data collection through a volunteer well monitoring network to assess groundwater depths, revision of well completion data, and early contributions to a well mitigation fund to address rehabilitation or replacement needs. After the first two (2) years (Phase I), an assessment will be made regarding future direction of the program (Phase II).

The SASb well protection program is organized around three core tasks: (1) stakeholder engagement and outreach, (2) coordination with and analysis of data from a volunteer well monitoring program, and (3) a well impact mitigation fund. Tasks 1 and 2 aim to acquire and integrate new information into well protection planning over time, and Task 3 provides a set-aside for reasonable financial protection to wells that may be impacted by drops in groundwater levels.

Task 1 – Stakeholder coordination and outreach:

The SASb GSAs will assist in the formation of a “shallow well advisory group” (SWAG) with representatives from the GSAs and local community members. The SWAG will meet bi-annually to coordinate community outreach, engage with stakeholders on well construction standards (e.g., Sacramento County EMD Wells Program), support the volunteer monitoring effort (task 2 below), and support further development of the well protection program. A critical objective of the SWAG is to assist in the definition of the scope and administrative details of the mitigation element of the well protection program.

Task 2 – Volunteer Monitoring Program (VMP):

Interest exists within the SASb agricultural-residential community to develop and participate in a volunteer well monitoring program (VMP). Data properly collected at individual wellheads is valuable information for identifying vulnerable wells and ascertaining if wells may be impacted by declining groundwater levels. In addition to groundwater levels, samples at selected wells may be used to assess water quality constituents of interest (e.g., nitrates, EC, arsenic, iron, manganese). Monitoring hundreds of wells in a single GSP is infeasible for the GSP[34];but, by involving many residents in a volunteer monitoring process, the VMP can improve the spatial and temporal resolution of groundwater level information, well completion data and water quality data. These improved data will in turn improve the accuracy of future well impact analysis, inform preventative rehabilitation (e.g., lowering pumps before wells are impacted), and empower local well owners to better understand the status of local groundwater conditions.

- Administration of the VMP includes outreach, communication, and training. It is assumed that activities will be coordinated by community representatives that also participate in the SWAG (task 1 above).
- Instrumentation (e.g., sensors) and administration (e.g., program support and training) needs will be assessed by the SWAG.
- Groundwater level and (in a subset of wells) groundwater quality data collection will take place at the scale of the individual participants. It is assumed that data interpretation will occur at the group level.

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[34] For scale and reference, the CA-DWR monitors around two thousand wells per year across the entire state as part of their ambient groundwater level monitoring.

- Solutions to automatically collect, transform, visualize, and report data collected by the VMP may be explored by the GSP working group during the first two (2) years of GSP implementation (i.e., Phase I – see next section).
- Using the DWR OSWCR database as a starting point, a well inventory for the basin will be developed. Processes will be developed by which residents can refine their well's location in the well inventory, and input key information.

Task 3 – Well impact mitigation fund:

In addition to increased monitoring, data collection, and coordination, modeled well impact estimates will be used to assess the risk to shallow/vulnerable wells in the SASb and to assess the need for a mitigation fund – built up over time – to rehabilitate or replace wells directly impacted by declining groundwater levels. The need and amount of the fund will be informed by the best available estimates of the number of wells that may be impacted if MTs are reached, and the value attributable to those wells. Importantly, if a well is impacted, data collected by the VMP will help determine the likely cause. Eligibility conditions that define the well impacts that are covered by the fund will be scoped by the GSAs, in coordination with the DWAG, and may include factors such as well age, construction status, and the nature of the problem with the well. Throughout implementation, the size of the fund will be adjusted in accordance with the best available information on well vulnerability.

Timing

The timing of Tasks 1, 2 and 3 in GSP implementation will proceed in two phases:

Phase I: For the first two (2) years of GSP implementation (2022-2023), additional effort will be placed on establishing agency-community relationships, building a volunteer monitoring network, and improving well completion data (Tasks 1 and 2). A well rehabilitation fund will be progressively built, commensurate in amount to current estimates of vulnerable wells. Data collected in this phase will inform the need, scope and structure of a rehabilitation fund (Task 3).

Phase II: By the third year of GSP implementation (2024), the GSP will re-assess and adjust startup efforts to focus on program maintenance and will determine the appropriate scope of a rehabilitation fund (Task 3). These activities will continue as appropriate throughout the implementation period.

Details of Program that are to be Developed

The administrative details to be resolved in the development of a Shallow Well Protection Program during the Phase I period may include the following. Note that this list of questions is provided only as an example of possible considerations and does not represent the content of the eventual Shallow Well Protection Program for the SASb.

1) Who should be covered by a Shallow Well Protection Program?
    - Domestic well owners
    - Agricultural irrigation well owners
    - Other private wells (industrial, commercial, institutional)

2) What area should be covered?
    - Only outside the boundaries of municipal water suppliers
    - Outside the distribution system of municipal water suppliers
    - Within water supplier service areas

3) What services should be covered?
    - Emergency water supply (bottled water, water truck)
    - Pump lowering
    - Pump replacement
    - Well deepening
    - Drilling of a replacement well

4) Would the full cost of services be covered?

5) What conditions in the groundwater basin are covered?
    - Regional decline in water levels
    - Local decline in water levels, i.e., influenced by a neighboring well

6) Is a Water Well Drillers Report necessary to cover a well in the program?

7) Should well owners be required to register in advance and provide information on their well to be a candidate for assistance under the program?

8) Should the program be proactive , i.e., identify wells at greatest risk and take early actions, reactive, or both?

9) How should the program be funded and administered?

It is intended that the GSAs will work in concert with the SWAG and other stakeholders to develop the administrative and policy details of the Shallow Well Protection Program for the SASb during the Phase 1 period, as described above. This management action is the commitment to develop and fund the phased program described above in the first several years of GSP implementation.

4.7.2 Well Permit Coordination

A second management action under this GSP is the development and implementation of a process for SASb GSAs to coordinate with the EMD Wells Program. The GSAs will work with EMD and the Sacramento County Board of Supervisors to modify well construction ordinances or take other measures to establish:

- Minimum screen depth requirements to limit high-capacity wells from impacting the shallow zone of the SASb aquifer and users on that shallow zone (i.e., shallow domestic and agricultural wells, groundwater-dependent ecosystems, inter-connected surface waters)

- Well spacing requirements for high-capacity wells to limit impacts on existing wells
- Consultation/coordination between EMD Wells Program and SASb GSAs to ensure new wells do not impact the performance or quality of information derived from wells in the GSP Monitoring Network.

4.7.3 Coordination Activities

A third management action under this GSP is a commitment to provide resources for ongoing coordination with various entities on various topics to support GSP implementation. Each of the proposed coordination activities are consistent with effective management of groundwater resources in the SASb and are also consistent with the requirements of SGMA for GSP development and implementation.

The specific activities included in this management action include:

a. Coordination with GSAs on overarching groundwater management issues consistent with the GSP (through a governance structure that is provided as a companion document to this GSP).

b. Coordination with agencies with local land use authority in the SASb to ensure that future land use plans consider the information generated through GSP implementation, including monitoring data and specific modeling results. The GSP has been developed using available information from existing land use plans. Identify and evaluate significant changes in those land use plans that may significantly impact the future groundwater conditions in the SASb. Proactively work with land use agencies to ensure future development is compatible with GSP goals, attainment of SMC and implementation actions by GSAs through information sharing and annual meetings with those agencies.

c. Coordination with entities sponsoring beneficial projects identified in this GSP to provide support and otherwise facilitate implementation of these projects, including support for grant funding opportunities, as appropriate

d. Coordination with water supply agencies to support their implementation of water use efficiency measures. For agencies responsible for the development of urban water management plans, it is anticipated that the 2020 versions of those plans will lead to increased water conservation practices. This coordination activity will encourage implementation of the urban demand management scenarios that were modeled with CoSANA. Coordination with RWA, Water Forum, and local agencies regarding regional water supply planning and water resources management.

e. Coordination with GSAs in adjacent basins, including consideration and/or development of formal agreements to support ongoing information sharing during GSP implementation (e.g., groundwater levels, boundary fluxes, outreach messages). Coordination with the Cosumnes Subbasin to address data gaps along the middle reach of the Cosumnes River to address uncertainties regarding interconnectedness between surface water and groundwater. Coordination with NASb and Water Forum to ensure Lower American River Flow standards are addressed appropriately, and that the subsurface flow conditions and movement of regional contamination plumes are properly controlled within the context of regional contamination cleanup efforts.

f. Coordination with Regional Water Authority and other regional partners to support development of a groundwater banking and accounting framework to enable effective implementation of future conjunctive use projects and other water resource management actions, consistent with attainment of the sustainability goal in the SASb. The Sacramento Regional Water Bank is envisioned as an institutional and legal framework for operating a sustainable storage and recovery program in the NASb and SASb. Participation in the Regional Water Bank will be voluntary, with incentives in place to expand conjunctive use operations. The primary goal will be to manage the subbasins sustainably and to enhance climate change resiliency, while protecting all beneficial uses and users. Fundamental principles of the Regional Water Bank are that water must be stored before it can be recovered, that losses must be taken into account, and that the net effect of its operations are to enhance groundwater conditions in the subbasins, in the form of increasing groundwater levels and storage. Operation of the Regional Water Bank will require monitoring, modeling and mitigation to ensure the protection of all users and beneficial uses. Planning for the Regional Water Bank, led by the RWA, is projected to proceed over the next several years, with active participation by the GSAs and other entities in the NASb and SASb.

g. Coordination with Regional Water Authority and other regional partners in the development of a refined climate change assessment for use in the 5-year update of the SASb GSP.

4.7.4 Address Data Gaps

A fourth management action under this GSP to be implemented by the GSAs is the collection of information to fill data gaps that are identified in the GSP. Specifically, this includes the following:

a. Collection of well depth and screened interval information for specific wells in the Monitoring Network as described in **Section 3**. Missing well depths were obtained and added to the DMS. Video logging is not possible for wells without screened interval information due to the access ports being too small. The GSAs are evaluating other solutions to fill this data gap.

b. Collection of groundwater and surface water information in the stretch of the Cosumnes River between Deer Creek and Twin Cities Road which has been identified in **Section 3** as an area where the interconnectedness of surface and groundwater is uncertain.

c. Analysis of water quality samples collected by shallow well owners under the Shallow Well Protection Program Voluntary Monitoring Network. The number of samples and the water quality constituents to be analyzed will be determined by the GSAs in coordination with the Shallow Wells Advisory Group described in **Section 4.7.1** above.

The GSAs will develop a plan, schedule and budget estimate for actions to address the data gaps identified above within the first year of GSP implementation.

Section 5: Plan Implementation

Groundwater management has been ongoing in the South American Subbasin (SASb) and the neighboring North American Subbasin (NASb) and Cosumnes Subbasin for decades. As described in prior sections, a variety of projects and management actions (PMAs) have been implemented in recent years which have largely stabilized current groundwater conditions in terms of groundwater levels, storage volume and interconnected surface waters. As planned changes in land use occur, a small annual decline in storage volume is likely to occur and will increase under potential future climate change conditions. Additional projects are currently planned and being implemented by local entities which will contribute to the maintenance of sustainable conditions in the SASb over the implementation horizon of this Groundwater Sustainability Plan (GSP). PMAs described in **Section 4** will improve groundwater conditions in the SASb and enable the continued and effective use of groundwater with sufficient flexibility to ensure a sustainable groundwater system into the future. These projects include recycled water use, winter recharge in years with adequate peak stream flows, and regional conjunctive use projects; management actions include well protection actions, GSA coordination activities, and information gathering that will benefit all uses and users in the SASb.

In this section, the elements of GSP implementation are identified and described. Those elements include:

- GSA management, administration, legal and day-to-day operations
- Implementation of the GSP monitoring program activities described in **Section 3**
- Technical support, including model updates and other technical analysis
- Coordination and partnership activities among GSAs within SASb and with other entities
- Reporting, including preparation of annual reports and 5-year evaluations and updates
- Projects and Management Actions (PMAs) as described in **Section 4**
- Ongoing outreach activities to local, regional, state and federal stakeholders
- Actions in response to Undesirable Results

Cost estimates and elements of a plan for funding GSP implementation are also presented in this section.

It should be noted that an effort has been performed to develop an agreement and governance structure for the implementation of the SASb GSP by the GSAs responsible for this GSP. This agreement (which is submitted as a companion document to this GSP) will establish the framework for joint activities by the GSAs that are described in this Section.

5.1 Description of GSP Implementation Elements

The following tasks and functions will be required for implementation of this GSP:

5.1.1 GSA Management, Administration, Legal and Day-to-Day Operations

GSA functions associated with the management and administration of the GSP implementation activities are covered under this category, which includes administrative, technical and finance staff support and related expenses; office supplies; insurance; and grant writing to support funding for specific projects and/or management actions. GSA staff and/or contractors will provide work products, administrative support, staff leadership, and management for the GSAs.

As the GSP implementation begins in 2022, staffing support and ongoing administrative and management needs will be further evaluated so that necessary budget refinements can be incorporated. Staffing needs will be reevaluated annually during the early years of GSP implementation to gain a better understanding of the support required. Staffing needs during out-years will be assessed on an as-needed basis.

Each of the GSAs in the SASb are administered independently. These agencies run their own meetings and oversee individual GSA projects and programs. GSA administration activities include coordination meetings within each GSA; coordination with other GSAs on projects or studies; coordination meetings of a GSP Implementation Ad-hoc Committee; email communications for updating GSA members about on-going activities; administration of projects implemented by the GSA; public outreach; and general oversight. Coordination meetings between the GSAs are anticipated to occur quarterly. Other coordination, oversight and administrative activities will occur on an as-needed basis.

Each GSA is responsible for and authorized to take appropriate action to achieve sustainable management of groundwater within their portion of the Subbasin based on the authority granted under Section 6 of the California Water Code. As such, GSAs may retain legal counsel to assist in these actions.

5.1.2 Implementation of the Monitoring Program Activities

This category covers the functions associated with monitoring activities, including logistics and coordination with entities performing monitoring of wells in the GSP Monitoring Network, and associated management of monitoring data. The GSP Monitoring Networks for groundwater level and groundwater quality, including the agencies performing that monitoring, are explained in **Section 3**.

To address data gaps that are identified during GSP implementation, improvements to or expansion of the GSP Monitoring Network may be necessary. In that event, coordination with existing well owners will be explored as a first step in expanding the monitoring network. This work may include data acquisition at additional monitoring wells; drilling new dedicated monitoring wells; monitoring well instrumentation; sampling and in-situ measurements; sample analysis; and maintenance and upkeep of associated data management system and data analysis and reporting. Costs for those facilities and activities are uncertain at this time but will be developed as the need arises during GSP implementation.

Areas of particular interest for additional data collection include information regarding well depth and screened intervals for specific wells in the GSP Monitoring Network and groundwater monitoring wells and stream gages along the middle reach of the Cosumnes River. These activities are included in the GSP as a management action and are described in **Section 4**.

Annual monitoring and data-related activities include:

- Groundwater Elevation Monitoring
- Groundwater Quality Monitoring
- Groundwater Extraction Monitoring/Modeling
- Stream flow Monitoring
- Obtaining and utilizing available satellite imagery and/or vegetation data to monitor GDEs as described in **Section 3**
- Monitoring Data Management (including data management system [DMS] maintenance), data validation (QA/QC), data entry and security, and data sharing

5.1.3 Technical Support, Including CoSANA Model Updates, Sustainable Management Criteria (SMC) Tracking, Other Data Analysis and Technical Support

CoSANA Model updates – Management activities and ongoing performance evaluation of the SMC are informed by CoSANA model output, which will require periodic updates and refinements as additional data and new information become available. Model updates and refinements will improve the model functionality and its capabilities in providing representative and defensible model output. These activities will include incorporation of new modeling tools and features; data input and model parameter updates; calibration updates as additional data from the monitoring network and stream gages are obtained; use of CoSANA to update water budgets, assess water usage, and assess the status of the SASb-wide groundwater storage volume; and related work to support ongoing analysis of implementation of PMAs, including conjunctive use, recharge and water banking projects.

SMC tracking – Synthesis of data will be performed to analyze and track the status of compliance with SMC at the representative monitoring point (RMP) wells in the SASb Monitoring Network. This synthesis will provide essential information for inclusion in the annual reports and 5-year GSP updates and will also provide information to trigger action by GSAs in the event problems in achieving SMC are detected.

Database Management System (DMS) – As data on groundwater conditions become available, the DMS will be updated and refined to support the annual reporting requirements, as well as supporting model refinements and updates. This data includes, but is not limited to, annual land use and cropping patterns, water demands by urban water purveyors and agricultural entities, groundwater levels, groundwater use, surface supply use, and hydrologic conditions data, including precipitation and streamflow. Additionally, new groundwater quality data will be added to the DMS.

Data analysis and other technical support – Data analysis will be needed for the annual reporting and 5-year GSP update and to support outreach activities. The GSAs may require support to integrate new information into the GSP as ongoing work proceeds to fill identified data gaps. In addition, as-needed data analysis and other technical support needs may arise to support the GSAs in implementation of the GSP.

5.1.4 Coordination Activities with Other GSAs and Entities

As identified in **Section 4**, GSAs in the SASb will need to budget for ongoing coordination during GSP implementation to meet SGMA requirements and to enable/promote sustainability of the SASb. Coordination will be required with the following entities on the following topical areas as a management action under the GSP:

- With other GSAs in SASb on GSP implementation measures, including, but not limited to, joint management actions, regional water bank/accounting, and grant applications supporting recharge projects.
- With agencies in SASb with land use jurisdiction to identify activities that may impact SASb groundwater sustainability.
- With GSAs in adjacent subbasins to coordinate possible future agreements, information exchange, monitoring network augmentation, and to resolve any issues regarding SMC along their common boundary. Additionally, as the CoSANA model is a common analysis tool among the NASb, SASb, and COSb, coordination is needed among various GSAs in these subbasins regarding data collection, model upgrades, calibration updates, and application.
- With water supply agencies to obtain updated information on monthly water use volumes, implementation of water use efficiency programs, and information regarding the impacts of those programs on water demands.
- With entities sponsoring projects in the SASb that will provide benefits to attainment of sustainability goals and objectives, including support for grant funding.
- With other regional entities to work on regional water bank development and implementation and to continue to refine climate change studies to develop the projections that can be used in preparing the 5-year update to the GSP.

To achieve this coordination, the SASb GSAs will need to develop governance and communication processes to support these activities efficiently and effectively.

5.1.5 Reporting, Including Preparation of Annual Reports and 5-year Evaluations and Updates

As part of GSP implementation, the GSAs must, either singly or jointly, prepare and submit annual reports and 5-year assessments to the California Department of Water Resources (DWR). Annual reports will be submitted to DWR by April 1st of each year for the previous water year (WY), and an initial 5-year GSP assessment and update will be due to DWR by April 2027. Requirements for each of these reports are explained below.

5.1.5.1 Annual Reporting

Per Water Code Sections 10727.2, 10728, and 10733.2, SGMA regulations require the GSAs to submit an annual report on the implementation of the GSP to the DWR. Each annual report will be submitted to DWR by April 1st for the previous WY (October 1st to September 30th). Development of each annual report will begin during October of each calendar year. Therefore, the first Annual Report will cover WY 2021 and will be submitted by the GSAs to DWR no later than April 1, 2022. (Note that WYs 2015 through 2020 will be included in the first annual report, as required by SGMA, because groundwater conditions have not been reported for those WYs.) The annual reports will be completed in a format consistent with Section 356.2 of the SGMA regulations and include the following three key sections:

5.1.5.1.1 General Information

General information will include a map of the Subbasin and an executive summary that includes a description of the sustainability goal, ongoing PMAs in the subbasin, jointly funded PMAs and their progress, as well as an updated implementation schedule.

5.1.5.1.2 Basin Conditions

This section will describe the current groundwater conditions and monitoring results used to evaluate how groundwater conditions have changed in the Subbasin since the previous WY. SGMA regulations require the following key components to be included in this section:

- Groundwater elevation data from monitoring wells in comparison to SMC and will include (1) groundwater elevation contour maps for the principal aquifer depicting seasonal high and low groundwater conditions, and (2) hydrographs of historical-to-current-reporting-year data showing groundwater elevations and WY type.
- Groundwater extractions during the WY summarized by water use sector, including a map showing the general location and volume of groundwater extractions, as well as the method of measurement (direct or estimate) and accuracy of measurements.
- Surface water supply for groundwater recharge or in-lieu use, including the annual volume and sources for the WY.
- Total water uses by water use sector and water source type, including the method of measurement (direct or estimate) and accuracy of measurements.
- Maps of changes in groundwater storage for the principal aquifer and a graph depicting historical-to-current-reporting-year WY type, groundwater use, annual change in groundwater in storage, and the cumulative change in groundwater storage for the Subbasin.

This information may change over time to incorporate potentially revised GSA priorities and to reflect new Subbasin conditions and applicable SGMA requirements.

5.1.5.1.3 Plan Implementation Progress

The progress made toward achieving interim milestones, as well as implementation of PMAs, will be explained in this section, along with a summary of plan implementation progress and sustainability progress.

5.1.5.2 Periodic Evaluations Every 5 Years

Per Water Code Sections 10727.2, 10728, 10728.2, 10733.2, and 10733.8, SGMA regulations require the GSAs to provide a written assessment of GSP implementation and progress towards meeting the sustainability goal at least every 5 years. A similar evaluation must also be submitted whenever the GSP is amended. The 5-year assessment reports will be completed in a format consistent with Section 356.4 of the SGMA regulations and include the following elements:

5.1.5.2.1 Sustainability Evaluation

The overall Subbasin sustainability and current groundwater conditions for each applicable sustainability indicator will be described, including progress toward achieving interim milestones and measurable objectives, and an evaluation of groundwater elevations at each of the RMPs in relation to minimum thresholds. The report shall describe any observed or anticipated problems in attaining SMC and actions taken by GSAs to either prevent or respond to such problems.

5.1.5.2.2 Plan Implementation Progress

This section will describe the current implementation status of PMAs, along with the effect on groundwater conditions resulting from their implementation, if applicable.

5.1.5.2.3 Reconsideration of GSP Elements

Elements of the GSP may require revision due to one or more of the following: collection of additional monitoring data during GSP implementation; collection of information to fill identified data gaps; exchange of information with adjacent subbasins; implementation of PMAs; significant changes in groundwater uses or supplies and/or land uses. Such new information may require revision to the following GSP elements: Subbasin setting, water budgets, monitoring network, SMC, PMAs, GSP implementation, and/or inter-basin coordination.

5.1.5.2.4 Monitoring Network Description

This section will provide an assessment of the monitoring network's function, an analysis of data collected to date, a discussion of data gaps and the steps taken to address them, and identification of areas within the Subbasin that are not monitored in a manner commensurate with the requirements of Sections 352.4 and 354.34(c) of the SGMA regulations.

5.1.5.2.5 Consideration of New Information for Basin Setting and SMC

New information made available after GSP adoption will be described and evaluated. If new information would warrant a change to the GSP, including a re-evaluation of the Subbasin setting and SMC, then corresponding revised descriptions will be included in the 5-year evaluation report.

5.1.5.2.6 Regulations or Ordinances

If DWR adopts new regulations that impacts GSP implementation, the update will also identify and address those requirements that may require updates to the GSP.

5.1.5.2.7 Legal or Enforcement Actions

Any enforcement or legal actions taken by the GSAs or their member agencies to contribute to attainment of the sustainability goal for the Basin will be summarized.

5.1.5.2.8 Plan Amendments

Each 5-year assessment report will include a description of amendments to the GSP, including adopted amendments, amendments that are underway during development of the report, and recommended amendments for future adoption.

5.1.5.2.9 Coordination

A summary of coordination activities will be provided in the 5-year assessment report, including activities between SASb GSAs, with GSAs in neighboring subbasins, and with agencies with jurisdiction over land use, water supply and well construction within the Subbasin.

The 5-year assessments will also include any other information deemed appropriate by the GSAs to support DWR in its periodic review of GSP implementation as required by Water Code Section 10733.

5.1.6 Projects and Management Actions

Section 4 of this GSP identifies three different groups of projects in the SASb, plus several management actions, as follows:

23. **Group 1** – Projects that are currently in place and will continue to be implemented by specific participating agencies within the SASb to support groundwater management and GSP implementation.

24. **Group 2** – Projects that are currently planned and will be implemented by specific participating agencies within the SASb in the near future which will contribute to attainment of SMC and the attainment of the SASb sustainability goal, and will otherwise support GSP implementation.

25. **Group 3** – Projects which have been identified which may occur in the SASb in the future, would provide benefits in contributing to the attainment of the sustainability goal and SMC, and would otherwise support GSP implementation.

26. Management actions that will be undertaken jointly by the SASb GSAs to provide assurance that beneficial uses and users of groundwater will be protected and maintained.

As described in **Section 4** and based on the results of CoSANA model scenario analyses, the projects in Groups 1 and 2 will be sufficient to ensure sustainability of the SASb and to avoid the occurrence of undesirable results. The Group 1 and 2 projects will be separately sponsored and funded by individual entities and will therefore not require funding by the GSAs. The supplemental multi-benefit projects in Group 3 would provide opportunity for improvement of groundwater conditions in the SASb and to support adaptive management in the event future conditions or outcomes are different than projected.

The management actions that will be undertaken by the GSAs in the SASb, either jointly or singly, include the following, which are described in greater detail in **Section 4**:

- Development and implementation of a Shallow/vulnerable well protection program in coordination with local well owners.
- Coordination with Sacramento County Environmental Management Wells Program to revise Well Construction requirements to protect existing wells and promote consistency with the GSP.
- Actions to fill identified data gaps in **Section 3**.
- A variety of coordination activities, including:
  - Coordination with GSAs in the SASb.
  - Coordination with agencies with local land use authority to enable appropriate consideration of GSP provisions in land use decisions and to establish regular communications between GSAs and those agencies.
  - Coordination with entities sponsoring the planned projects described in **Section 4** that will be beneficial to attainment of the goals of the GSP.
  - Coordination with water supply agencies to support water use efficiency measures and coordination with Regional Water Authority (RWA), Water Forum and local agencies regarding regional water supply planning and water resources management, including development of refined climate change projections.
  - Coordination with GSAs in adjacent basins to share information (e.g., groundwater levels and boundary fluxes) and to coordinate outreach activities and messages, as appropriate.
  - Coordination with RWA and others to support the development, formation and operation of the Sacramento Regional Water Bank and associated accounting framework in the SASb.

Table 5-1 presents management actions, responsible entity, and proposed means for generating revenues to support these actions.

Table 5-1: Proposed Responsible Entities and Proposed Funding Mechanisms for Proposed Management Actions

Management Actions	Proposed Responsible Entity	Proposed Funding Mechanism
Shallow Well Protection Program	GSAs under MOU	Combination of fees and property tax, potentially supplemented by grant funds
Well Construction coordination – Proposed Ordinance revisions	GSAs under MOU	Combination of fees and property tax
Actions to fill identified data gaps	GSAs under MOU	Combination of fees and property tax
Coordination activities with various entities	GSAs under MOU	Combination of fees and property tax

5.1.7 Outreach/Engagement with Stakeholders

Activities under this element of the GSP implementation plan include continuation of education, outreach, and engagement with stakeholders, building off the framework and activities established in the GSP Working Group meetings that led to the development of the GSP and further described in the Communication and Engagement Plan, as described in **Section 2.** Such activities performed during GSP implementation include maintaining the SASb website and the online/social media presence of member agencies, convening regular community meetings, workshops, and public events. The formation of a stakeholder advisory group has been suggested by engaged stakeholders and should be considered by the GSAs, given the benefit derived from stakeholder input during GSP development and the basic premise of SGMA to promote such engagement. These activities may also include electronic newsletters, informational surveys, coordination with entities conducting outreach to diverse and/or disadvantaged communities in the Subbasin, coordination with tribal representatives, and development of brochures and print materials. Decisions regarding the nature and extent of these outreach activities will be made by the GSAs, acting either singly or jointly.

5.1.8 Actions in response to Undesirable Results

In the event Undesirable Results are either anticipated or observed based on the information derived from the monitoring and reporting functions described above, the GSAs will take the following actions:

- Clearly identify the information pointing to either anticipated or observed Undesirable Results, e.g. failure to meet SMC at specific Monitoring Network wells at problematic frequency or duration, failure to meet criteria for protection of GDE or ISW, unanticipated failures of shallow wells

- Commence an investigation to determine the cause of the anticipated or observed problem

- Develop and implement a plan and schedule for resolution of the problem, including allocation of resources.

- Track progress in resolution of the problem
- Report the above in the annual report to DWR.

It should be noted that the technical work supporting the development of this GSP does not project the occurrence of Undesirable Results in the SASb, based on best available information. The above process is described to address unanticipated future events.

5.2 Estimate of GSP Implementation Costs

The implementation costs for the SASb GSP will include funding for functions associated with the GSP implementation elements described above, including GSA management and administration, monitoring, technical support, data management, coordination, reporting, GSP management actions, and outreach. GSP implementation costs will also cover the building of sufficient fiscal reserves to address other potential costs for the near-term GSP planning horizon.

Implementation of the SASb GSP over the 20-year implementation horizon by the SASb GSAs is projected to cost $860,000 per year, to be shared among the GSAs, and does not include the cost of new wells or equipment. The estimated costs for management and administration of each GSA are separate and could range from $120,000 to $460,000 per year, depending on the specific GSA and its activities.

Table 5-2 summarizes the estimated costs by implementation element; the table includes a range of GSA-specific management and administrative costs in addition to the estimate of shared costs. These costs are based on the best available estimates at the time of Plan development and may vary during the period of Plan implementation. Grant awards may offset some costs. If the GSAs develop additional projects or management actions during the GSP implementation period, the cost estimates will be refined and reported to DWR through annual reports and the 5--year periodic assessments.

Development of this GSP was funded through a Proposition 1 Groundwater Grant Program and Proposition 68 Grant, with additional local share contributions. The GSAs may pursue additional grant funding for GSP implementation, if it is available. The GSAs will identify other sources of funding to cover GSP implementation costs, which may include parcel fees, groundwater extraction fees, increased water rates, other grants, and low interest loans. The exact funding mechanisms will vary by GSA and will depend on the legal authority of each GSA.

Table 5-2: Summary of Estimated GSP Implementation Costs

GSP Implementation Tasks	Annual Cost Range (varies by GSA)	Annual Costs (Shared Among GSAs)
GSA Management, Administration, Legal and Day-to-Day Operations		
Administrative Staff Support /Accounting	$50,000 – $190,000	
GSA management and staff support	$50,000 – $190,000	
Legal support	$10,000 – $40,000	
Implementation of the GSP Monitoring Program Activities		
Monitoring data collection, Coordination with monitoring entities, Data Validation		$80,000
Data management		$35,000
New monitoring wells, equipment (not including costs for Management Action 4)		To be determined (TBD)
Technical Support, including Model Updates and other Technical Analysis		
CoSANA Model updates		$70,000
Special data analysis needs		$20,000
SMC Tracking		$40,000
GSP Reporting		
Annual Reports		$60,000
5-Year GSP Assessments (annual contribution to fund $1.0 million reserve for 5-year update to GSP)		$200,000
GSP Management Actions		
Management Action 1 – Shallow/Vulnerable Well Protection Program		$100,000
Management Action 2 – Well construction requirement revisions		$20,000
Management Action 3 – Coordination activities		$100,000
Management Action 4 – Address Data Gaps		$30,000
Ongoing Outreach Activities to Stakeholders		
Outreach & Education		$25,000
Contingency		
Contingency (~10%)	$10,000-40,000	$80,000
Total [not including new monitoring wells]	**$120,000-460,000**	**$860,000**

5.2.1 Financial Reserves and Contingencies

To mitigate financial risks associated with expense overruns due to unanticipated expenditures and actual expenses exceeding estimated costs, the GSAs may carry a general reserve with no restrictions on the types of expenses for which it can be used. Adoption of a financial reserves policy is authorized by SGMA Sections 10730(a) and 10730.2(a)(1). A reserve for operations usually targets a specific percentage of annual operating costs and may consider factors such as billing frequency and the recurrence of expenses to address cash flow constraints.

5.2.2 GSP Implementation Costs Through 2042

Implementation of this GSP is estimated to have a total annual cost as described in **Table 5-2**. The estimated annual costs include an approximate 10% contingency amount which would be used for unanticipated expenditures.

5.3 Schedule for Implementation

The schedule for agency administration, management and coordination activities, GSP reporting, and community outreach and education is provided in **Table 5-3**. While most activities are continuous during GSP implementation, annual reports will be submitted to DWR by April 1st of each year and periodic 5-year assessment reports will be submitted to DWR by April 1st every five years after the initiation of Plan implementation in 2022 (i.e., assessment report submittal in 2027, 2032, 2037, and 2042).

Table 5-3: GSP Implementation Schedule

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																						
Agency Administration & Operations	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Management & Coordination																						
Monitoring: Groundwater	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Monitoring: Streamflow	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Data Collection	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Data Management	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
GSP Reporting																						
Annual Reports		▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
Five-year Assessment Report							▨					▨					▨					▨
Outreach & Education	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

5.4 GSP Implementation Funding Approach

The SGMA regulations require various financial information for the implementation of a GSP. The requirements state that a GSP must include:

27. An estimate of the cost of implementation of the GSP and a description of how the GSA(s) will meet those costs.

28. Cost estimates for each project and management action that the GSA(s) will implement that will help the basin achieve sustainability and a description of how the GSA(s) will meet those costs.

A summary of the costs related to implementation of the GSP (**Table 5-2**), was provided previously in this Section. In Section 4, the project and management actions (PMAs) identified to meet the requirements of SGMA and meet the sustainability requirements for the SASb are described. Given this information, the following sub-sections outline the funding approach for the identified activities, management actions, and projects.

5.4.1 Legal and Financial Resources

As noted in this report, the SASb contains six separate GSAs. Five of the six GSAs entered into an MOU (**Appendix 1-B**) to establish the GSPWG. RD 551, the sixth GSA, subsequently entered into an agreement with the NDGSA to be represented on the GSPWG. Each GSA is a slightly different type of public agency, but all are local agencies that were approved by DWR as meeting the requirements to serve as a GSA for their portion of the subbasin. As a GSA, the local agencies have the legal authority to:

> "…impose **fees**, including, but not limited to, permit fees and fees on groundwater extraction or other regulated activity, to fund the costs of a groundwater sustainability program, including, but not limited to, preparation, adoption, and amendment of a groundwater sustainability plan, and investigations, inspections, compliance assistance, enforcement, and program administration, including a prudent reserve." (Water Code Section 10730)

The following sections present a summary of the GSAs, their legal authority and financial means to fund the implementation of the GSP and associated management actions. More background information about each GSA is presented in Section 1.4.1. The GSAs will execute an MOU to address governance and cost sharing for GSP implementation.

5.4.1.1 Sacramento Central Groundwater Authority GSA

The Sacramento Central Groundwater Authority (SCGA) is a Joint Powers Authority of five entities in the South American Subbasin: the cities of Sacramento, Folsom, Rancho Cordova, and Elk Grove, and the County of Sacramento. These five agencies are the signatories of the JPA. The governing board of the SCGA is made up of sixteen members that include representation 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.

SCGA recently completed a fee study outlining the level of annual fees necessary to support SCGA and the costs associated with implementing the GSP and funding for PMAs. A copy of the fee study can be found at https://scgah2o.saccounty.net/Pages/SCGA-Groundwater-Fee.aspx. The fee study outlined a funding methodology based on a "hybrid" approach. The "hybrid" component of this study is that the urban water purveyors will be billed directly and pay

SCGA based on the number of parcels and groundwater usage by the purveyor within their service area and located within the SCGA GSA. All other parcels, i.e., those outside the service areas of the urban water purveyors, will be billed through the property tax rolls and those revenues generated will be distributed to SCGA. Under this approach, all parcels within the SCGA GSA will be contributing to the funding of SCGA through a parcel fee and, if using groundwater, a groundwater usage fee.

The SCGA Board held several public meetings discussing the fee study approach, methodology, and charges. As part of the fee study approach, the fee program was implemented through a Proposition 218 process. In April 2021, SCGA mailed out a customer notification outlining the proposed fee to the affected parcels. On June 22, 2021, SCGA held a public hearing to receive customer comments and determine if a majority protest existed. A majority protest did not occur and subsequently the SCGA Board adopted the fee program.

5.4.1.2 Sacramento County GSA

Sacramento County GSA is an approximately 1,500-acre area of the South American Subbasin primarily overlying Cosumnes River Preserve lands. Sacramento County GSA has entered into a Memorandum of Understanding with SCGA to include this 1,500-acre area in its GSA and fee study. As a result, this area was included in the SCGA fee study and the County’s share of costs could be funded using the methodology described under the SCGA GSA. Imposing this fee would require County action.

5.4.1.3 Sloughhouse Resource Conservation District GSA

SRCD is a resource conservation district (RCD) formed in 1956. RCDs are special districts of the State of California, set up to be locally governed agencies with their own locally appointed or elected, independent boards of directors. California RCDs implement projects on public and private lands, and educate landowners and the public about resource conservation. SRCD is governed by a five-member Board of Directors. SRCD is engaged in the discussions of a multi-GSA MOU to identify the cost sharing approach and estimated costs associated with GSP implementation and completion of PMAs. SRCD will develop its own fee structure to fund its portion of the SASb GSP implementation based on the estimated cost share as developed in the MOU.

5.4.1.4 Omochumne-Hartnell Water District GSA

OHWD is a California Water District formed 1953 and it has the authority to exercise powers related to groundwater management and rural irrigation services. OHWD is also engaged in discussions for an MOU to fund its share of the GSP implementation and completion of PMAs. OHWD recently completed a fee study that included the cost sharing assumptions as outlined in the MOU for those parcels within the South American Subbasin. The OHWD fee program is based on irrigable agriculture acreage as outlined by the California DWR Statewide Crop Mapping data. OHWD held a public meeting and adopted the fee study for the projected costs associated with the South American Subbasin GSP based on the MOU and cost sharing estimate.

5.4.1.5 Northern Delta GSA

The Northern Delta GSA (NDGSA) initially formed as a Joint Powers Agency by 17 local agencies, each with water management responsibilities. The individual agencies were formed to manage water for flood, irrigation, and drainage within their local area, typically an area encompassing a single island in the Sacramento-San Joaquin.

NDGSA Board of Directors has proposed to impose a fee to generate revenue sufficient to fund both annual Agency operations costs and expenses associated with the implementation of the GSP. Because the NDGSA overlies multiple groundwater basins, the income from fees will be maintained and accounted separately by basin. Any activities undertaken by the NDGSA that benefit all of the Agency’s service area, such as administrative actions, will be funded by drawing down the separate funds proportionally by geographic area; any activities that only provide services and benefits to one groundwater basin will be financed with funds collected from property within that same basin. This accounting practice will ensure that each geographic area pays only its share of the costs.

The proposed fee schedule will apply to all assessable parcels within the Agency’s boundaries as the NDGSA’s administrative and GSP-development services are provided to all parcels. Some parcels may not be assessable due to public ownership. The actual fee will be set annually by the NDGSA Board, based on the budget needs, but not to exceed the proposed rate. If activities are proposed to attain the sustainability criteria established in the GSP that would require supplemental funding and fees greater than the fees recommended in this report, the NDGSA would need to adopt a new fee schedule to fund these costs, and if necessary, will comply with the requirements in Article XIIID of the California Constitution, commonly referred to as Proposition 218 requirements.

5.4.2 Implementation Costs Split

The estimated annual costs to be shared amount the GSAs are described in **Table 5-2**. The GSAs are currently developing an MOU to identify how these costs will be shared among the GSAs. Each of the GSAs is able to meet its commitments to the GSP Implementation, including management actions, from their individual adopted fee processes. Any additional funding needs may be made up through other grants, bonds, or cost-sharing opportunities, which will be determined as they are needed.

5.5 Funding Sources and Mechanisms

SGMA authorizes GSAs to charge fees, such as pumping and permitting fees, to fund the costs of groundwater management and sustainability programs. 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 GSP implementation evolves over time through data collection and the assessment of the beneficial impacts of PMAs on groundwater sustainability. The total and individual agency contributions will be evaluated and may be refined, as needed.

The GSAs may pursue funding from state and federal sources for GSP implementation. The GSAs will further evaluate funding mechanisms and fee criteria and may perform a cost-benefit analysis of fee collection to support consideration of potential refinements. **Table 5-4** presents examples of potential financing options.

Table 5-4: Potential Funding Sources for GSP Implementation

Funding Source	Certainty
Ratepayers	High – User rates pay for operation and maintenance (O&M) of a utility's system. Depends upon rate structure adopted by the project proponent and the Proposition 218 rate approval process. Can be used for project implementation as well as project O&M.
General Funds or Capital Improvement Funds (of Project Proponents)	High – General or capital improvement funds are set aside by agencies to fund general operations and construction of facility improvements. Depends upon agency approval.
Special taxes, assessments, and user fees (within Project Proponent service area or area of project benefit)	High – Monthly user fees, special taxes, and assessments can be assessed by some agencies when new facilities directly benefit existing customers. Depends upon the rate structure adopted by the project proponent and the Proposition 218 rate approval process.
Bonds	Low – Revenue bonds can be issued to pay for capital costs of projects allowing for repayment of debt service over 20- to 30-year timeframe. Depends on the bond market and the existing debt of project proponents. Not anticipated in SASb.
Integrated Regional Water Management (IRWM) implementation grants administered by the California Department of Water Resources (DWR)	Medium – Proposition 1, IRWM implementation grants.
Proposition 68 grant programs administered by various state agencies	Medium – Grant programs funded through Proposition 68 (passed by California voters in June 2018 and administered by various state agencies) are expected to be applicable to fund GSP implementation activities. These grant programs are expected to be competitive, where $74 million has been set aside for Groundwater Sustainability statewide.
Disadvantaged Community (DAC) Involvement Program	Medium – DWR DAC Involvement Program This program is not guaranteed to be funded in the future.

Section 6: References and Technical Studies

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