SANTA MARGARITA
Groundwater Agency

GROUNDWATER SUSTAINABILITY PLAN

PUBLIC REVIEW DRAFT JULY 2021

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SANTA MARGARITA
Groundwater Agency

Public Review Draft

Executive Summary

Santa Margarita Basin
Groundwater Sustainability Plan

July 23, 2021

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Acronyms & Abbreviations

AFY................acre-feet per year
Basin ....Santa Margarita Groundwater Basin
C&E Plan ....Communication and Engagement Plan
CEC................contaminants of emerging concern
CWC ....California Water Code
DAC ....Disadvantaged Communities
DMS...............Data Management System
DWR ....California Department of Water Resources
GDEs..............groundwater dependent ecosystems
GSP ....Groundwater Sustainability Plan
HCM ....Hydrogeologic Conceptual Model
JPA.................Joint Powers Agreement
MHA ....Mount Hermon Association
SCWD............Santa Cruz Water Department
SGMA ....Sustainable Groundwater Management Act
SLVWD ....San Lorenzo Valley Water District
SMC ....sustainability management criteria
SMGWA ....Santa Margarita Groundwater Agency
SVWD............Scotts Valley Water District

EXECUTIVE SUMMARY

The State of California enacted the Sustainable Groundwater Management Act (SGMA), effective January 1, 2015, as the first legislation in the state's history to mandate comprehensive sustainable groundwater resources management. The Santa Margarita Groundwater Agency (SMGWA) was formed under SGMA to develop the Groundwater Sustainability Plan (GSP or Plan) for the Santa Margarita Groundwater Basin (Basin). The GSP describes how the SMGWA intends to manage groundwater to achieve groundwater sustainability and meet the requirements of SGMA. The plan provides the basis for ongoing management of the Basin by SMGWA to both achieve sustainability in the 20-year planning horizon and maintain sustainability over the 50-year implementation horizon specified by SGMA. By following the GSP, SMGWA, its cooperating agencies, and other local stakeholders will collaboratively manage the Basin to maintain a safe and reliable groundwater supply for all beneficial groundwater uses and users.

This GSP is organized into sections per the California Department of Water Resources (DWR) guidance (DWR, 2016).

Groundwater Sustainability Plan Sections

The Introduction describes SMGWA's formation and organization, and it introduces the sustainability goals for the Basin. The Plan Area and Basin Setting describes current knowledge of the physical aspects of the Basin, relying on a multitude of studies conducted by the SMGWA's cooperating agencies. It includes a summary of current basin conditions, including groundwater levels, groundwater quality, and interconnected surface water. This information is used in the GSP to guide development of Sustainable Management Criteria (SMC) for the SMGWA to reach during the GSP implementation period. In order for the SMGWA to achieve the sustainability goals and SMC, additional projects and management actions likely need to be implemented. The GSP introduces potential projects and management actions that may be considered by the SMGWA and provides details on how and when they may be implemented to achieve sustainability. The GSP also summarizes how the SMGWA intends to comply with SGMA requirements for monitoring and reporting and provides the initial groundwater management budget and schedule for the first 5 years of GSP implementation.

1 Introduction

The SMGWA has developed the Santa Margarita Basin GSP to provide a roadmap for achieving groundwater sustainability in the Basin. The Introduction section of the GSP describes in detail the SMGWA organization and management structure, the GSP sustainability goal, and defines the many terms specific to SGMA and groundwater used in the GSP.

The SMGWA has legal authority to perform duties, exercise powers, and accept responsibility for managing groundwater sustainably within the Basin. The SMGWA was formed through a Joint Powers Agreement (JPA) in June 2017, among the Scotts Valley Water District (SVWD), the San Lorenzo Valley Water District (SLVWD), and the County of Santa Cruz (County). The SMGWA is governed by a Board of Directors comprising 2 representatives from each member agency, single representatives from the City of Scotts Valley, City of Santa Cruz, and Mount Hermon Association (MHA), and 2 private well owners.

The Introduction section includes the sustainability goal for the Basin used as a guide to develop the GSP. Groundwater sustainability is generally defined as follows:

- Providing a safe and reliable groundwater supply that meets the current and future needs of beneficial users
- Supporting groundwater sustainability measures and projects that enhance a sustainable and reliable groundwater supply
- Providing for operational flexibility within the Basin by supporting a drought reserve that accounts for future climate change
- Planning and implementing cost-effective projects and activities to achieve sustainability

The SMGWA will successfully implement the GSP by managing groundwater and surface water use conjunctively and by implementing projects and management actions, as needed to meet the sustainability goal.

2 Plan Area and Basin Setting

The Plan Area and Basin Setting section summarizes how groundwater is currently managed in the Basin and describes groundwater conditions in the past, present, and future.

Description of the Plan Area

The Santa Margarita Groundwater Basin is a 34.8-square-mile area defined in DWR's Bulletin 118 which is the State's official publication on the occurrence and nature of groundwater in California (Figure ES- 1). The Basin forms a roughly triangular area that extends from Scotts Valley in the east, to Boulder Creek in the northwest, to Felton in the southwest. The Basin is bounded on the north by the Zayante trace of the active, strike-slip Zayante-Vergeles fault zone, on the east by a buried granitic high that separates the Basin from Santa Cruz Mid-County Basin, and on the west by the Ben Lomond fault, except where areas of alluvium lie west of the fault. The southern boundary of the Basin with the West Santa Cruz Terrace Basin is located where Tertiary sedimentary formations thin over a granitic high and give way to young river and coastal terrace deposits.

Almost half of the Basin is classified as open space with much of that being moderately rugged, forested terrain. Rural residential development is the next largest land use type, followed by smaller suburban developments in the communities of Scotts Valley, Boulder Creek, Felton, Ben Lomond, and Lompico. Approximately 29,000 people reside in the Basin, and about 63% of these people live in census-designated communities. The remaining population (about 37%) live in rural areas. The City of Scotts Valley is the only local entity with land use jurisdiction. The County has land use jurisdiction for all unincorporated areas outside of Scotts Valley. Commercial land use is concentrated in the City of Scotts Valley and the community of Felton. Much of this development occurred during a period of population growth between 1980 and 2000, which coincided with construction of commercial and industrial complexes. General Plans for the County and City of Scotts Valley are reviewed in the GSP to

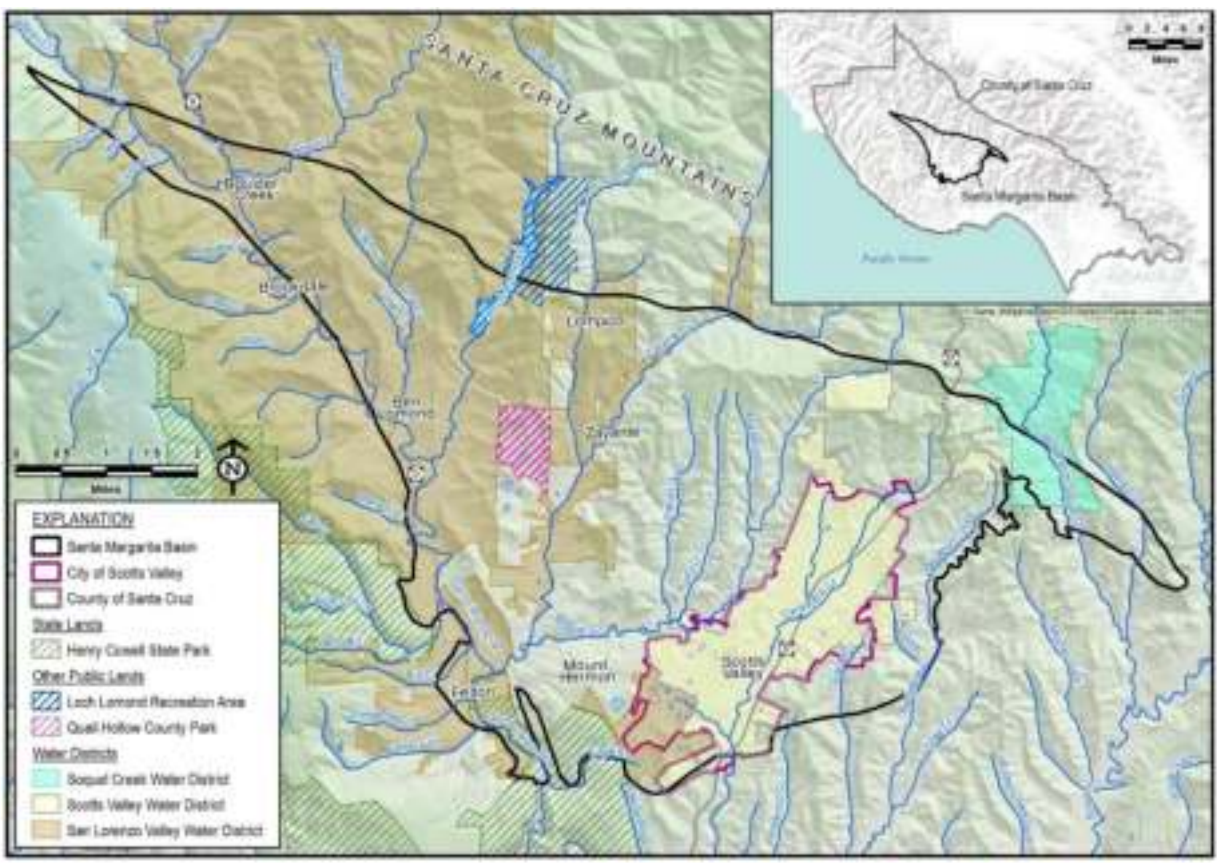

Figure ES- 1. Santa Margarita Basin

identify local development goals and how the GSP can operate within these confines.

Water supply in the Basin is sourced from groundwater, surface water, springs, and recycled water. The SLVWD and SVWD are the 2 largest water suppliers in the Basin, with both dependent on local water sources.

SLVWD's water supply is from surface water diverted, just outside of the basin, on tributaries of the San Lorenzo River, and from springs and groundwater. The SLVWD supplies water to a 5.6-square-mile service area with about 13,000 customers in the Basin.

SVWD uses groundwater exclusively for potable supply and recycled water for non-potable supply. The SVWD supplies water to a 5.5-square-mile service area with about 10,700 customers in the Basin.

The remaining approximately 5,300 people residing in the Basin use groundwater pumped by small water systems or their own private domestic wells. The Mount Hermon Association is the largest private water supplier that includes a year-round conference center and camp that serves more than 60,000 guests each year and a permanent community of approximately 1,300 people. There are 12 small water systems in the Basin serving a population of about 1,000. Springs or groundwater are the source of water for 11 of the 12 small water systems. Based on residential parcels that are not served water by one of the water districts, an estimated 777 private wells are pumping less than 2 acre-feet per year that supply water to about 3,000 people.

The City of Santa Cruz does not pump any groundwater in the Basin. However, it is an indirect user of groundwater in the Basin because the surface water it diverts from the San Lorenzo River partially comprises baseflows supported by Basin groundwater discharge to creeks. It does own and operate the 2.8-billion-gallon capacity Loch Lomond Reservoir that it uses for water storage. The City has 2 diversion points on the San Lorenzo River: at Felton within the Basin and at Tait Street 5 miles downstream of the Basin. The San Lorenzo River provides roughly 55% and Loch Lomond (Newell Creek) provides roughly 14% of Santa Cruz's municipal water supply.

In addition to public supply and private domestic use, groundwater is used for a few commercial and industrial purposes. It is used for dust control and operations at a single remaining sand quarry and for large-scale landscaping and pond filling at a few locations. There are also a few small wineries that cumulatively irrigate less than 2 acres with groundwater.

The SLVWD and SVWD have, prior to SGMA, managed groundwater in the Basin and developed a number of water management plans including master plans, surface water management plans, and analyses of water supply availability and reliability for the Basin. The information generated in past management efforts is instrumental in developing this GSP.

Existing conjunctive use strategies, low impact development, conservation, recycled water, and other water efficiency programs have been used successfully by the water districts to manage groundwater use and to lower potable demand. The water districts comply with all regulatory water quality testing and Drinking Water Source assessments for active supply wells.

The County is also involved in a variety of management efforts related to water quality, stormwater management, threatened and endangered species monitoring, and watershed and stream habitat protection. The County is responsible for all permitting for well construction and destruction. If needed, the County may update its well ordinance to implement elements of this GSP.

Regulatory agencies are involved in protecting the Basin's overall good groundwater quality. The County has been working for decades to reduce nitrate loading of surface water. The County's Local Area Management Plan developed in 2021 allows for the continued use of septic systems in Santa Cruz County while providing protection of water quality and public health. The Central Coast Regional Water Quality Control Board is responsible for overseeing point source groundwater pollution from chemical spills or leaks. Several groundwater contamination sites in Scotts Valley and Felton have had past remediation of volatile organic compounds and gasoline-related chemicals in groundwater. These remediation programs have generally been resolved and there are no sites undergoing active groundwater remediation at present.

Groundwater dependent ecosystems (GDEs) in the Basin support threatened and endangered species. Priority species identified in the GSP that rely on GDEs in the Basin include steelhead trout, coho salmon, lamprey, western pond turtle, California giant salamander, and California red-legged frog. Ongoing programs such as Santa Cruz County's Juvenile Steelhead and Stream Habitat Monitoring Program have monitored steelhead density and stream habitat since 1994, but clear associations between groundwater extraction and a reduction in fish density or available habitat has not been made. The species and habitat data are compiled into an annual report and a geodatabase for spatially referenced information. This work is ongoing and can be used to establish links between streamflow, groundwater conditions, GDE habitat, and presence or absence of priority aquatic species.

GSP development is a collaborative effort among the SMGWA's cooperating agencies and technical consultants. Decisions shaping policy are informed by input from resource management agencies, community members, and interested stakeholders. Extensive public outreach and engagement efforts prior to and during GSP development are documented in a Communication and Engagement Plan (C&E Plan). Beneficial users of groundwater in the Basin identified in the C&E Plan include municipal water suppliers, agricultural users, private domestic well owners, small water systems, local land use planning agencies, surface water users, ecological users, California Native American Tribes, disadvantaged communities, protected lands (including recreational areas), and public trust uses (including wildlife, aquatic habitat, fisheries, recreation, and navigation).

When developing the GSP, the SMGWA considered impacts on all beneficial uses and users, including domestic well owners, Disadvantaged Communities (DACs), and priority species. California Water Code (CWC) §106.3 recognizes that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." The Human Right to Water bill extends to all Californians, including disadvantaged individuals, groups, and communities in rural and urban areas.

Basin Setting

The basin setting is described in the form of a hydrogeologic conceptual model (HCM) to provide an understanding of the general physical characteristics related to regional hydrology, land use, geology and geologic structure, water quality, principal aquifers, and aquitards. The HCM also provides the context to develop Basin water budgets, groundwater models, and monitoring networks. The HCM was developed based on prior studies and monitoring data collected by cooperating agencies over the past 30 years.

The Basin's climate is classified as Mediterranean, characterized by warm summers and mild winters. Almost all precipitation occurs from November through April. Due to increased elevation and the orographic effect of Ben Lomond Mountain west of the Basin, precipitation increases across the Basin east to west from about 42 inches to 52 inches per year.

The Basin consists of sandstone, siltstone, mudstone, and shale overlying granitic and metamorphic rocks, all of which have been folded into a geologic trough called the Scotts Valley Syncline. The sandstone units in the geologic sequence are the principal aquifers that supply much of the groundwater produced for local water supply. The Basin's principal aquifers are the Santa Margarita, Lompico, and Butano Sandstones. The Monterey Formation is an aquitard between the Santa Margarita and Lompico Sandstones. The following describes the general characteristics of the principal aquifers and Monterey Formation:

- The Santa Margarita aquifer is the shallowest principal aquifer, with widespread surface exposures in the southern and central portions of the Basin. It is a high-yielding aquifer that is critical to creek baseflow and private domestic water supply.
- The Monterey Formation, a low-yielding aquitard that is only used for domestic water supply found at relatively shallow depths and not for municipal supply. The Monterey Formation interacts with surface water where it outcrops in creek beds. Its low permeability limits recharge of the underlying Lompico aquifer.
- The Lompico aquifer is used extensively for municipal supply in the Mount Hermon / Scotts Valley area where the formation is thickest. This mostly confined aquifer has significantly less

- direct recharge from precipitation than the Santa Margarita aquifer because of its much smaller surface exposure. The area where the Monterey Formation is absent beneath the Santa Margarita aquifer in the south Scotts Valley area is important for groundwater recharge of the Lompico aquifer.
- The Butano aquifer is the deepest of the productive aquifers and is only used for water supply in northern Scotts Valley. It is recharged by surface water and precipitation where it is exposed along the Basin's northern boundary. SVWD is the only municipal user of the Butano aquifer, although private well owners pump from it in areas where it occurs at or close to the surface.

Precipitation is the main source of natural groundwater recharge to the Basin's aquifers. It enters the shallowest aquifers either as direct infiltration through the soil or indirectly from streamflow infiltrating through the streambed. Most creeks in the Basin are fed by groundwater discharges with groundwater accounting for most summer and fall baseflows.

The major creeks and river in the Basin include the San Lorenzo River, Boulder Creek, Love Creek, Newell Creek, Lompico Creek, Zayante Creek, Bean Creek, and Carbonera Creek. Many of these are home to protected species. GDEs are widespread through the Basin and consist of springs, riverine, riparian, open water and groundwater supported wetlands. Fall Creek and the San Lorenzo River have bypass flow requirements that limit diversion timing and rates at certain times of the year.

SMGWA cooperating agencies regularly monitor groundwater elevations, groundwater extraction, groundwater quality, and surface water flow and quality for groundwater management and operations of their water systems. These data are critical for evaluation of past and current groundwater conditions.

Data gaps in the hydrogeologic conceptual model coincide with areas of uncertainty in the GSP. The primary data gap is a lack of monitoring wells in parts of the basin that are not provided public water supply and have concentrated private well extractions. These include areas where groundwater is connected to surface water and areas where there is no nearby creek. Additionally, the deep Butano aquifer is poorly understood because it only has 2 dedicated monitoring wells. In parts of the Basin, these data gaps have led to some uncertainty on how aquifers interact with each other and surface water, and how they respond to stresses such as groundwater pumping and reduced precipitation. Eight new monitoring wells to be completed in 2022 will address these data gaps.

Groundwater Conditions

Groundwater conditions in the Basin are generally sustainable, with the exception of the Mount Hermon / South Scotts Valley area where there are lowered groundwater levels in 2 of the Basin's primary aquifers. In this area, a portion of the Santa Margarita aquifer is dewatered due to a 30- to 40-foot drop in groundwater level, and the Lompico aquifer has had a 150- to 200-foot groundwater level drop.

Groundwater levels in both aquifers started to decline as early as the 1970s when there was extensive development in the south Scotts Valley area. Groundwater level declines were exacerbated by an 11-year drought starting in 1984. During this drought, the Scotts Valley area experienced an average rainfall deficit of 8.6 inches relative to the long-term average annual rainfall of 42 inches.

Coinciding with a climate-driven reduction of natural aquifer recharge, water demand in the Basin peaked thereby further worsening groundwater conditions. At this time, there were a number of different groundwater users pumping from the Santa Margarita aquifer in the Mount Hermon / South Scotts Valley area including 2 groundwater contamination remediation systems, Valley Gardens golf course, Hanson Quarry, Manana Woods Mutual Water Company, Mount Hermon Association, SVWD and SLVWD.

As Santa Margarita aquifer groundwater levels fell as much as 40 feet during the drought, levels dropped to pump intakes in several wells screened in the Santa Margarita aquifer and upper parts of the Lompico aquifer, including Mount Hermon Association, SLWVD, and SVWD wells, forcing them to drill new wells screened in deeper parts of the Lompico aquifer.

Even though the Santa Margarita aquifer recharges quickly when there is average or better rainfall, its groundwater levels in the Mount Hermon / South Scotts Valley area have not recovered much from the initial decline that ended in 1994. The main reason it has not had much recovery is thought to be that lowered groundwater levels, especially in the dewatered portions of the aquifer, cause water infiltrating at the surface to pass through the Santa Margarita aquifer and into the underlying formations instead of remaining in the Santa Margarita aquifer. Underlying formations are either the top of the low permeability Monterey Formation from where it mostly flows out at surface seeps to Bean Creek, or the Lompico aquifer where it is in direct contact with the Santa Margarita aquifer due to the absence of the Monterey Formation. Other contributing factors that have led to decreased recharge of the Santa Margarita aquifer since the 1980s include conversion of the City of Scotts Valley to a sewer system that has reduced the amount of septic systems return flow to groundwater, and increased development that has reduced the amount of pervious area available for recharge.

The Santa Margarita aquifer in the Olympia area of the Basin also has gradual declining groundwater levels over the past 35 years. With a decline of about 20 feet (average rate of 0.6 foot per year), the change is much smaller than declines experienced in the South Scotts Valley area.

Climate change is projected to generally result in more variable precipitation (i.e., longer and more extreme droughts with fewer but more extreme rainfall events), slightly lower total precipitation, and warmer temperatures in comparison to current conditions. These climate conditions will 1) reduce natural recharge to groundwater causing further lowering of groundwater levels if groundwater extraction is not supplemented with other sources, and 2) reduce available surface water which will, at times, result in greater pressure on groundwater to meet water demands within the Basin.

Lowered groundwater levels in certain parts of the Basin have caused a corresponding reduction in groundwater stored in the Basin. Since the 1980s, and even possibly starting in the 1960s, there has been a consistent loss of groundwater stored in the Basin due primarily to over-pumping the Lompico aquifer in the Mount Hermon / South Scotts Valley area.

Groundwater in the Basin is generally of good quality and does not regularly exceed primary drinking water standards. However, both naturally occurring and anthropogenic groundwater quality constituents of concern are present in some aquifers and areas. The main naturally occurring groundwater quality concerns in the Basin are salinity (measured as total dissolved solids and chloride), iron, manganese, and arsenic. The main anthropogenic groundwater quality concerns are nitrate and contaminants of emerging concern (CEC) which are mainly from septic and sewer discharges together with organic compounds from environmental cleanup sites or other unidentified local releases.

Surface water is connected to groundwater throughout the Basin. The highly permeable nature of the Santa Margarita aquifer and its proximity to surface water features lends it to being the main source of baseflows to creeks. The Butano aquifer also contributes a significant volume of baseflow where it outcrops and is intersected by numerous creeks along the Basin's northern boundary. The upper Bean Creek watershed and its tributaries are one of the few areas where streams lose water to groundwater. This is an important source of groundwater recharge to the aquifers. Groundwater elevations in the Basin's only 2 monitoring wells near creeks show groundwater levels consistently higher than the streambed, indicating that groundwater is contributing to streamflow in these locations year-round. Four additional shallow monitoring wells will be completed in 2022 to improve understanding of interconnected surface water, to add as representative monitoring points, and to improve how the groundwater model simulates groundwater and surface water interactions.

There is no known evidence of land subsidence in the Basin. The consolidated geology makes subsidence unlikely. Subsidence caused by land surface movement related to tectonics and other phenomena besides groundwater pumping are not subject to SGMA.

Water Budget

In compliance with SGMA, water budgets in the GSP cover historical (1985-2018), current (2010-2018), and projected (2020-2072) timeframes. The water budgets are developed from an inventory of precipitation, surface water, and groundwater inflows and outflows.

Santa Margarita Basin Groundwater Model

To be used as a tool for developing the GSP, an existing groundwater model was improved and updated. The model was first developed in 2006 and updated in 2015, 2016, and 2017. For the model to be a suitable tool for quantifying water budgets, simulating future groundwater conditions based on climate change assumptions and potential projects and management actions required as part of GSP development, a number of structural and model input refinements were made.

Water inflow and outflow volumes across the land surface, via surface water, and for groundwater are estimated using the Santa Margarita Basin groundwater model.

The availability of water for groundwater recharge is driven by precipitation, surface runoff to creeks, and evapotranspiration. Surface water flows into and out of the Basin, and is connected to groundwater in much of the Basin. Water flows both from creeks to groundwater and vice versa based on the gradient between creek stage and adjacent groundwater levels. Overall, there is more groundwater discharging to creeks than being recharged by creeks. Groundwater pumping removes groundwater from the aquifer system, though some of it reenters the groundwater system as return flows from septic systems, quarry usage, landscape irrigation, and sewer and water distribution system losses. Figure ES- 2 graphically depicts the historical (1985-2018) average annual groundwater budget inflows, outflows, and change in storage.

Historical basin-wide changes of groundwater in storage average 1,100 acre-feet per year (AFY), most of which are losses from the Lompico aquifer in the Mount Hermon / South Scotts Valley area implementation.

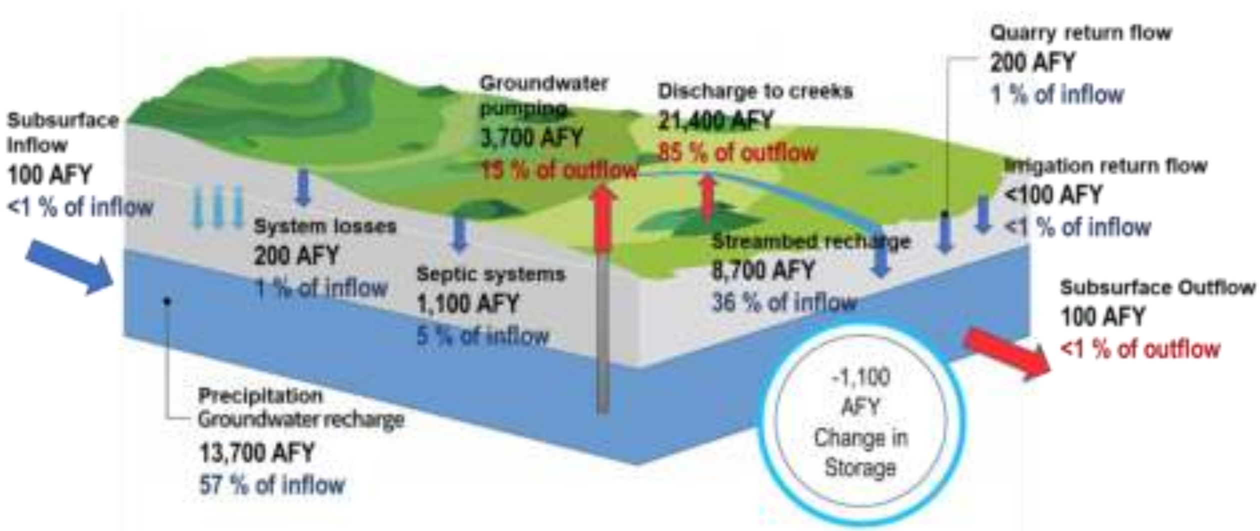

Figure ES- 2. Historical Groundwater Budget

Notable differences between the current (2010 – 2018) and historical groundwater budgets are reduced precipitation recharge due to less than average rainfall and reduced groundwater pumping from improved water efficiency and other efforts. This has resulted in about 1,000 AFY less groundwater lost from storage compared to the historical period.

Primary changes to the projected groundwater budget in comparison to the historical and current budgets are reduced precipitation recharge and increased year-to-year climate variability. With groundwater extractions similar to current volumes and without additional projects and management actions, it is projected that the Basin will experience an average annual loss of groundwater in storage of 500 AFY, which is less than historical losses and slightly more than current losses.

The table below shows the sustainable yield of the Basin by aquifer and compared to past use. This is an estimated volume of groundwater that can be pumped on a long-term average annual basis without causing undesirable results.

Table ES-1. Basin Sustainable Yield

Aquifer	Historical Pumping 1985 – 2018 (AFY)	Current Pumping 2010 – 2018 (AFY)	Sustainable Yield (AFY)
Santa Margarita	1,070	770	850
Monterey	320	180	140
Lompico	1,770	1,520	1,290
Butano	530	480	540

3 Sustainable Management Criteria

Developing Sustainable Management Criteria (SMC) as metrics of groundwater sustainability is a requirement of the SGMA. Of the 6 indicators of sustainability, 4 apply to the Basin: chronic lowering of groundwater levels, reduction of groundwater in storage, degraded water quality, and depletion of interconnected surface water. Land subsidence and seawater intrusion are not applicable.

Locally defined, quantitative SMC define what constitutes sustainable groundwater conditions in the Basin and commit the SMGWA to actions to achieve those conditions by 2042. SMC were developed using best available information and science, direction provided by the SMGWA Board, public feedback, and input from cooperating agencies and a surface water Technical Advisory Group.

There are known data deficiencies in the hydrogeologic conceptual model related to parts of the Basin and aquifers that do not have monitoring wells, including areas of private domestic pumping and interconnected surface water. The SMC in this GSP are likely to be reevaluated and potentially modified in the future as new data and monitoring features are developed.

The SMGWA developed Sustainability Goals discussed in Section 3.1 and identified undesirable results, minimum thresholds, measurable objectives, and interim milestones for each of the applicable sustainability indicators. The details of the metrics are covered in Sections 3.4 through 3.7. SMC are assigned to a subset of the existing monitoring network called representative monitoring points. A summary of the management goals for the Basin's 4 applicable sustainability indicators is provided below.

Chronic Lowering of Groundwater Levels: Do not allow groundwater levels to decline to levels that materially impair groundwater supply, negatively impact beneficial uses, or cause undue financial burden to a significant number of beneficial users.

Reduction of Groundwater in Storage: Maintain groundwater extraction so that other sustainability indicators are not negatively affected.

Degradation of Groundwater Quality: By implementing the GSP, maintain groundwater quality so that State drinking water standards for chemical constituents of concern are not exceeded, with the exception of nitrate (as N) which must be less than half the regulatory standard.

Depletion of Interconnected Surface Water: For interconnected surface waters, ensure that groundwater use or projects or management actions do not adversely impact the sustainability of GDEs or selected priority species or cause undue financial burden to beneficial users of surface water.

The SMGWA will use existing monitoring networks, supplemented with additional new monitoring wells to fill data gap areas, for annual assessments and reporting of groundwater levels, groundwater quality, groundwater and surface water use, precipitation, and streamflow. Data collected will be used to monitor progress towards sustainability during GSP implementation. Details on the Basin's GSP monitoring network are provided in Section 3.3.

Historical and future data collected by the monitoring network will be stored in a regional Data Management System (DMS) that will facilitate a centralized source of data when the GSP's annual reports are prepared.

4 Projects and Management Actions

Section 4 of the GSP describes potential projects and management actions that may be implemented to achieve the Basin's sustainability goal. Projects and management actions discussed in this section are in varying stages of development.

Several projects have the added benefit of creating supplemental drought supply to improve water supply reliability for the City of Santa Cruz, SLVWD, and SVWD. Some projects will benefit groundwater levels in aquifers pumped by *de minimis* groundwater users. Projects are grouped based on where the water resources are sourced and the type of water.

Baseline Projects and Management Actions (Group 1): Projects and management actions considered existing commitments by cooperating agencies and are currently being implemented. They are expected to continue, as needed, throughout GSP implementation. These projects and management actions do not achieve sustainability on their own. Group 1 projects include:

- Water use efficiency programs
- SVWD low-impact development
- SLVWD conjunctive use
- SVWD recycled water use

Projects and Management Actions Using Existing Water Sources Within the Basin (Group 2, Tier 1): Projects representing current thinking regarding the Basin's best option for reaching sustainability. Projects and management actions rely on existing water sources within the Basin and include expansion of some of the Group 1 baseline projects. Group 2, Tier 1 projects include:

- SLVWD and SVWD additional water use efficiency
- SLVWD existing infrastructure expanded conjunctive use (Phase 1)
- SLVWD and SVWD inter-district conjunctive use with Loch Lomond (Phase 2)
- SLVWD Olympia groundwater replenishment

Projects and Management Actions Using Surface Water Sources Outside the Basin (Group 2, Tier 2): Projects that rely on surface water sources outside of the Basin. Group 2, Tier projects include:

- Transfer of inter-district conjunctive use
- Aquifer storage and recovery in the Scotts Valley area

Projects and Management Actions Using Purified Wastewater Sources (Group 2, Tier 3): Projects that recharge purified wastewater in the Basin. Potential projects include:

- Purified wastewater recharge of 710 to 1,500 AFY in the Scotts Valley area with wastewater treated at Soquel Creek Water District's Chanticleer Advanced Water Purification Facility
- Purified wastewater recharge of 3,500 AFY in the Scotts Valley area with wastewater treated at a new facility within the Basin
- Purified wastewater augmentation at Loch Lomond.

Identified Projects and Management Actions Requiring Future Evaluation (Group 3): New projects or extensions of existing projects that need feasibility analysis. If Group 2 projects are deemed unfeasible or projected outcomes change, SMGWA may look to Group 3 projects to meet SMGWA sustainability goals. Group 3 projects include:

- Public/private stormwater recharge and low-impact development
- Enhanced Santa Margarita aquifer conjunctive use
- SLVWD Quail Hollow pumping redistribution
- Santa Margarita aquifer private pumpers connected to public water system
- Direct potable reuse
- Water use restrictions
- Scotts Valley non-potable / potable reuse

Not all projects and actions are needed to attain sustainability, but they provide possible options in the event that backup projects are needed. Importantly, the listed projects are not developed enough for SMGWA cooperating agencies to fully commit to any projects prior to submission of the GSP to DWR in January 2022. Project development will be led by cooperating agencies. For projects with multi-stakeholder benefits, cooperating agencies will work in coordination with one another.

Measures that the SMGWA member agencies will take to achieve Basin sustainability are focused on increasing Lompico aquifer groundwater levels in the Mount Hermon / South Scotts Valley area. The most immediate action will be to expand conjunctive use of surface water and groundwater using existing infrastructure. It is likely that this measure will be followed by development of infrastructure to gain access to SLVWD's entitlement of 313 AFY of Loch Lomond water for further conjunctive use opportunities. Combining the 2 projects would potentially provide for a long-term average of 540 AFY of in-lieu recharge by SLVWD and SVWD resting their extraction wells during the wet seasons when surface water is available for conjunctive use. Groundwater modeling has demonstrated the combined projects will raise Mount Hermon / South Scotts Valley area Lompico aquifer groundwater levels by 20 to 50 feet. The anticipated increases in groundwater levels from 540 AFY of conjunctive use enables the SMGWA to meet its long-term measurable objectives for chronic lowering of groundwater levels, depletion of interconnected surface water, and reduction of groundwater in storage, while having no impact on groundwater quality.

Costs associated with the project infrastructure would be funded through a combination of increased operating revenue and outside funding sources. Potential outside funding sources could include Integrated Regional Water Management Grant Programs, Sustainable Groundwater Management Grant Program, State Revolving Fund low interest loans, U.S. Department of Agriculture grants and/or low interest loans, or U.S. Bureau of Reclamation Drought Resiliency and/or Title XVI Recycled Water.

5 Groundwater Sustainability Plan Implementation

Over the next 5 years, the estimated cost to implement the GSP is $1,967,900, or $393,580 annualized over 5 years. The estimated budget by GSP implementation activity can be found in Section 5, Table 5-1. The budget's major cost categories include:

- Administration and business operations
- GSP management and coordination
- Monitoring and GSP reporting (annual and 5-year update reports)
- Maintaining the data management system (DMS)

Monitoring, regulatory reporting, filling data gaps, and maintaining the DMS accounts for roughly half the budget. The remaining budget covers activities associated with supporting SMGWA governance and management.

The GSP implementation budget does not include the cost of evaluating, planning, designing, and constructing a project(s) to achieve groundwater sustainability. Individual cooperating agencies will cover their respective costs of these activities because the SMGWA will not serve as the lead agency for implementing projects and management actions. Project costs may be shared between multiple agencies if the project provides greater water supply reliability and resiliency benefit to multiple agencies. Regional collaboration to achieve both basin sustainability and increase regional water supply reliability and resiliency is encouraged by the SMGWA.

Costs associated with new project infrastructure may be funded through a combination of increased operating revenue and outside funding sources. Potential outside funding sources could include IRWM Grant Programs, Sustainable Groundwater Management Grant Program, State Revolving Fund low interest loans, USDA grants and/or low interest loans, or USBR Drought Resiliency and/or Title XVI Recycled Water.

The SMGWA is funded by its member agencies through annual contributions based on a cost sharing agreement. The cost allocation is currently established at 60% to SVWD, 30% to SLVWD, and 10% to the County of Santa Cruz; the cost allocation is subject to change. SMGWA's approach to meeting GSP implementation costs is considered in two phases. In the GSP Implementation Phase 1 (2022 – 2027) funding is anticipated to be obtained from annual contributions from the SMGWA member agencies. Contribution amounts will be assessed based upon the SMGWA's annual budgetary requirements and equitable cost share rationale between the member agencies. The SMGWA will continue to pursue funding opportunities from state and federal sources to support GSP implementation activities.

The approach for meeting GSP implementation costs after 2027 will be evaluated as GSP implementation proceeds. As authorized under Chapter 8 of the SGMA, a GSA may impose fees, including, but not limited to, permit fees and fees on groundwater extraction or other regulated activity, to fund the costs including groundwater sustainability planning and program activities and administration.

SANTA MARGARITA
Groundwater Agency

Public Review Draft

Section 1. Introduction

Santa Margarita Basin
Groundwater Sustainability Plan

July 23, 2021

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Acronyms & Abbreviations

AFY................acre-feet per year
DMS...............data management system
DWR..............California Department of Water Resources
GSA................Groundwater Sustainability Agency
GSP................Groundwater Sustainability Plan
JPA.................Joint Powers Agreement
MHA..............Mount Hermon Association
SGMA...........Sustainable Groundwater Management Act
SLVWD.........San Lorenzo Valley Water District
SMC...............sustainability management criteria
SMGWA........Santa Margarita Groundwater Agency
SVWD............Scotts Valley Water District

1 INTRODUCTION

1.1 Purpose of the Groundwater Sustainability Plan

In 2014, the State of California enacted the Sustainable Groundwater Management Act (SGMA). This act requires groundwater basins in California that are designated as medium- or high-priority be managed sustainably over at least a 50-year planning and implementation horizon. Satisfying the requirements of the SGMA generally requires 4 basic activities:

1. Forming one or multiple Groundwater Sustainability Agency(s) (GSAs) to fully cover a basin;
2. Developing one or multiple Groundwater Sustainability Plan(s) (GSPs) that fully cover the basin;
3. Implementing the GSP and managing the basin according to the GSP to achieve quantifiable objectives; and
4. Regular reporting of groundwater conditions and progress towards sustainability to the California Department of Water Resources (DWR).

This document fulfills the Groundwater Sustainability Plan (GSP, or Plan) requirement for the Santa Margarita Basin (Basin) categorized as a medium-priority basin. The GSP describes the Basin's physical attributes related to groundwater, surface water, and land use; develops quantifiable management objectives that take into account interests of the Basin's beneficial groundwater uses and users; and identifies a group of projects and management actions that will allow the Basin to achieve sustainability within 20 years of Plan adoption (2042), and to maintain sustainability for an additional 30 years beyond 2042.

The GSP was developed specifically to comply with SGMA's statutory and regulatory requirements. As such, the GSP uses terminology used in these requirements (see Water Code Section 10721 and 23 CCR Section 351) which is oftentimes different from the terminology used in other contexts (e.g. past reports or studies, past analyses, judicial rules or findings). Definitions used in this GSP, including those from SGMA statutes and regulations are included in Appendix 1A for reference.

1.2 Sustainability Goals

The GSP requires that the Santa Margarita Basin Groundwater Agency (SMGWA) establish a sustainability goal that culminates in the absence of undesirable results within 20 years of the applicable statutory deadline. The 20-year deadline to achieve the sustainability goal in the Santa Margarita Basin is January 2042.

Sustainability goals were discussed by the SMGWA Board at Board meetings at several Board meetings. Contributions from Board directors, agency staff, and the public resulted in the following sustainability goals.

The goals of the SMGWA are to:

- Implement the Sustainable Groundwater Management Act (SGMA), which requires the management and use of groundwater in the Basin in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.
- Provide a safe and reliable groundwater supply that meets the current and future needs of beneficial users.
- Support groundwater sustainability measures and projects which enhance a sustainable and reliable groundwater supply in the Basin, utilizing integrated water management principles by:
  - Safeguarding water supply availability for public health and welfare
  - Maintaining and enhancing groundwater availability for municipal, private, and industrial users and uses
  - Maintaining and enhancing groundwater contributions to streamflow, where beneficial users are dependent upon such contributions (fish, frogs, salamanders, dragonflies etc.)
  - Maintaining and enhancing groundwater levels that support groundwater dependent ecosystems
  - Maintaining and enhancing groundwater quality for existing and future beneficial uses
- Provide for operational flexibility within the Basin by supporting a drought reserve that considers future climate change
- Plan and implement projects and activities to achieve sustainability that are cost effective and do not place undue financial hardship on the SMGWA, its member agencies, or basin stakeholders. A cost-benefit analysis, taking into consideration financial, social,

environmental, and adverse consequences, may be conducted to evaluate whether a project or activity results in undue financial hardship.

Measures that the SMGWA member agencies will take to achieve Basin sustainability are focused on increasing Lompico aquifer groundwater levels in the Mount Hermon / south Scotts Valley area. The most immediate action will be to expand conjunctive use of surface water and groundwater using existing infrastructure. It is likely that this measure will be followed by development of infrastructure to gain access to San Lorenzo Valley Water District's (SLVWD) entitlement of 313 acre-feet per year (AFY) of Loch Lomond water for further conjunctive use opportunities. Combining the 2 projects would potentially provide for a long-term average of 540 AFY of in-lieu recharge by SLVWD and Scotts Valley Water District (SVWD) resting their extraction wells during the wet seasons when surface water is available for conjunctive use. Groundwater modeling has demonstrated the combined projects will raise Mount Hermon / south Scotts Valley area Lompico aquifer groundwater levels by 20 to 50 feet and Monterey Formation levels by 20 feet. Additionally, resting SVWD wells extracting from the Butano aquifer may raise Butano aquifer groundwater levels by 20 to 50 feet in the central to northern Scotts Valley areas. The anticipated increases in groundwater levels from 540 AFY of conjunctive use enables the SMGWA to meet its long-term measurable objectives for chronic lowering of groundwater levels, depletion of interconnected surface water, and reduction of groundwater in storage, while having no impact on groundwater quality.

Larger, more costly projects using either treated surface water or purified wastewater imported from outside the Basin, as described in Section 4, will be evaluated during the first 5 years of GSP implementation. The larger projects will provide cooperating agencies additional water supply resiliency and drought protection, beyond the level likely needed for sustainable management of groundwater in the Basin.

1.3 Agency Information

The Santa Margarita Basin GSP has been developed by one exclusive GSA, the Santa Margarita Groundwater Agency (SMGWA).

1.3.1 Organization and Management Structure of the Santa Margarita Groundwater Agency

The SMGWA was formed through a Joint Powers Agreement (JPA) in June 2017 among the SVWD, SLVWD, and the County of Santa Cruz (County). SLVWD uses both local surface water and groundwater resources to supply potable water to their customers, while SVWD relies only on groundwater resources. The County of Santa Cruz regulates land use, issues well permits, oversees small public water systems, and conducts various watershed management efforts in the Basin.

The SMGWA is governed by a Board of Directors comprising 2 representatives from each member agency, 1 representative from the City of Scotts Valley, 1 from the City of Santa Cruz, 1 from Mount Hermon Association (MHA), and 2 private well owner representatives. There are a total of 11 directors.

Each member agency has one alternate to act as a substitute director. One alternate acts as a substitute director for the 2 directors representing private well owners, and 1 alternate for each entity acts as a substitute director for the City of Scotts Valley, City of Santa Cruz and MHA. Alternate directors have no vote, and do not participate in any discussions or deliberations of the Board unless appearing as a substitute for a director due to absence or conflict of interest.

There are no dedicated SMGWA staff. All staffing support and funding for the SMGWA is provided by its 3 member agencies. Although not a member agency, the City of Santa Cruz provides staff support to the SMGWA because it obtains approximately 69% of its water supply from the San Lorenzo River watershed which covers almost the entire groundwater basin.

Ms. Piret Harmon is the authorized representative for the SMGWA. Her contact information is listed below:

Ms. Piret Harmon
General Manager
Scotts Valley Water District
2 Civic Center Drive
Scotts Valley, CA 95066
Phone: (831) 600-1902
Email: pharmon@svwd.org

1.3.2 Legal Authority of the Santa Margarita Groundwater Agency

Figure 1-1 shows the extent of the Santa Margarita Basin. This GSP covers the entire Basin area for which the SMGWA is the exclusive GSA. No portion of the Basin is covered by a non-exclusive GSA. Therefore, the SMGWA provides the sole legal authority to implement this GSP throughout the entire Plan area and no authority is needed from any other GSA to implement the GSP.

The SMGWA has legal authority to perform duties, exercise powers, and accept responsibility for managing groundwater sustainably within the Santa Margarita Basin. Legal authority comes from the SGMA, the JPA signed by SMGWA member agencies effective on June 1, 2017, and JPA Bylaws. The JPA is included as Appendix 1B. These laws and agreements, taken together, provide the necessary legal authority for the SMGWA Board of Directors to carry out the preparation and implementation of the Basin's GSP.

1.3.3 Santa Margarita Groundwater Agency Guiding Principles

Prior to starting GSP development, the SMGWA Board conducted a joint goal setting process that allowed them to establish a solid foundation for the planning work required during the GSP development. The process was facilitated by Dave Ceppos, a Managing Senior Mediator at California State University Sacramento, College of Continuing Education, Consensus and Collaboration Program. Mr. Ceppos conducted background reviews, conducted a situation assessment presenting the report to the Board at its July 2018 meeting.

The Board formed a Facilitation Committee to work with the facilitator in designing and implementing a joint goal setting process. The Facilitation Committee met several times reviewing the recommendations from the assessment report, preparing guiding principles and determining the appropriate timeline for necessary activities. Collectively they developed a proposed "Santa Margarita Groundwater Agency (SMGWA) Guiding Principles" document (Guiding Principles) that was approved at the November 2018 Board meeting, and then amended at the December 2018 Board meeting. The final Guiding Principles are included as Appendix 1C to this GSP.

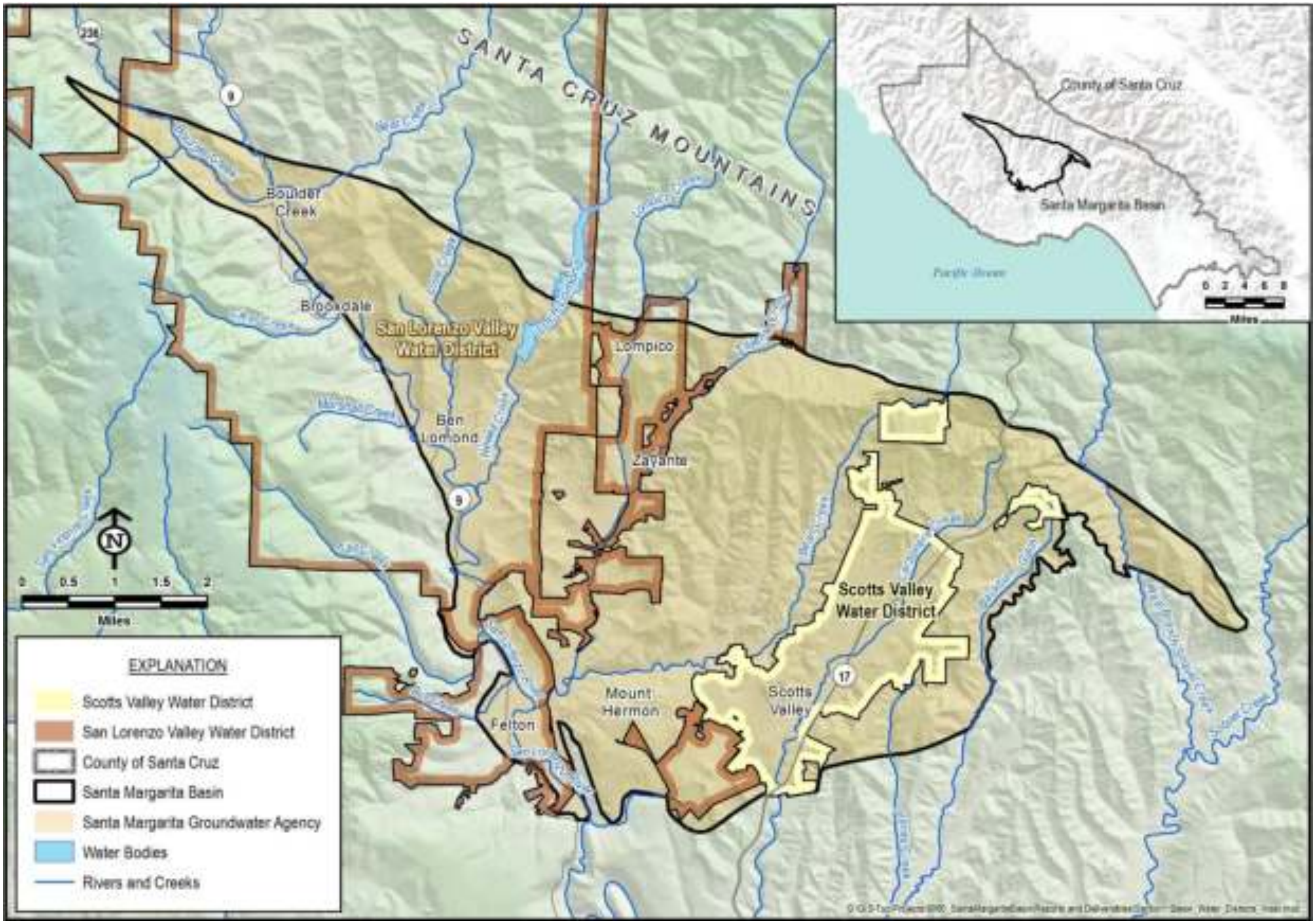

Figure 1-1. Extent of SMGWA GSP Plan Area with Member Agency Boundaries

Development of the Guiding Principles marked a major milestone for the SMGWA. They define a set of mutual core values and commitments that the current Board and future Boards will focus their efforts towards. The Guiding Principles add to the SMGWA's other documents, including the agency's Joint Powers Agreement (Appendix 1B) and Bylaws, that define how the Agency does and will function. As used by other organizations and agencies, Guiding Principles (and similar) are an important and applied tool that guides the work of a governing body. Amongst many uses, the SMGWA Guiding Principles can:

- Be provided to the Basin Beneficial Users as a written description of key interests and a commitment/pledge by the Board as to how it will implement SGMA.
- Be used by all Board members to regularly assess the direction of discussions and potential Board decisions and to ensure that said discussions and decisions are consistent with these Guiding Principles.

1.3.4 Estimated Cost of Implementing the GSP and the Santa Margarita Groundwater Agency's Approach to Meet Costs

Over the next 5 years, the estimated cost to implement the GSP is $1,967,900. The annualized cost over those 5 years is $393,580. The estimated budget by GSP implementation activity can be found in Section 5, Table 5-1.

The estimated cost of implementing the GSP is presented by category identified below but also includes maintaining a prudent fiscal reserve and other miscellaneous costs. The budget's major cost categories include:

- Administration and business operations
- GSP management and coordination
- Monitoring and GSP reporting (annual and 5-year reports)
- Maintaining the data management system (DMS)

Monitoring, regulatory reporting, filling data gaps, and maintaining the DMS accounts for roughly half the budget. The remaining budget covers activities associated with supporting SMGWA governance and management.

The GSP implementation budget does not include the cost of evaluating, planning, designing, and constructing a project(s) to achieve groundwater sustainability. As discussed in Sections 4 and 5, individual member and cooperating agencies will cover their respective costs of these activities because the SMGWA will not serve as the lead agency for implementing projects and management actions. Project costs may be shared between multiple agencies if the project provides greater water supply reliability and resiliency benefit to multiple agencies. Regional collaboration to achieve both basin sustainability and increase regional water supply reliability and resiliency is encouraged by the SMGWA.

Costs associated with new project infrastructure may be funded through a combination of increased operating revenue and outside funding sources. Potential outside funding sources could include IRWM Grant Programs, Sustainable Groundwater Management Grant Program, State Revolving Fund low interest loans, USDA grants and/or low interest loans, or USBR Drought Resiliency and/or Title XVI Recycled Water.

The SMGWA is funded by its member agencies through annual contributions based on a cost sharing agreement. The cost allocation is currently established at 60% to SVWD, 30% to SLVWD, and 10% to the County of Santa Cruz; the cost allocation is subject to change. SMGWA's approach to meeting GSP implementation costs is considered in two phases. In the GSP Implementation Phase 1 (2022 – 2027) funding is anticipated to be obtained from annual contributions from the SMGWA member agencies. Contribution amounts will be assessed based upon the SMGWA's annual budgetary requirements and equitable cost share rationale between the member agencies. The SMGWA will continue to pursue funding opportunities from state and federal sources to support GSP implementation activities.

The approach to meeting the GSP implementation costs after 2027 will be evaluated as GSP implementation proceeds. As authorized under Chapter 8 of the SGMA, a GSA may impose fees, including, but not limited to, permit fees and fees on groundwater extraction or other regulated activity, to fund the costs including groundwater sustainability planning and program activities and administration. The SMGWA will further evaluate the funding mechanisms, the potential application of fees and the fee criteria for non-*de minimis* and *de minimis* users alike.

1.4 GSP Organization

1.4.1 Groundwater Sustainability Plan Organization

The SMGWA's GSP is organized based upon the DWR's GSP Annotated Outline with additional information to address content requirements found in the *Preparation Checklist for GSP Submittal* (DWR, 2016).

The GSP is organized as follows:

Executive Summary

The executive summary presents an overview of the overall GSP, background information on the groundwater conditions in the Basin, an overview the GSP development process, and key information from each of the five GSP sections.

Section 1. Introduction

This first section presents the purpose of the GSP, the Basin's Sustainably Goal, information about the SMGWA, and organization of the GSP.

Section 2. Plan Area and Basin Setting

This section describes the Santa Margarita Groundwater Basin's physical attributes related to groundwater, surface water, and land use. Historical and current Basin groundwater conditions and groundwater management are described together with the Basin's historical and current water budget. In addition to historical and current water budgets, projected water budgets covering the 50-year period planning horizon with and without projects and management actions are included to estimate future conditions of supply, demand, and aquifer response to Plan implementation. This section provides the background information needed to develop the technical aspects of Section 3: Sustainable Management Criteria and Section 4: Projects and Management Actions to Achieve Sustainability Goal.

Section 3. Sustainable Management Criteria

This section presents the Basin's sustainability goal and provides the management criteria, for the Basin's applicable sustainability indicators, by which to measure the Basin's sustainability. This section also describes the monitoring networks used to assess groundwater levels, groundwater quality, and interconnected surface water.

Section 4. Projects and Management Actions

This section provides a description of projects and management actions necessary to achieve the Basin's sustainability goal while being responsive to projected changes in future water demand and climate change. Projects and management actions are specifically developed to address sustainability goals and sustainable management criteria from Section 3.

Section 5. Plan Implementation

This final section of the GSP provides an estimate of GSP implementation costs, its implementation schedule, and outlines of the procedural and substantive requirements for annual and periodic (5-year) GSP evaluations.

1.4.2 Preparation Checklist for GSP Submittal

This GSP must be submitted online to DWR by January 31, 2022. The DWR online submittal process includes an Elements Guide where each statutory requirement in the GSP regulations is linked to the relevant page number and section in this GSP. Access to the checklist and GSP can be found at: https://sgma.water.ca.gov/portal/gsp/status.

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Section 2. Plan Area and Basin Setting

Santa Margarita Basin
Groundwater Sustainability Plan

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ACRONYMS & ABBREVIATIONS

1,2-DCA.........1,2-dichlorothane
AB..................Assembly Bill
AF..................acre foot/acre feet
AFY...............acre foot/feet per year
AMI...............Advanced Metering Infrastructure
amsl...............above mean sea level
ASHCP...........Anadromous Salmonid Habitat Conservation Plan
Basin Plan ......Water Quality Control Plan, Central Coast Region
bgs..................below ground surface
BMOs............Basin Management Objectives
BMPs.............Best Management Practices
cfs...................cubic feet per second
CALEPA........California Environmental Protection Agency
CASGEM.......California Statewide Groundwater Elevation Monitoring
CCR...............Consumer Confidence Report
CCRWQCB....Central Coast Regional Water Quality Control Board
CDFW...........California Department of Fish and Wildlife
CECs.............Contaminants of Emerging Concern
CGPS.............Continuous Global Positioning Station
CISDCE cis-1,2-dichloroethene
COC..............constituent of concern
CWC.............California Water Code
DAC..............disadvantaged communities
DDW.............State Water Resources Control Board Division of Drinking Water
DEA..............diethanolamine
DoD...............Department of Defense
DTSC............Department of Toxic Substances Control
DWR.............California Department of Water Resources
DWSAP.........Drinking Water Source Assessment and Protection
SCEH............County of Santa Cruz Environmental Health Services Agency
EIR................Environmental Impact Report
GAC..............granular activated carbon
GDEs.............groundwater dependent ecosystems
GIS................Geographic Information System
GPCD............gallons per capita per day
GSP...............Groundwater Sustainability Plan
GWMP..........Groundwater Management Plan
HCM.............hydrogeologic conceptual model

HCP................Habitat Conservation Plan
InSAR ....Interferometric Synthetic Aperture Data
ITP.................Incidental Take Permit
JPA................Joint Powers Agreement
LAMP ....Local Area Management Plan
LID................low impact development
LUST.............leaking underground storage tank
MCL..............maximum contaminant levels
MHA ....Mount Hermon Association
MTBE ....methyl tertiary-butyl ether
N....................nitrogen
NMFS............National Marine Fisheries Service
NO_3 ....nitrate
OWTS ....onsite wastewater treatment systems
PCE ....tetrachloroethene
Qal.................alluvium
Qt...................terrace deposits
SCWD...........Santa Cruz Water Department
SLVWD ....San Lorenzo Valley Water District
SMGWA ....Santa Margarita Groundwater Agency
SMGWBAC...Santa Margarita Groundwater Basin Advisory Committee
SqCWD..........Soquel Creek Water District
SVWD...........Scotts Valley Water District
SWRCB..........State Water Resources Control Board
SWS ....Small Water System
Tbl.................Lower Butano Sandstone
Tbm...............Middle Butano Sandstone
Tbu................Upper Butano Sandstone
TCE................trichloroethene
TDS................total dissolved solids
Tl...................Locatelli Formation
Tlo.................Lompico Sandstone
Tm.................Monterey Formation
TMDL ....Total Maximum Daily Load
TNC...............The Nature Conservancy
Tp..................Purisima Formation
Tsc.................Santa Cruz Mudstone
Tsm ....Santa Margarita Sandstone
UCMR............Unregulated Contaminant Monitoring Rule
USDA............U.S. Department of Agriculture

USEPA..........United States Environmental Protection Agency
USFWS..........United States Fish and Wildlife Service
USGS............United States Geological Survey
UWMP..........Urban Water Management Plan
VC.................vinyl chloride
VOCs.............volatile organic compounds
WAAP...........Wasteload Allocation Attainment Program
WHO.............World Health Organization
WRF..............Water Reclamation Facility
WY................Water Year

2 PLAN AREA AND BASIN SETTING

2.1 Description of the Plan Area

2.1.1 Summary of Jurisdictional Areas and Other Features

2.1.1.1 Area Covered by the GSP

This GSP covers the entire Santa Margarita Basin (DWR Basin 3-027) as defined in DWR Bulletin 118 (DWR, 2016b). The Basin is located at the northern end of the Central Coast hydrologic region. The area of the Basin is 34.8 square miles (22,249 acres). To the south and southeast of the Basin is the Santa Cruz Mid-County Basin, and to the south is the West Santa Cruz Terrace Basin. The Santa Margarita Basin includes the City of Scotts Valley, and the communities of Boulder Creek, Brookdale, Ben Lomond, Lompico, Zayante, Felton, and Mount Hermon. The Santa Margarita Basin's neighboring basins are shown on Figure 2-1. Based on 2010 census block data, the population of the Basin is approximately 29,000 (U.S. Census Bureau, 2010).

2.1.1.2 Adjudicated Areas

There are no adjudicated areas within the Basin.

2.1.1.3 Alternative Groundwater Sustainability Plans

There are no areas within the Basin covered by Alternative GSPs.

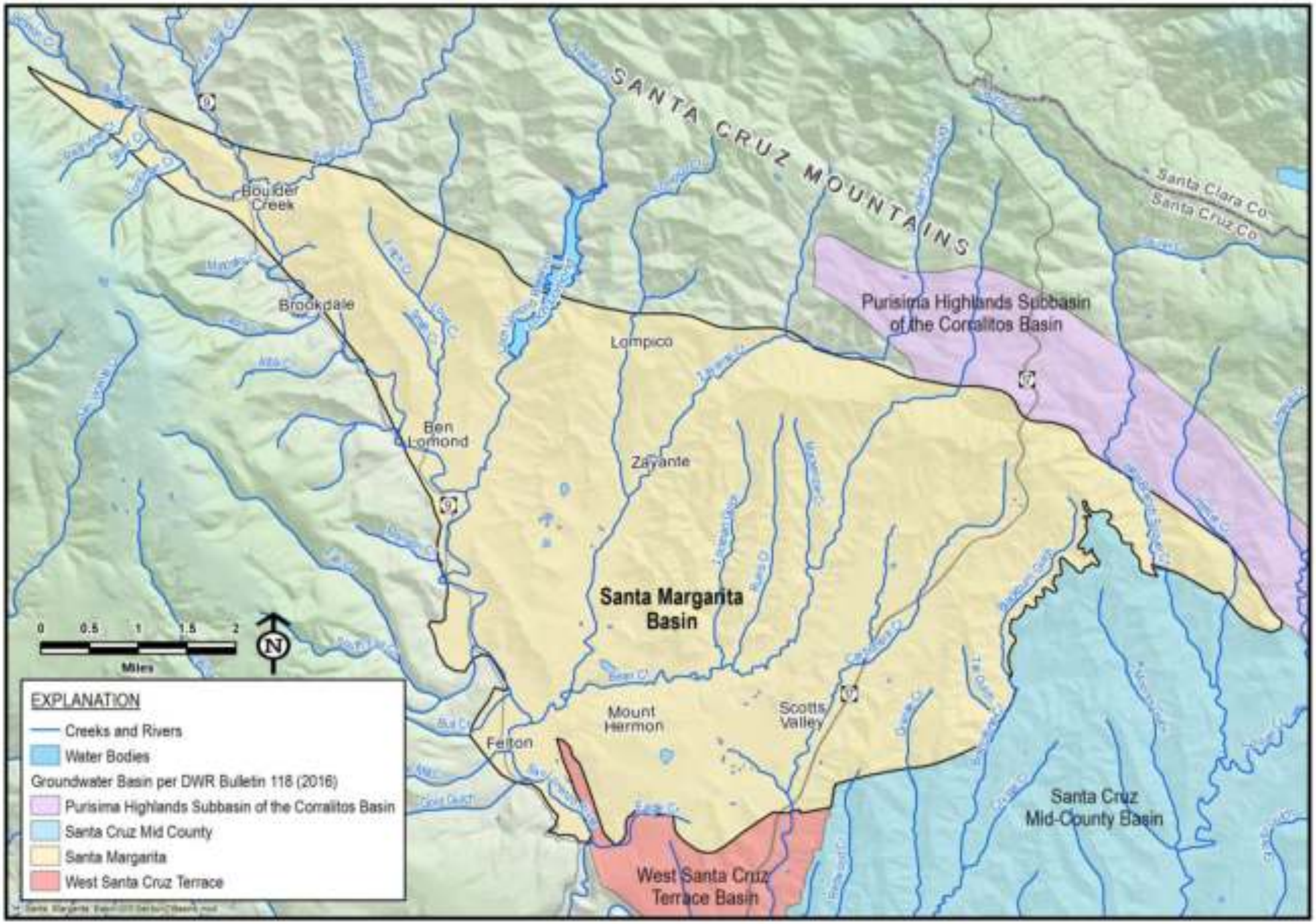


Figure 2-1. Groundwater Basins Adjacent to the Santa Margarita Basin

2.1.1.4 Jurisdictional Areas

2.1.1.4.1 County of Santa Cruz

The Basin is completely within the County of Santa Cruz (County) as shown on the inset map of Figure 2-2. Jurisdictional Areas within the Santa Margarita Basin. The County was founded in 1850 as 1 of the 27 original California counties at the time of statehood. The County has a total area of 607 square miles (388,480 acres), 445 square miles of which is land area (73%) and the remaining 162 square miles is water (27%) (US Census, 2010). The County has land use jurisdiction for all unincorporated areas outside of the City of Scotts Valley and is the largest agency with land use jurisdiction in the Basin. The population residing in the Basin's unincorporated areas is approximately 18,300 (California Department of Finance, 2020). Of the population in unincorporated areas, it is estimated that 5,300 people are within the jurisdictional area of 1 of the Basin's 2 water districts, but because there is no water service to those parcels, they rely on small water systems or private wells. The County is not a supplier of water but does permit and regulate private groundwater wells and small water systems that serve this population. The County of Santa Cruz Environmental Health Division (SCEH) of the County's Health Services Agency includes the Water Resources Program which participates in countywide planning and management efforts on a variety of water resource programs, including groundwater management, water quality, stormwater management, water conservation, fish (steelhead) monitoring, and watershed and stream habitat protection. The County is a member agency of the Santa Margarita Groundwater Agency (SMGWA).

2.1.1.4.2 Water Districts

2.1.1.4.2.1 San Lorenzo Valley Water District

The San Lorenzo Valley Water District (SLVWD) is a member agency of the SMGWA. SLVWD, established in 1941, supplies water to the communities of Boulder Creek, Brookdale, Lompico, Ben Lomond, Zayante, Mañana Woods and Felton, and to a portion of the City of Scotts Valley, through a network of over 185 miles of distribution lines, pump stations and reservoirs. SLVWD's jurisdictional boundaries encompass approximately 62 square miles (39,680 acres, Figure 2-3). Its current service area served by existing infrastructure in the Basin is approximately 5.6 square miles (3,885 acres, Figure 2-3). There are more than 7,900 connections that serve approximately 26,000 customers throughout its service area, some of which is outside of the Basin. The SLVWD serves approximately 13,000 customers in the Basin. Water used to supply customers in the Basin is from 3 sources within the Basin:

1. Stream diversions on tributaries to the San Lorenzo River. Currently, 4 of 9 diversion are active due to damage sustained to the other diversions in the CZU Lightning Complex wildfire in the summer of 2020. The estimated reconstruction timeframe for these damaged diversions is 2 to 4 years.
2. One groundwater spring

3. Seven active groundwater production wells

SLVWD owns, operates, and maintains 2 water systems:

1. The *San Lorenzo Valley System* is split into 2 sub-systems: north and south. The North San Lorenzo Valley System includes the unincorporated communities of Boulder Creek, Brookdale, Lompico (SLVWD annexed the Lompico County Water District in 2016), and Ben Lomond. Its source of water is surface water and groundwater. Part of the North San Lorenzo Valley System is outside of the Basin (Figure 2-3). The South San Lorenzo Valley System encompasses portions of the City of Scotts Valley and adjacent unincorporated neighborhoods. The Mañana Woods subdivision became part of the San Lorenzo Valley System as a result of the District's annexation of the Mañana Woods Mutual Water Company in July 2006. The southern portion of the system is supplied by groundwater pumped in the Pasatiempo area and through an emergency intertie with the northern portion of the system. SLVWD is pursuing efforts to utilize its emergency interties on a routine basis for conjunctive use and improved resiliency.

2. The *Felton System* was acquired by SLVWD from California American Water in September 2008 and includes the town of Felton and adjacent unincorporated areas. It was owned and operated by Citizen Utilities Company of California prior to 2002. The system is supplied by surface water and springs and covers an area of 2.9 square miles or 1,884 acres. Part of the Felton System is outside of the Santa Margarita Basin (Figure 2-3). The Felton System is connected to the San Lorenzo Valley System by an intertie that is only used at this time for emergencies.

2.1.1.4.2.2 Scotts Valley Water District

The Scotts Valley Water District (SVWD) is a public agency responsible for the management and supply of water to the Scotts Valley area (Figure 2-2). SVWD is a member agency of the SMGWA.

SVWD was formed under the County Water District Law, specifically California Water Code Section (CWC§) 30321 and received certification from the California Secretary of State in 1961. SVWD serves an area of about 5.5 square miles (3,520 acres, Figure 2-2) in northern Santa Cruz County, and is located approximately 5 miles inland from the Monterey Bay. It provides water to most of the incorporated area of the City of Scotts Valley and a portion of an unincorporated area north of the City. SVWD supplies potable water to approximately 10,700 customers through 4,300 service connections, excluding fire services. SVWD relies exclusively on groundwater from municipal wells for potable water supply, while supplementing non-potable demand with recycled water from the City of Scotts Valley Tertiary Treatment Plant. Non-potable recycled water is primarily used for landscape irrigation.

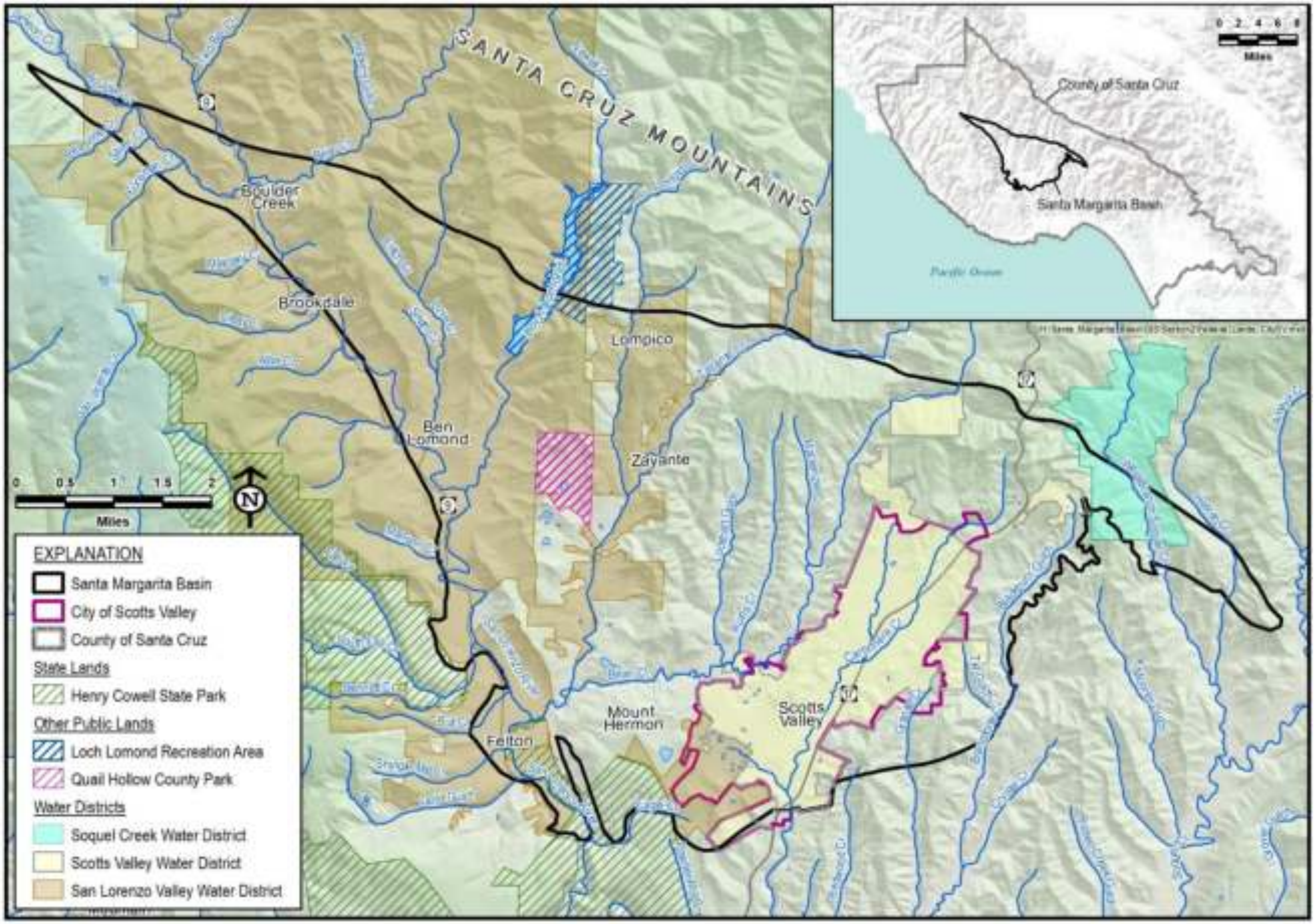


Figure 2-2. Jurisdictional Areas within the Santa Margarita Basin

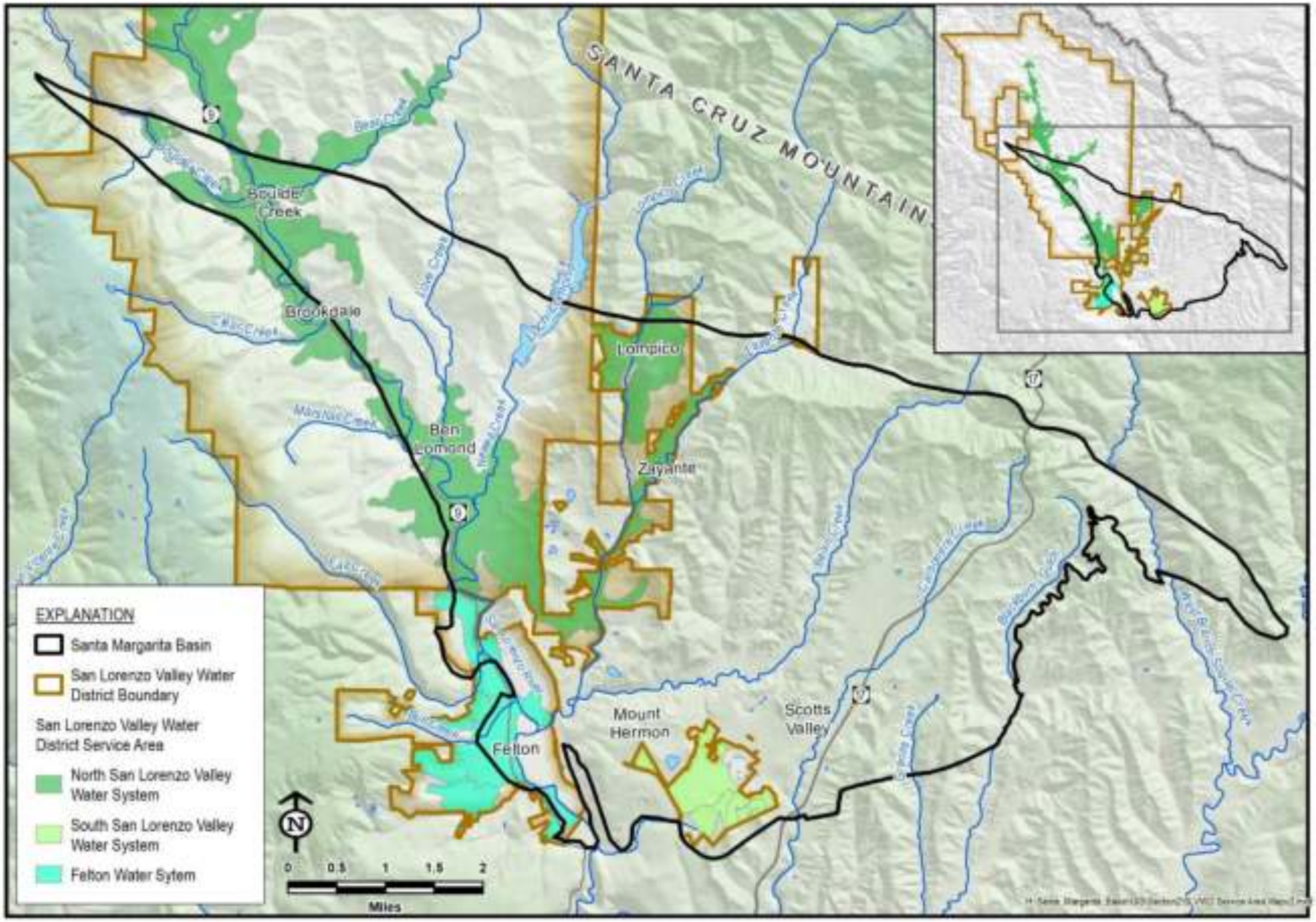


Figure 2-3. San Lorenzo Valley Water District Boundary and Water Systems

2.1.1.4.2.3 Soquel Creek Water District

The Soquel Creek Water District (SqCWD) extracts its water supply from aquifers within the neighboring Santa Cruz Mid-County Basin and does not have any active service area or extract groundwater in the Santa Margarita Basin. Figure 2-2 shows a small portion of the SqCWD within the northeastern part of the Basin. The jurisdictional area is a legacy of a now-abandoned plan to construct a reservoir on the West Branch of Soquel Creek.

2.1.1.4.3 City of Scotts Valley

The City of Scotts Valley is not a potable water supplier, but it is responsible for storm water and wastewater management. City of Scotts Valley residents and businesses are supplied potable water by SVWD and SLVWD (Figure 2-2). The City of Scotts Valley and SVWD Recycled Water Program is a cooperative effort to reuse treated wastewater. The City of Scotts Valley operates the Scotts Valley Water Reclamation Facility (WRF) and the Tertiary Treatment Plant which since 2002 has produced recycled water for its own use and for distribution by SVWD. The recycled water is non-potable and is used primarily for landscape irrigation and to a lesser extent for dust control. Effluent from the WRF that is not used in the Basin is transported through a land outfall to the City of Santa Cruz marine outfall in the Monterey Bay operated and maintained by the City of Santa Cruz Public Works Department.

2.1.1.4.4 Federal and State Lands

The only state managed land in the Basin is Henry Cowell State Park (Figure 2-2). There are no federal lands. The USGS National Map (USGS, 2019) show portions of the Loch Lomond Recreation Area and Quail Hollow County Park as state lands (Figure 2-2). They are however, managed by the City of Santa Cruz and County of Santa Cruz, respectively.

2.1.1.4.5 Tribal Lands

There are no federally designated tribal lands and no federally recognized tribes in the Basin. The Basin is located within a California Tribal and Cultural Area that historically belonged to a division of the Ohlone people known as the Awaswas. The Awaswas people inhabited the land from present-day Davenport to Aptos. Descendants of the Awaswas people are members of the Amah Mutsun Tribal Band. The Tribal Band is petitioning the federal government for tribal recognition and has formed the Amah Mutsun Land Trust to access, protect, and steward lands important to the tribe (Amah Mutsun, 2019).

2.1.1.5 City of Santa Cruz

The City of Santa Cruz has no service area in the Basin and is not a member agency of the SMGWA. However, the City is an indirect groundwater user in the Basin because the surface water it diverts from the San Lorenzo River for municipal use partially comprises baseflows supported by Basin groundwater discharge to creeks. The City owns property, which is partly located in the Basin, associated with water supply use and construction of the Loch Lomond Reservoir (Figure 2-2).

The San Lorenzo River and Loch Lomond Reservoir provide about 69% of the water supplied to approximately 95,000 City of Santa Cruz Water Department customers (City of Santa Cruz, 2016a). Surface water from Loch Lomond Reservoir is conveyed by the Newell Creek Pipeline to the Graham Hill Water Treatment Plant in the City of Santa Cruz. Surface water from the San Lorenzo River is diverted in 2 locations for use by the City of Santa Cruz. There is 1 diversion location in the Basin in Felton that is used to divert water upstream to the Loch Lomond Reservoir and 1 location downstream of the Basin that is used to divert water to the City treatment plant. Between 2006 and 2015, 14% of the City of Santa Cruz water supply was from Loch Lomond Reservoir and 55% was from the San Lorenzo River. Additional details are provided in Section 2.2.4.8 on surface water bodies in the Basin.

2.1.1.6 Existing Land Use Designations

Land use planning in the Basin is the responsibility of the County of Santa Cruz and the City of Scotts Valley. Boulder Creek, Felton, Lompico, and Ben Lomond are all census-designated areas within the county but are not incorporated towns. Current land use designations in the Basin are shown on Figure 2-4 and are summarized in Table 2-1 by major land use groups. The land use features on Figure 2-4 were developed by the County of Santa Cruz, in collaboration with the Cities of Capitola, Santa Cruz, Scotts Valley, and Watsonville, to aggregate individual land use designation datasets into a summarized single dataset for use in the July 2015 Wasteload Allocation Attainment Program (WAAP) for Watersheds in Santa Cruz County (County of Santa Cruz, 2016).

Table 2-1. Santa Margarita Basin Land Use Designation Summary

Land Use Category	Area		Relative Percent
	Acres	Square Miles	
Open Space/Undeveloped	10,117	15.8	45.5%
Rural Residential	5,755	9.0	25.9%
Suburban Residential	2,930	4.6	13.2%
Roads/Parking Lots/Utilities	1,491	2.3	6.7%
Camps/Church/Institutions	772	1.2	3.5%
Industrial/Sand Quarries	741	1.2	3.3%
Commercial	425	0.7	1.9%
Agriculture	18	0.03	0.1%
Total	**22,249**	**34.8**	**100%**

Just under half the Basin is identified as open space/undeveloped (Table 2-1). Open space includes areas for outdoor recreation, preservation of natural resources, or vacant lands. Rural residential land use is the next largest land use covering 5,755 acres of the Basin (25.9% of the Basin, Table 2-1). This land use consists primarily of single-family residential housing located outside of the suburban centers and typically between the tributaries of the San Lorenzo River. Suburban residential housing (13.2% of the Basin) occurs within the San Lorenzo Valley and south of Bean Creek. It includes the City of Scotts Valley, and the communities of Mount Hermon, Felton, Ben Lomond, Brookdale, Boulder Creek, Lompico, and Zayante (Figure 2-4). The Basin has several camps and conference centers which account for approximately 3.5% of land use.

Commercial land use is concentrated in the City of Scotts Valley and the community of Felton. Much of this development occurred during a period of population expansion between 1980 and 2000, which coincided with construction of commercial and industrial complexes. Three large sand quarries exist within the Basin area: Hanson (also known as Kaiser) Quarry, Olympia (also known as Lone Star) Quarry, and Quail Hollow Quarry. Hanson and Olympia Quarries ceased operations in the early 2000s and are currently undergoing restoration. Quail Hollow is still active.

Most irrigated areas in the Basin are in or near Scotts Valley, and consist of schools and large parks. Agriculture within the Basin is limited due to the steep and forested nature of the Basin, and relatively shallow soils. Currently, only approximately 0.1% of the Basin is zoned agricultural. There are a few very small wineries that cumulatively irrigate less than 2 acres. Currently, there are no official records of cannabis cultivation and water use in the Basin although there is speculation that it is occurring.

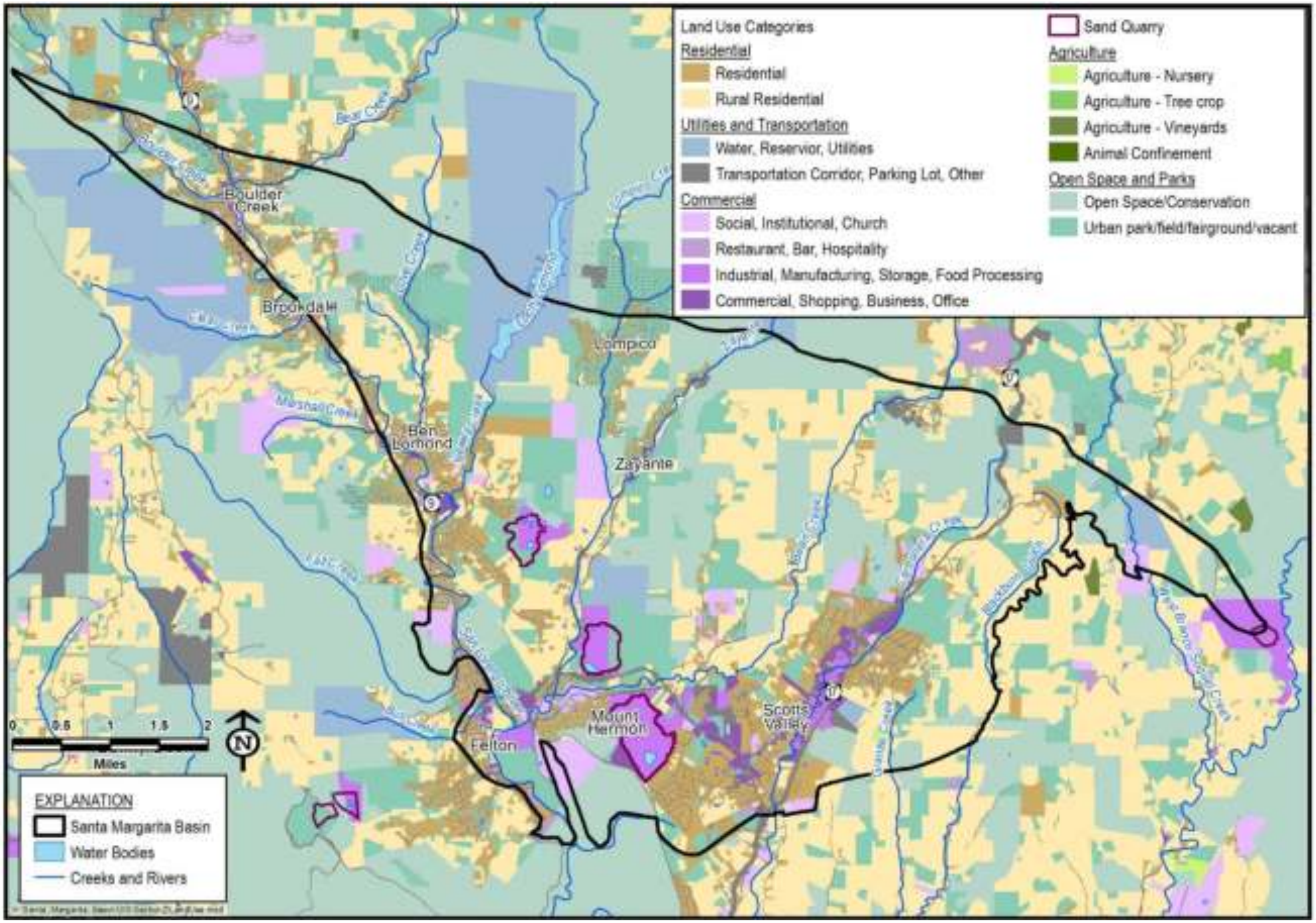


Figure 2-4. Land Use in the Santa Margarita Basin

2.1.2 Water Resources Monitoring and Management Programs

Groundwater resources in the Basin have been used as a shared resource for many decades and collaboratively managed for nearly 2 decades by local agencies. The SMGWA was preceded by a local advisory committee called the Santa Margarita Groundwater Basin Advisory Committee (SMGWBAC) that had some of the same functions and same member agencies as the SMGWA. The SMGWBAC was formed by a Memorandum of Understanding in 1995 by the SVWD, SLVWD, Mount Hermon Association, Lompico County Water District (merged with SLVWD in 2016), City of Scotts Valley and County of Santa Cruz. The SMGWBAC consisted of 1 representative and 1 alternate from each member agency. The committee met biannually and was actively involved in all facets of groundwater management of the Basin. In 2016, the SMGWBAC established a GSA Formation Committee, which led the effort of preparing a draft Joint Powers Agreement for the SMGWA. With the creation of the SMGWA, the SMGWBAC function became redundant and the committee was dissolved in 2017.

The SMGWA cooperating agencies have had active roles in groundwater resource management and monitoring in the Basin as members of the SMGWBAC and independently to support their water supply operations. The subsections that follow describe the cooperating agencies' groundwater elevations, groundwater extraction, groundwater quality, and surface water flow and quality management and monitoring programs. The purpose of these monitoring efforts is to responsibly manage the water resources relied upon for public water supply.

None of the existing water resources monitoring and management programs that use water within the Basin have triggers that limit operational flexibility with respect to groundwater or surface water use. However, the City of Santa Cruz, which diverts San Lorenzo River surface water at Felton to Loch Lomond Reservoir and at Tait Street (downstream of the Basin has explicit triggers related to bypass flows at the San Lorenzo River Big Trees gauge. The water rights permit for Fall Creek diversions, a tributary to the San Lorenzo River, has similar bypass flow requirements on the San Lorenzo River that influence SLVWD diversion timing and rates. Groundwater and surface water monitoring programs that are in operation in the Basin are incorporated into SMGWA's monitoring network described in Section 3.

2.1.2.1 United States Geological Survey

The United States Geological Survey (USGS) has operated and reported on the Big Trees streamflow gauge (11160500) on the San Lorenzo River, south of Felton (Figure 2-5), since October 1937.

2.1.2.2 California Department of Water Resources CASGEM Program

The Santa Cruz County Environmental Health Services Department administers the DWR California Statewide Groundwater Elevation Monitoring (CASGEM) program to evaluate regional groundwater elevations. The CASGEM well network includes monitoring locations throughout the County, including six wells within the Basin. Statewide groundwater elevation monitoring through CASGEM has provided DWR with data needed to track seasonal and long-term groundwater elevation trends in groundwater basins throughout the state. Following submittal of the GSP, CASGEM wells within the Basin will be migrated into the SMGWA's monitoring network to monitor groundwater conditions resulting from GSP implementation.

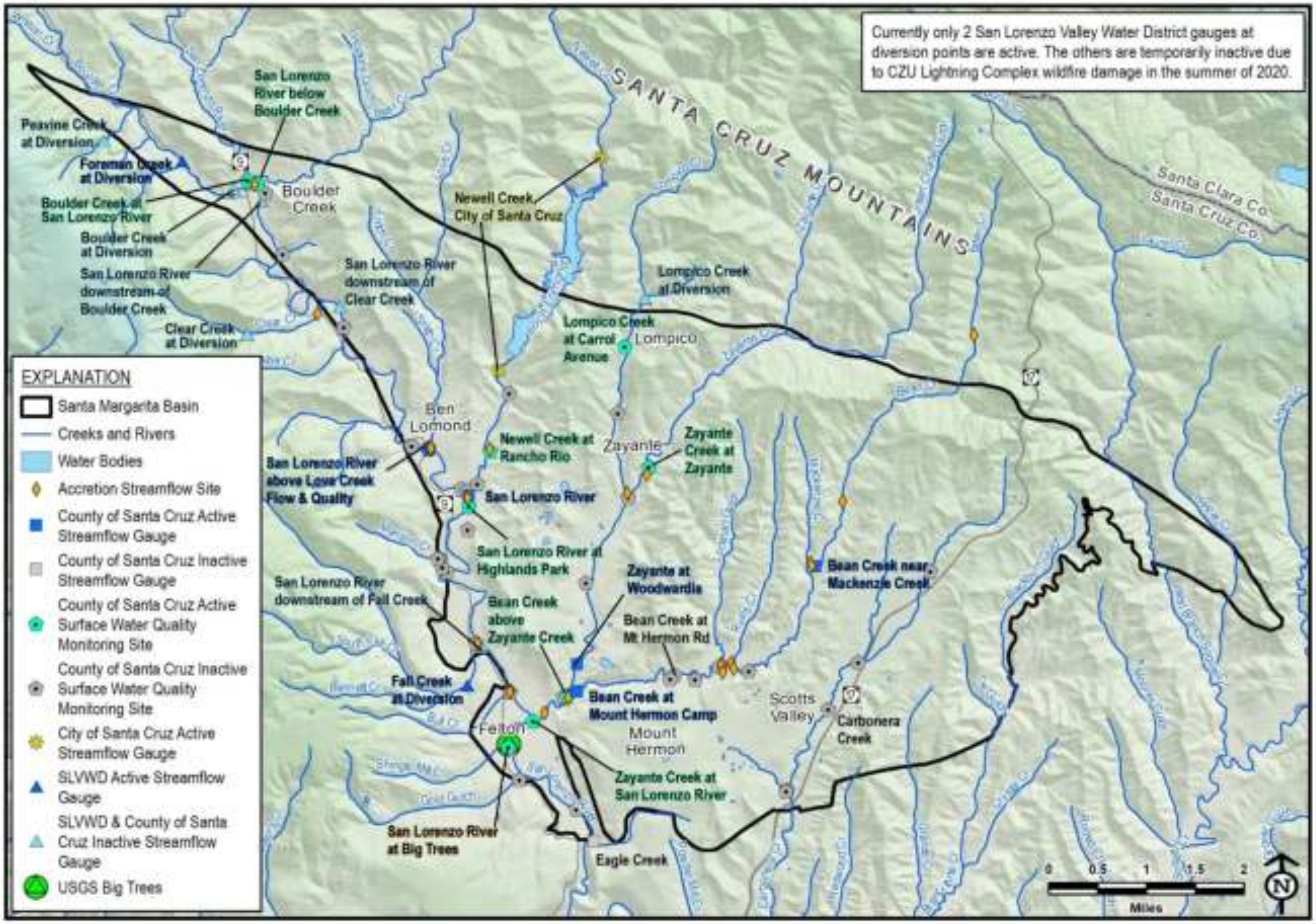


Figure 2-5. Surface Water Monitoring Sites

2.1.2.3 Central Coast Regional Water Quality Control Board Basin Plan

Surface water and groundwater quality in the Basin is managed per the water quality objectives and beneficial uses described in the Central Coast Region, Water Quality Control Plan (Basin Plan; Central Coast Regional Water Quality Control Board (CCRWQCB), 2019). The Basin Plan is developed by the CCRWQCB, together with the State Water Resources Control Board (SWRCB), and California Environmental Protection Agency (CALEPA). The Basin Plan lists various beneficial water uses and describes the water quality which must be maintained to allow those uses. Present and potential future beneficial uses for inland waters in the Basin Plan are surface water and groundwater as municipal supply; agricultural; industrial; groundwater recharge; water recreation; cold fresh water habitat; wildlife habitat; sport fishing; rare, threatened or endangered species; migration of aquatic organisms; and, spawning, reproduction, and/or early development of fish.

Water quality is an important factor in determining water use and benefit. For example, drinking water must be of higher quality than the water used to irrigate pastures. Since the Santa Margarita Basin does not have its own Basin-specific groundwater quality objectives, the broad groundwater objectives of the Central Coast Region Basin Plan are summarized in Table 2-2. Site-specific median groundwater quality objectives are provided at 2 locations within the Basin: near Felton and near Boulder Creek (

Table 2-3). It is unclear from the Basin Plan which aquifers these apply to. The County has interpreted the location near Felton to apply to the Santa Margarita Sandstone, and the location near Boulder Creek to apply to the Butano Sandstone within the Basin (personal communication with John Ricker, March 2020). The Basin Plan also includes mean surface water quality objectives for total dissolved solids (TDS), chloride, sulfate, boron, sodium for Boulder Creek, Zayante Creek, and the San Lorenzo River (

Table 2-3 and Figure 2-5).

The Basin Plan addresses the problem of nitrate loading in the San Lorenzo River. Nitrate released from septic systems, livestock, fertilizer use, and other sources passes readily through the sandy soil, into the Basin groundwater, and eventually into the San Lorenzo River. As such, the San Lorenzo River has been designated as impaired by the State and the United States Environmental Protection Agency (USEPA) due to elevated levels of nitrate, which stimulate increased algal growth and release of compounds that degrade drinking water quality and require increased cost for treatment. Increased nitrate and algal growth also cause impacts in the San Lorenzo lagoon[1], degrading salmonid habitat and potentially creating harmful algal blooms. Approximately 65% of the nitrate load in the San Lorenzo River originates from the Basin's Santa Margarita Sandstone, the majority of which comes from septic systems (County of Santa Cruz, 1995).

Table 2-2. Central Coast Basin Plan Groundwater Water Quality Objectives Applicable to the Santa Margarita Basin

Chemical Constituent	General Objectives for Groundwater	Objectives for Municipal & Domestic Groundwater Supply
Tastes and odors	Groundwaters shall not contain taste or odor producing substances in concentrations that adversely affect beneficial uses.	---
Radioactivity	Radionuclides shall not be present in concentrations that are deleterious to human, plant, animal, or aquatic life; or result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal, or aquatic life.	Groundwaters shall not contain concentrations of radionuclides in excess of the limits specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 5, Section 64443. This incorporation-by-reference is prospective including future changes to the incorporated provisions as the changes take effect.
Bacteria	---	The median concentration of coliform organisms over any seven-day period shall be less than 2.2/100 mL
Organic Chemicals	---	Groundwaters shall not contain concentrations of organic chemicals in excess of the maximum contaminant levels for primary drinking water standards specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 5.5, Section 64444, Table 64444-A. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect.

[1] The San Lorenzo lagoon is found at the mouth of the San Lorenzo River and is most prominent when a sandbar disconnects the river from the ocean.

Inorganic Chemicals	---	Groundwaters shall not contain concentrations of inorganic chemicals in excess of the maximum contaminant levels for primary drinking water standards specified in California Code of Regulations, Title 22, Division 4, Chapter 15, Sections 64431 and 64433.2. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect.

Table 2-3. Central Coast Basin Plan Groundwater and Surface Water Quality Objectives Applicable in the Santa Margarita Basin (Source: Central Coast Regional Water Quality Control Board, 2019)

Chemical Constituent	Median Groundwater Quality Objectives (mg/L)			Mean Surface Water Quality Objectives (mg/L)		
	Near Felton	Near Boulder Creek	San Lorenzo River (above Bear Creek)	San Lorenzo River (at Tait Street Check Dam)*	Zayante Creek	Boulder Creek
Total dissolved solids	100	250	400	250	500	150
Chloride	20	30	60	30	50	10
Sulfate	10	50	80	60	100	10
Boron	0.2	0.2	0.2	0.2	0.2	0.2
Sodium	10	20	50	25	40	20
Nitrate as N	1	5	---	---	---	---

* Downstream of the Santa Margarita Basin

To reduce nitrate levels in the San Lorenzo River, the County developed the San Lorenzo Nitrate Management Plan in 1995, and the CCRWQCB adopted a Nitrate Total Maximum Daily Load (TMDL) in the Basin Plan. These plans call for various measures to prevent any increased nitrate discharge and to reduce existing sources, particularly requiring individual enhanced treatment systems as existing septic systems in sandy soils are replaced or upgraded. Further, the use of recycled water in the basin requires additional treatment for denitrification before the water can be used.

The Basin Plan update in 2003 described the San Lorenzo River as impaired for both sediment and pathogens. The San Lorenzo River Technical Advisory Committee was formed to help the CCRWQCB develop actionable plans to decrease the levels of these constituents in the river. Responsibility for tracking, reporting status, and evaluating the effectiveness of voluntary implementation actions, is shared by the Regional Board and participating members of the San Lorenzo River Technical Advisory Committee. TMDLs have been adopted for both sediments and pathogens and are being implemented to reduce the sources of those pollutants. The technical advisory committee has found that the highly erodible soils of the Santa Margarita Sandstone have been a significant source of sediment in the River. Measures are needed to reduce site disturbance, reduce runoff, promote infiltration, and implement erosion control practices. The pathogen TMDL calls for improved septic system management to reduce failures and address other sources such as livestock, stormwater runoff, and homeless encampments.

2.1.2.4 County of Santa Cruz Monitoring

The County of Santa Cruz has several water resources monitoring and management programs, including programs for groundwater levels, groundwater quality, surface water flow, and nitrate control from septic sources.

2.1.2.4.1 Groundwater Elevation Monitoring

County of Santa Cruz Environmental Health (SCEH) has a private well groundwater elevation monitoring network in parts of the County, including in the adjacent Santa Cruz Mid-County Basin. While this network does not currently include wells in the Santa Margarita Basin, SCEH staff expects to add Santa Margarita Basin wells in the near future.

2.1.2.4.2 Groundwater Quality Monitoring

2.1.2.4.2.1 Private Wells

SCEH requires submission of data on well production and water quality (nitrate, chloride, total dissolved solids, iron, and manganese) as a condition of approval for all new developments served by an individual well. Since 2010, the County requires submittal of those quality data for any new well construction. There are no ongoing monitoring requirements for private wells after the initial sample is collected and reported to the County.

2.1.2.4.2.2 Small Water Systems

SCEH Drinking Water Program regulates state small water systems (5-14 connections) and public water systems (15-199 connections) to ensure the water provided through these small water systems meets federal and state water quality standards. The County requires sampling, testing, and reporting of chemical and biological parameters and oversees regulatory compliance for these systems. All systems are also required to report their monthly water production at the end of each year.

- State Small Water Systems with 5-14 connections are regulated under both county and state regulations through the SCEH Drinking Water Program. State small water systems are required to provide quarterly bacteriologic water quality results to the County, and additional results on a less frequent basis.

- Public Water Systems located within communities serving 15-199 connections and those that serve more than 25 people for more than 60 days a year through non-community or transient uses (businesses, schools, restaurants, etc.) are regulated by the SCEH Drinking Water Program acting for the State Water Resources Control Board Division of Drinking Water (DDW) through a Local Primacy Agency agreement. Public water systems are required to provide monthly bacteriologic sampling results to the County, with other results provided on an annual or less frequent basis.

2.1.2.4.2.3 Wasteload Allocation Attainment Program

The County's WAAP identifies, prioritizes, and describes programs to reduce contaminant loads in surface water that could impact the health of the community's surface water and drinking water. The program monitors surface water quality for nitrate and *E. coli*, identifies impaired waters by comparing monitoring results to federal water quality standards, identifies the sources of pollution, and prioritizes best management practices to bring impaired surface waters into compliance with federal standards.

2.1.2.4.3 Surface Water Flow Monitoring and Management

The County currently operates 5 low-flow stream gauges (Figure 2-5) within the Basin with the goal of understanding dry-season flows in support of coho and steelhead habitat-enhancement efforts. More recently, stream flow monitoring has supported the ongoing GSP process. The 5 gauging locations with their periods of record by water year (WY) are:

- Zayante Creek at Woodwardia (WY2009 – WY2010; WY2017 – current)
- Bean Creek at Mount Hermon Camp (WY2009 – WY2012; WY2017 – current)
- Bean Creek at Mount Hermon Road (WY2012 – WY2013 sponsored by SVWD, WY2019 – current)
- Newell Creek 100 feet upstream of the San Lorenzo River (WY2019 – current)
- Eagle Creek above its entry into the San Lorenzo River (WY2018 – current)

These gauges are only operated during the dry season, with monthly site visits to make field observations, repair equipment, calibrate devices, and measure flow and specific conductance. Each gauge is equipped with a pressure transducer, which collects continuous water depth data at 15-minute intervals. Field observations and measurements are used to calibrate the gauging records. In addition to collecting data at these gauge locations, flow at specific tributaries (e.g., Ferndell Creek) are measured to improve understanding of the Santa Margarita boundary aquifer conditions. Balance Hydrologics has made these observations and prepared annual reports as deliverables to the County.

The USGS operated a gauge on Bean Creek at the Mount Hermon Road site (Figure 2-25) from WY1998 through WY2007, also with continuous flow measurements calibrated by monthly visits. No record of specific conductance or other water-quality measurements were published.

Beginning in 2017, Balance Hydrologics conducted annual late-season stream observation walks (“accretion runs”), where flow, nitrate, and specific conductance are measured at select locations along the San Lorenzo River and its tributaries. Measurements are collected along the reach from Felton up through Boulder Creek. The goal of the accretion study is to improve understanding of the surface water and groundwater interactions within the Basin. As part of the GSP process, sites along Zayante Creek, Lompico Creek, and Bean Creek were added to the accretion runs in the summer of 2019. Most of the added sites are focused along Bean Creek and its tributaries. During the summer and fall of 2019, three separate accretion runs (May, July, and September) were conducted on the San Lorenzo River, Lompico Creek, Zayante Creek, Bean Creek, and Eagle Creek. Measurements were collected at all sites over a period of 1 to 2 days for each run. The number of accretion runs was increased during 2019 to capture the changes in flow during the dry-season recession and to aid in understanding the surface-water groundwater interactions within the Basin.

2.1.2.4.4 Local Area Management Plan

The County's Local Area Management Plan (LAMP) was developed in 2021. The purpose of the LAMP is to provide for the continued use of Onsite Wastewater Treatment Systems (OWTS, also known as septic systems) in Santa Cruz County while providing protection of water quality and public health. The LAMP updates and expands the wastewater management approaches conducted by Santa Cruz County since 1985.

2.1.2.5 San Lorenzo Valley Water District Groundwater Monitoring and Management

SLVWD conducts routine groundwater extraction, groundwater level, and streamflow monitoring to support its water resource management. SLVWD has monitored groundwater production since 1984, with current monthly production monitoring ongoing in the SLVWD's 7 active extraction wells. Groundwater elevations have also been monitored in production areas since the 1960s, with consistent monitoring since the mid-1970s. SLVWD monitors groundwater elevations in all its production wells plus monitoring wells listed in Table 2-4. SLVWD monitors streamflow downstream of its diversions.

Table 2-4. SLVWD Groundwater Production and Groundwater Elevation Monitoring Wells

Well Name	Well Status	Reference Point Elevation (feet msl)	Primary Screened Formation	Screen Interval Depth (feet bgs)
SLVWD Production Wells – Groundwater Production and Groundwater Elevation Measured Monthly				
San Lorenzo Valley System – Northern Portion				
Quail Hollow #4A	active	597	Santa Margarita	180 – 250
Quail Hollow #5A	active	516	Santa Margarita	124 – 164
Olympia #2	active	528	Santa Margarita	225 – 245, 275 – 298
Olympia #3	active	538	Santa Margarita	230 – 308
San Lorenzo Valley System – Southern Portion				
Pasatiempo #5A	active	750	Lompico	400 – 700
Pasatiempo #7	active	734	Lompico	380 – 440, 495 – 525
Pasatiempo #8	active	790	Lompico	560 – 660, 680 – 780
Mañana Woods #1	inactive	~515	Santa Margarita /Lompico	136 - 436
Mañana Woods #2	inactive	516	Santa Margarita /Lompico	156 – 196, 236 – 276, 306 – 326
SLVWD Monitoring Wells – Groundwater Elevation Measured Monthly				
San Lorenzo Valley System – Northern Portion				
Quail Hollow MW-A	active	425	Santa Margarita	38 – 88

Well Name	Well Status	Reference Point Elevation (feet msl)	Primary Screened Formation	Screen Interval Depth (feet bgs)
Quail Hollow MW-B	active	593	Santa Margarita	95 – 195
Quail Hollow MW-C	active	650	Santa Margarita	120 – 220
Quail Hollow Ranch	inactive	627	Santa Margarita	225 – 275
Quail Hollow #8*	active	407	Santa Margarita	100 – 130
Olympia #1*	active	448	Santa Margarita	131 – 159, 127-157
San Lorenzo Valley System – Southern Portion				
Pasatiempo MW-1	active	775	Lompico	600 – 660
Pasatiempo MW-2	active	775	Santa Margarita	280 – 340

*Former production well
feet msl = elevation in feet relative to mean sea level
feet bgs = depth in feet below ground surface

2.1.2.6 Scotts Valley Water District Groundwater Monitoring and Management

SVWD has been actively managing groundwater since the early 1980s; with the goal of increasing water supply reliability and protecting local water supply sources. In 1983, SVWD instituted a Water Resources Management Plan to monitor and manage water resources in the Scotts Valley area. In 1994, SVWD formally adopted a Groundwater Management Plan ([GWMP], Todd Engineers, 1994) in accordance with Assembly Bill 3030 (AB 3030), also known as the Groundwater Management Act (CWC §10750 *et seq.*). The overall purpose of the GWMP was to provide a planning tool that helps guide SVWD manage the quantity and quality of its groundwater supply, and to comply with the requirements of AB3030. The goal of the SVWD GWMP is stated as:

> *By implementation of a groundwater management plan for Scotts Valley, SVWD hopes to preserve and enhance the groundwater resource in terms of quality and quantity, and to minimize the cost of management by coordination of efforts among agencies.*

Development of Basin Management Objectives (BMOs) are required for the GWMP under CWC § 10753.7(a)(1) as a systematic process to support groundwater basin management. The BMOs for SVWD's GWMP are summarized as:

- Encouraging public participation through an annual report of groundwater management activities and its presentation at 1 or more public meetings
- Coordinating with other local agencies
- Continued monitoring and evaluation of groundwater conditions

- Implementing groundwater augmentation projects
- Investigating groundwater quality and preventing groundwater contamination

These BMOs guided the SVWD groundwater management program and served as major objectives of groundwater management for SVWD. Groundwater management covered by the GWMP will be replaced by this GSP.

Starting in 1994, annual reports that analyze and describe the condition of the Basin were produced as part of GWMP implementation. The format of the annual reports has evolved over time to meet the needs of SVWD. Starting in 2013, the format began following a 2-year cycle with more comprehensive reports being produced in even years. Based on past experience, there were only incremental year-to-year changes in the Basin; therefore, the 2-year cycle provided a more cost-effective approach to accomplish the objectives of the annual report. The odd year reports are concise summaries focused on SVWD operations whereas the even year reports provide more regional assessments that include an evaluation of data from neighboring water districts and private suppliers, an assessment of water quality issues, an assessment of Basin conditions and change in groundwater in storage simulations from the updated Basin's groundwater model.

Development of a monitoring network to track Basin conditions within SVWD's service area has been part of GWMP implementation. Table 2-5 lists the SVWD monitoring wells that are currently included in their monitoring network. All existing monitoring wells will be incorporated into the SMGWA monitoring network.

Table 2-5. Wells Used for the Scotts Valley Water District Groundwater Management & Monitoring Program

Well Name	Well Status	Top of Casing Elevation (feet msl)	Primary Screened Formation	Screen Interval Depth (feet bgs)
SVWD Production Wells – Measurements taken monthly for both static and dynamic levels				
SVWD Well #3B	active	672.5	Lompico, Butano	700-730, 880-1050, 1180-1370, 1400-1670
SVWD Orchard Well	active	723	Lompico, Butano	705-784, 805-1063, 1084-1455
SVWD Well #9	inactive	528.1	Monterey	155-195, 315-355
SVWD Well #10	inactive	510.9	Lompico	190-220, 240-270, 325-355
SVWD Well #10A	active	512.0	Lompico	280-380, 400-450
SVWD Well #11A	active	602.6	Lompico	399-419, 459-469,495-515
SVWD Well #11B	active	588.0	Lompico	348-388, 423-468, 500-515
SVWD Monitoring Wells - Key Indicator Wells – Measurements taken monthly				
#15 Monitoring Well[2]	active	660.0	Lompico, Butano	700-1100
#9 Monitoring Well	active	528.0	Monterey	N/A

Well Name	Well Status	Top of Casing Elevation (feet msl)	Primary Screened Formation	Screen Interval Depth (feet bgs)
SVWD Monitoring Wells - Measurements taken semi-annually				
SVWD AB303 MW-1[1,2,3]	active	561.1	Santa Margarita	114-124
SVWD AB303 MW-2[2]	active	524.2	Lompico	705-715, 810-850
SVWD AB303 MW-3A[1,2,3]	active	522.7	Lompico	630-680
SVWD AB303 MW-3B[1,2,3]	active	522.1	Santa Margarita	120-125
Canham Well [2]	active	782.8	Butano	1,281-1,381
Stonewood Well [2]	active	898.5	Butano	799-859
SV1-MW	inactive	704.3	Santa Margarita	60-80
SV3-MW A [2]	active	584.7	Santa Margarita	60-80
SV3-MW B [2]	active	584.7	Santa Margarita	100-110
SV3-MW C [2]	active	584.7	Lompico	150-160
SV4-MW	active	447.8	Santa Margarita	50-60
TW-18[1,2,3]	active	715.0	Santa Margarita	285-345
TW-19[1,2,3]	active	659.5	Lompico	960-1060

Notes:[1] Groundwater elevation measurement data submitted to DWR CASGEM Program
[2] Equipped with electronic data transducer
[3] CASGEM well
feet msl = elevation in feet relative to mean sea level
feet bgs = depth in feet below ground surface

2.1.2.7 Mount Hermon Association Groundwater Monitoring and Management

The Mount Hermon Association measures monthly depth to groundwater and extraction data from their actively pumped wells and reports it to SVWD as part of the GWMP described in Section 2.1.2.6.

Table 2-6. Wells Used for the Mount Hermon Association Groundwater Management & Monitoring Program

Well Name	Well Status	Top of Casing Elevation (feet msl)	Primary Producing Formation	Screen Interval Depth (feet bgs)
MHA Production Wells – Measurements taken monthly for both static and dynamic levels				
MHA #1	inactive	772	Monterey, Lompico	255-265, 285-395, 435-495
MHA #2	active	740	Lompico	290-300, 400-415, 430-460, 490-590, 600-615, 625-725
MHA #3	active	584	Lompico	680-800, 860-980

2.1.2.8 City of Santa Cruz Surface Water Monitoring and Environmental Management

As both an in-Basin user (Loch Lomond Reservoir, Felton diversion) and downstream user (Tait diversion) of San Lorenzo River watershed surface water, the City of Santa Cruz actively participates in surface water monitoring and management in the Basin. The key issues that have implications on the City of Santa Cruz water supply are nitrate impacts on surface water quality from the more than 13,000 septic systems in the San Lorenzo River watershed and groundwater use impacts on surface water baseflow supporting anadromous fisheries, particularly in Bean and Zayante Creeks. Reduced surface water baseflow in the Basin that may impact important coho salmon rearing streams increases the regulatory burden on the City, as any impact caused by the City’s operations is evaluated within the context of overall habitat and population conditions. Finally, water resource management in the Basin also has impacts on the City of Santa Cruz’s ability to fully exercise its water rights, which further complicates its ability to maintain supply reliability and improve habitat conditions for special status salmonids in the watershed.

2.1.2.8.1 Surface Water Monitoring and Management

The City of Santa Cruz monitors surface water stage and discharge in conjunction with their surface water supply diversions on the San Lorenzo River and Newell Creek. The City of Santa Cruz contributes financially to operation of the USGS flow gauge on the San Lorenzo River at Big Trees, upstream of the City operated diversion in Felton. The City monitors surface water discharge on Newell Creek both upstream and downstream of the Loch Lomond Reservoir (Figure 2-25).

The City of Santa Cruz is preparing an Environmental Impact Report (EIR) to support proposed water rights changes that would apply minimum streamflow requirements on its water rights permits and licenses. The EIR will also address the City’s water supply reliability issues by, among other things, improving the flexibility of operations and enabling conveyance of water to neighboring agencies, including the member agencies of the SMGWA. These operations could support enhanced conjunctive use of surface water and groundwater for the City of Santa Cruz, and potentially the region. Flexibility in the diversion location for San Lorenzo River water and a consistent place of use for all City water rights may encourage regional water resource management.

2.1.2.8.2 Habitat Management

The City of Santa Cruz is committed to enhancing stream flows and habitat in the San Lorenzo River for local anadromous fisheries, particularly for coho salmon and steelhead. Since 2007, the City has provided bypass flows to benefit salmonids in its water source streams beyond what was required by its water rights. The City has conducted extensive studies on flows needed for all steelhead life stages, and the effect of maintaining flows at various levels in the San Lorenzo River downstream of the Tait Street diversion. The City has also assessed passage flows downstream of Felton Diversion. The City continues to monitor various attributes related to fish habitat in the San Lorenzo River watershed. Under the City of Santa Cruz Water Department Watershed Monitoring Program, the following are specifically monitored:

- Temperature monitoring in a variety of locations throughout the San Lorenzo River watershed
- Turbidity monitoring upstream of Loch Lomond
- Dissolved oxygen and pH monitoring below Loch Lomond
- Juvenile salmonid and habitat in a variety of locations throughout the San Lorenzo River watershed, as a part of a collaborative effort funded by the City of Santa Cruz, SLVWD, SVWD and the County

2.1.3 Land Use Elements

2.1.3.1 General Plans

Land use authority in the Basin falls under the jurisdiction of 2 agencies, the County of Santa Cruz and the City of Scotts Valley. These agencies have each adopted general plans with land use classifications that identify desired areas for development, open space, and conservation purposes. The general plans also cover zoning regulations and development standards that determine the location, type and density of growth allowed in the region, along with various policies for protection of watershed and groundwater resources. General plans are reviewed to understand the adverse environmental impacts they may have when implemented.

State general plan guidance was significantly revised in 2017 (Governor's Office of Planning and Research, 2017). Changes to planning laws triggered these revisions, including SGMA's requirement that general plans consider water supply at their next update. Any significant update to a general plan, including to its housing element, will trigger the SGMA mandate to consider potential development impacts on groundwater supply and consistency between the general plan and the GSP.

2.1.3.1.1 City of Scotts Valley General Plan

The City of Scotts Valley adopted its General Plan in 1994 and began updating it in 2012 to address the changes the city has experienced throughout the past 2 decades since its implementation. The update is not yet complete; however, when it is, it will create a blueprint for development through the year 2040 and will address many topics including physical growth, transportation, quality of life, economic vitality, municipal services, and environmental conservation. A draft EIR associated with the General Plan is currently under development, with a public hearing expecting in early fall 2021 and adoption of the EIR and General Plan shortly thereafter.

2.1.3.1.2 County of Santa Cruz General Plan

The County adopted its current general plan in 1994. A Sustainable Santa Cruz County Plan was adopted in 2015 to promote sustainable land use, housing, economic development, and transportation objectives in the urban areas of the County (County of Santa Cruz, 2014). The Sustainable Santa Cruz County Plan has a timeframe through the year 2035. The County is currently in the process of updating various parts of the General Plan, including the water resource protection policies. The update is expected to be completed in 2022.

The County General Plan contains 2 components that significantly affect the management of water resources within the Basin. Measure J was passed by voters in 1978, which called for a comprehensive growth management system which established population growth limits, affordable housing provisions, the preservation of agricultural lands and natural resources, and the retention of a distinction between urban and rural areas. This has resulted in greatly diminished development density and growth rates in areas that do not receive municipal water service. Each year when the Board of Supervisors adopts the growth goal and annual building permit allocation, limitations of water supply are taken into consideration.

The Conservation and Open Space Element of the County General Plan includes many policies and programs for protection and management of groundwater resources, recharge areas, wetlands, streams, riparian corridors, and sensitive habitat areas. Many of these polices are incorporated into the County Code. An example of such a program is the restriction on building disturbance in Santa Cruz Sandhills habitat. The Sandhills are a unique community of plants and animals found only on Zayante soils, which are derived from the Santa Margarita Sandstone, and mostly found in the Scotts Valley, Ben Lomond, and Bonny Doon areas. Due to their limited geographic range and narrow habitat specificity (Zayante soils), the endemic communities and species of the Sandhills are naturally extraordinarily rare. The Sandhills are also areas of high groundwater recharge potential. Estimated to cover 6,000 acres originally, approximately 40% of Sandhills habitat has been lost, primarily due to sand quarrying and development. A detailed process has been developed by the County to identify whether parcels fall within the Sandhills or not. This process is accessed online at: https://www.sccoplanning.com/Portals/2/County/Planning/env/Permit%20Processing%20Chart.pdf.

These policies, programs, and code requirements were reviewed during development of GSP elements for depletion of surface waters and groundwater dependent ecosystems (GDEs). The County General Plan maps of recharge areas, sensitive habitats, and biotic resources are also used. Several elements including the Conservation and Open Space Element are currently in the process of being updated and wording has been proposed to incorporate references to the GSP into the updated General Plan. The updates are expected to be adopted in 2022.

2.1.3.2 Potential Water Demand Changes due to GSP Implementation

GSP implementation is not expected to increase water demand over the next 20 years. The only water demand changes anticipated as part of GSP implementation are a slight decrease in municipal demand due to water use efficiency achieved through technological improvements and regulatory compliance as well as customer conservation, and reduced water losses due to increased efforts on pressure control, leak detection and innovative data analytics and management. However, increased demand from population growth is projected to slightly outpace water demand reductions from water use efficiency, resulting in slightly increasing demands for the next 20 years (WSC and M&A, 2021).

Pumping reductions are not included as part of GSP implementation. The small amount of increased municipal demand is expected be met by conjunctive use of existing surface water and groundwater sources to raise groundwater levels in the Mount Hermon / South Scotts Valley area to SMGWA's desired elevations. Supplemental water sources in the form of treated surface water from outside of the Basin or indirect potable reuse of purified wastewater may be needed if conjunctive use does not increase groundwater levels as expected. These potential projects are described in more detail in Section 4.

There are no known land use plan changes in neighboring basins that would affect the ability of the SMGWA to achieve groundwater sustainability.

2.1.3.3 Process for Permitting New and Replacement Wells

SCEH is the only agency responsible for issuing water well permits within the Basin. The Santa Cruz County water well permit requirements are outlined in Chapter 7.70 of the County Code and are based on water well standards developed and updated by DWR and are available at: http://www.codepublishing.com/CA/SantaCruzCounty/html/SantaCruzCounty07/SantaCruzCounty0770.html

The County also requires documentation of water efficiency measures as a condition of approval for any well serving any proposed groundwater use expected to use greater than 2 AFY.

The County plans to update its well ordinance to implement elements of this GSP, including metering requirements for non-*de minimis* users by the end of 2022. The County will also address the need to prevent impact on public trust values in surface water from new wells, depending on how this issue evolves in the State. This could include a requirement for increased setbacks from streams and/or deeper seals to reduce the potential to draw from alluvium that is in direct hydraulic contact with a stream.

2.1.3.4 Additional GSP Elements

2.1.3.4.1 Wellhead Protection

The California Department of Health Services' Division of Drinking Water and Environmental Management developed the Drinking Water Source Assessment and Protection (DWSAP) Program in January 1999. The program was developed in response to the 1996 reauthorization of the federal Safe Drinking Water Act, which included an amendment requiring states to develop a program to assess sources of drinking water and encourage protection measures. The DWSAP program enables partnership between local, state, and federal agencies to ensure that drinking water quality is maintained and protected.

Several specific efforts related to wellhead protection in the Basin include the following:

- SLVWD and SVWD have met DWSAP requirements for all active water supply wells since 1999.
- The City of Santa Cruz and SLVWD have completed periodic watershed sanitary surveys of potential sources of contamination in the water supply watersheds, which encompass the entire Basin.
- The State Water Board's 2012 Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems establishes additional setback and design requirements for OWTS located within 600 feet of municipal wells. These requirements are incorporated into the County's Local Area Management Plan for OWTS.

2.1.3.4.2 Well Construction Policies

As discussed above in Section 2.1.3.3, the County permits water wells within the Basin. Well construction standards are found in the County Code, Chapter 7.70. The purpose of the County's well construction standards is to regulate the location, construction, repair, and modification of all wells to prevent groundwater contamination and ensure that water obtained from groundwater wells is suitable for the purpose for which it is used and will not jeopardize the health, safety, or welfare of the people of Santa Cruz County. The County requires well construction and modification standards developed by DWR in Bulletin 74-90.

2.1.3.4.3 Well Abandonment and Destruction Program

The County issues well destruction permits for wells being abandoned within the Basin. The purpose of the County's well abandonment and well destruction policies is to prevent inactive or abandoned wells from acting as vertical pathways for the movement of contaminants into groundwater. Well destruction requirements are found in the County Code, Chapter 7.70.100. SCEH requires that well destruction standards developed by DWR in Bulletin 74-90 be followed.

2.1.3.4.4 Replenishment of Groundwater Extractions

No managed replenishment of groundwater extractions has historically occurred or is currently taking place in the Basin.

2.1.3.4.5 Conjunctive Use and Underground Storage

Conjunctive use is the coordinated operation of multiple water sources to achieve improved supply reliability. Most conjunctive use concepts are based on storing groundwater supplies in times of surplus for use during dry periods when surface water supplies would likely be reduced. Opportunities exist to improve water supply reliability in the Basin using conjunctive use and underground storage.

While there are no formal conjunctive use programs between SMGWA members and other water agencies, conjunctive use practices have been studied and are implemented by SMGWA member agencies with access to surface water. For example, SLVWD meets demand through conjunctive use of surface water and groundwater sources. Since SLVWD has limited storage other than natural groundwater storage, they divert surface water from streams as much as possible to store groundwater for use during dry periods. There are bidirectional interties between SLVWD's water systems that, although only permitted for emergency use, could potentially be used to transfer water supplies within its service area (Exponent, 2019). SLVWD is pursuing efforts to utilize its emergency interties on a routine basis for conjunctive use and improved resiliency. There is also an intertie connecting SLVWD and SVWD systems for transfer of water in emergency situations. Currently, there is no formal conjunctive use agreement between the water districts.

SMGWA members and other agencies are continually exploring regional partnerships to enhance water supplies through a range of potential options that can benefit the Basin as a whole. Projects under consideration are described in more detail in Section 4: Projects and Management Actions.

2.1.3.4.6 Current Water Management Projects and Programs

2.1.3.4.6.1 Groundwater Contamination Cleanup

Environmental contamination assessment and remediation programs within the County and Basin are overseen by the CCRWQCB. The SCEH is also involved with sites with hazardous materials impacts to soils. To protect their potable water supplies and more effectively manage the Basin, SMGWA member agencies are informed about local environmental compliance sites where groundwater quality has been impacted by pollution or chemical spills.

There are currently no contamination sites undergoing active groundwater remediation within the Basin; cleanup efforts taking place in the Basin are only related to soil vapor as described in the subsections below. Historically, groundwater remediation of volatile organic compounds (VOCs) and gasoline-related chemicals in groundwater occurred at several Scotts Valley and Felton sites.

The remediation efforts at these sites concluded after the concentrations of contaminants in groundwater decreased below the established water quality standards. There is always a possibility that groundwater will be re-impacted in the future from these sites if the contaminant source was not completely addressed. Detailed information for all sites regardless of open or closed status is available from the SWRCB GeoTracker website at: https://geotracker.waterboards.ca.gov/ and the Department of Toxic Substances Control (DTSC) Envirostor web site at: www.envirostor.dtsc.ca.gov/public. One additional groundwater contamination cleanup site located 275 feet outside of the Basin at the former Valeteria Dry Cleaners in Felton is included in the summaries below since it impacts water quality in the San Lorenzo River located only 400 feet to the east of it and within the Basin.

Figure 2-6 shows the location of all SWRCB GeoTracker sites, and for reference, those sites described in more detail below are labeled on the map. Sites indicated on Figure 2-6 include cleanup program sites, land disposal sites, and Leaking Underground Storage Tank (LUST) sites. Organic and emerging contaminant threats to water quality in the Basin are discussed in more detail in Section 2.2.5.4.4.

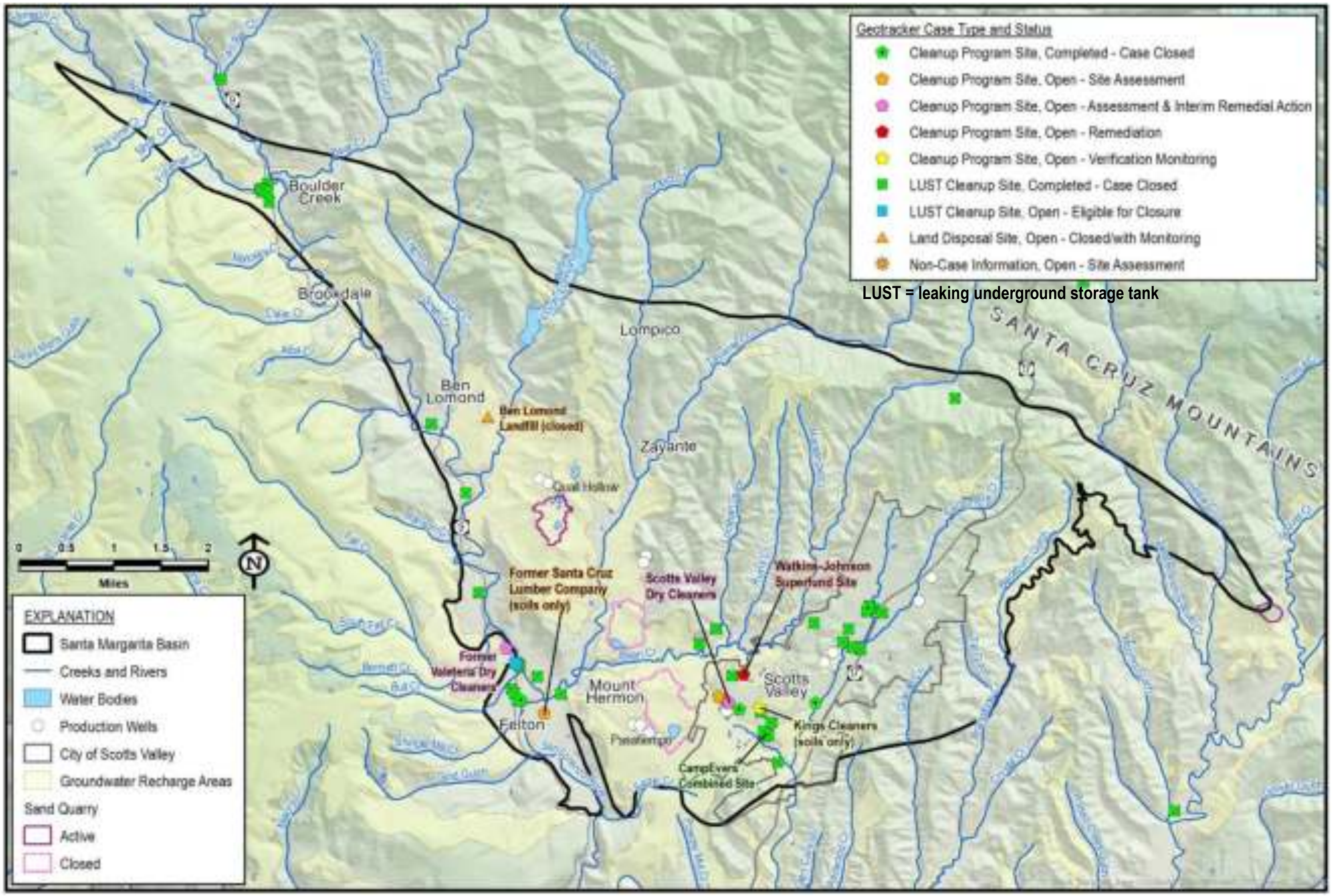


Figure 2-6. Location of Groundwater Contamination Cleanup Sites in the Santa Margarita Basin

Watkins-Johnson Superfund Site

The Watkins-Johnson site, located at 440 Kings Village Road in Scotts Valley, is a former semiconductor manufacturer where industrial processes included metal machining, degreasing operations, metal plating, glass cleaning, glass etching, welding, soldering, painting, and photo lab activities. A variety of organic chemicals, inorganic acids, and metals were used at the site. The site is a Federal Superfund Site listed on the National Priorities List, with remediation activities under the jurisdiction of USEPA Region 9 and the RWCQB.

The site's remedial investigation and feasibility study started in 1984 after organic chemicals were detected in the soil and groundwater at the site and in the surface water of Bean Creek near the site. Groundwater remediation began in October 1986. Key constituents detected in the groundwater include trichloroethene (TCE), cis-1,2-dichloroethene (CISDCE), and vinyl chloride (VC). In the soil, key constituents include TCE, methylene chloride, and chloroform. Of primary interest was the potential for contaminants in the soil to migrate into the underlying aquifers: the Santa Margarita Sandstone and Lompico Sandstone. SVWD Well #9, which is located approximately 400 feet south of the Watkins-Johnson site and screened in the lower Santa Margarita and Monterey Formations, has been impacted by TCE and CISDCE at concentrations below drinking water standards. Although this well is no longer used by SVWD, when it was used, water pumped from it required filtration by a granular activated carbon (GAC) system prior to putting the water into the distribution system.

Groundwater remediation at the site consisted of pumping groundwater beneath the site with a series of extraction wells. The extracted water was treated using a GAC adsorption system. Treated water was used onsite, recharged to the perched zone onsite, and discharged to Bean Creek. The groundwater remediation system was deactivated on July 5, 2016.

More than 3 decades after investigations began at the Watkins-Johnson site, its remediation is moving towards closure, but the current site owner still needs to complete the source control component of the remedial action to ensure protectiveness over the long-term. The site is currently designated by the CCRWQCB as an open case with ongoing remediation for residential use due to existing soil gas plumes of benzene, TCE, tetrachloroethene (PCE), arsenic and cadmium in soils. A draft Focused Feasibility Study proposing potential remediation alternatives including soil excavation was submitted to USEPA in January 2019.

Scotts Valley Dry Cleaners

Remediation of the Scotts Valley Dry Cleaners site, located at 272 Mount Hermon Road in Scotts Valley, is overseen by the CCRWQCB. PCE, which is used as a dry-cleaning solvent, was found in the soils and groundwater both on-site and off-site of the dry-cleaning operations in 1993.

Groundwater extraction remediation systems were used at the site from August 2005 to August 2015. The extracted water was treated by a GAC adsorption system and discharged under a National Pollution Discharge Elimination System Permit to the City of Scotts Valley storm water drain system. In addition to groundwater extraction, injection of sodium permanganate into groundwater through dedicated injection wells in 2009 attempted *in situ* cleanup of chlorinated solvents in groundwater.

Cleanup at the Scotts Valley Dry Cleaners site currently involves operation of soil vapor extraction and air sparging systems. These remediation systems only extract soil vapor in the unsaturated soils above groundwater and thus no groundwater is extracted.

Former Valeteria Dry Cleaners

The former Valeteria Dry Cleaners site, located at 6519-6539 Highway 9 in Felton, released PCE into groundwater just outside of the Basin. It is included in this discussion regarding groundwater cleanup sites because it could potentially impact the Basin even though it is physically located outside of the Basin; it is only 400 feet west of the San Lorenzo River that flows through the Basin and VOC contaminated groundwater discharges to the river via springs.

The PCE in groundwater from the site is thought to have originated from dry cleaning solvent wastes being disposed into the onsite septic system (Integral Consulting Inc, 2020). In the 1980s, PCE was first detected in surface water samples from both the San Lorenzo River and springs on the river's western bank. Associated with PCE are lower concentrations of TCE, and limited detections of CISDCE. PCE and TCE are the only VOCs consistently detected above their drinking water maximum contaminant levels (MCLs) of 5 µg/L (equal to 0.005 mg/L).

Integral Consulting Inc. (2020) summarizes previous environmental assessments and remediation as:

> "Subsequent assessment activities in the 1990s and 2000s included a passive soil gas survey, additional surface water sampling, septic system sludge sampling, aquifer testing, and installation and sampling of numerous groundwater monitoring wells and soil borings. Initial remedial activities were conducted in 2002 with the removal of the historical septic tank and 325 cubic yards of surrounding soils from the onsite area. An on- and offsite area soil vapor assessment was conducted in 2008 followed by installation of a soil vapor extraction and sub-slab venting system in 2009 and sub-slab sampling in onsite area structures in 2010 and 2011. The onsite area soil vapor extraction system has since been operated periodically primarily for soil venting."

A July 21, 2020 Remedial Action Plan describes the plume of chemical constituents of concern (COC) above the MCL to extend laterally 320 feet long by 180 feet wide downgradient from the former source area to Spring 1A at the San Lorenzo River. The vertical extent of the plume in groundwater generally follows the groundwater table at around 20 feet below ground and extends to an approximate depth of 60 feet below ground. The downgradient extent of COCs has been delineated to the extent practical at the springs near the San Lorenzo River.

Camp Evers Combined Site

The Camp Evers combined site is associated with 4 current and former gasoline stations (BP, Shell, Chevron, and Tosco), that were located at or near the intersection of Scotts Valley Drive and Mount Hermon Road. The primary COCs at this site are Methyl-tert-butyl ether (MTBE) and other fuel-related compounds. The Camp Evers combined site cleanup was overseen by the CCRWQCB. Historically, the plume has extended at least 1,700 feet north of SLVWD's Mañana Woods Well #2. When this well was used, its pumped water was passed through a pre-treatment system to remove low MTBE concentrations. The well is no longer pumped by SLVWD.

Remediation at the various sites consisted of underground storage tank (UST) removal, and groundwater extraction and treatment before discharging to the City of Scotts Valley storm water drain system. Remedial efforts started in the early 2000s and the Camp Evers Combined Site completed their remediation efforts and closed all cases as of November 21, 2017.

Ben Lomond Landfill (Closed)

The Ben Lomond Landfill, at 9835 Newell Creek Road in Ben Lomond, operated as a landfill until 2012, but is now a trash transfer station. Groundwater monitoring has been ongoing at the now-closed landfill since 1980, as the site is associated with elevated levels of VOCs and heavy metals. Contamination associated with the site is not predicted to expand its footprint and is not thought to significantly impact 2 municipal Quail Hollow wells operated by SLVWD east of Newell Creek (Johnson, 2009).

The following 2 non-LUST sites do not have groundwater contamination, only soil contamination and cleanup:

King's Cleaners

The King's Cleaners site, located at 222 Mount Hermon Road in Scotts Valley, was found in 2000 to have some PCE in the soil samples and elevated soil gas concentrations. No PCE was detected in groundwater. SCEH assumed oversight responsibility for this site from the CCRWQCB in April 2017.

No remedial actions have occurred at the Kings Cleaners site over the past several years. However, in 2019/2020 there has been regulatory oversight for development of a Work Plan to confirm current soil vapor concentrations and whether residual PCE concentrations detected in soil vapor investigations conducted during September 2000 and November 2009 pose a vapor intrusion health risk at the subject site and adjacent commercial businesses.

Former Santa Cruz Lumber Company

Santa Cruz Lumber Company, located at 5843 Graham Hill Road in Felton, operated from 1945 to 1986. Operations at the site included pressure treatment of a variety of wood products with the chemical Wood-Last, a water-based copper, chromium, and arsenic solution. During initial investigations in 1986, groundwater contamination was not found, but soils were contaminated by CCA.

Remedial excavation and removal of over 2.6 thousand tons of soil took place in 1987 because it contained elevated levels of metals and other constituents associated with wood products. More recent soil sampling, in April 2018, found elevated levels of arsenic, hexavalent chromium, and formaldehyde, though hexavalent chromium may be naturally occurring. Contaminants were not found in groundwater (Trinity Source Group, Inc., 2017). A Work Plan to remove these chemical constituents was requested by SCEH.

A privately owned well screened in the Lompico aquifer, 250 feet west of the site, has elevated arsenic concentrations in groundwater between 0.014 mg/L and 0.026 mg/L (the primary drinking water standard is 0.01 mg/L). Slightly elevated arsenic is also found in other wells in the vicinity, such as SLVWD Pasatiempo #6 and wells just outside the Basin, southeast of Felton. As described above, onsite investigations did not find groundwater contamination, and therefore given the information available, elevated arsenic in this area's groundwater is considered naturally occurring in the Lompico aquifer.

2.1.3.4.6.2 Migration of Contaminated Water

Groundwater quality sampling of supply wells in the Basin allows for analysis of contaminated water migration. Historical supply well water quality data indicates that contaminated water migration is spatially and temporally limited to only a few locations over time. Detected contaminants in supply wells have mostly been from point source contaminant releases related to the regulated sites discussed above and contaminant concentrations were typically at or below relevant drinking water standards. Nitrate has also been detected in supply wells in some areas of the Basin at concentrations less than the drinking water standards, likely due to non-point source septic system releases. More information on groundwater quality is provided in Section 2.2.5.4

Contaminated groundwater detected in supply wells originated from 3 main areas in Scotts Valley: Camp Evers area gas stations, downtown dry cleaners, and the Watkins-Johnson Superfund Site. Contaminated groundwater has generally migrated down-hydraulic gradient from these sites within the Santa Margarita aquifer, but plume migration has also been influenced at various times by the operation of each of the sites' groundwater extraction and treatment systems, and cones of depression created by municipal extraction wells. Currently, all groundwater extraction and treatment systems have been decommissioned, and there is no municipal pumping in the Santa Margarita aquifer in the area where contamination originated.

There are 2 known locations where contamination has migrated down through the Santa Margarita aquifer into the underlying Monterey Formation or Lompico aquifer and impacted SLVWD and SVWD public supply wells. These 2 wells are currently inactive:

- SLVWD Mañana Woods #2 is screened in both the Santa Margarita and Lompico aquifers in an area where the Monterey Formation is absent between the 2 aquifers. This well was impacted with MTBE and other gasoline breakdown products that were first detected in 2006. After discovering the impacts, groundwater pumped from this well was passed through a GAC treatment system to reduce VOCs below drinking water standards (Johnson, 2009).

- SVWD Well #9 is down-hydraulic gradient from Camp Evers and only 300 feet up-hydraulic gradient from onsite Watkins-Johnson monitoring wells impacted with VOCs. It is screened in the Monterey Formation. SVWD Well #9 is impacted with MTBE and several VOCs at concentrations below applicable drinking water standards.

Given that concentrations of contaminants in municipal extraction wells have not increased with time, it is assumed that contaminant sources have been addressed such that there is now limited migration of contaminant plumes. Regulating agencies provide impacted SMGWA member agencies with relevant information on monitoring and clean up. This information combined with regular monitoring of groundwater quality at all municipal extraction wells provides the information the public water supply agencies need to protect their wells.

Nitrate concentrations in groundwater throughout the Basin appear to have stabilized at a level that is well below drinking water standards. County standards now require that any new or replacement septic systems in sandy soils must incorporate enhanced treatment and denitrification to reduce nitrate discharge to groundwater.

2.1.3.4.6.3 Stormwater Recharge

There are intentional efforts to reduce stormwater runoff in the Basin by increasing on-site recharge. Stormwater retention and recharge is required by the City of Scotts Valley guidelines for new development projects (City of Scotts Valley, 2017). The City's guidelines are based on the CCRWQCB adopted Order R3-2013-0032 (July 2013). The Post-Construction Requirements mandate that development projects use Low Impact Development (LID) to detain, retain, and treat runoff. This has resulted and will continue to result in new on-site stormwater recharge in the Basin.

SVWD contributes to stormwater recharge via the implementation of LID projects in Scotts Valley. LID projects consist of applying stormwater best management practices (BMPs) – such as infiltration basins, vegetated swales, bio-retention and/or tree box filters – to retain and infiltrate stormwater that is currently being diverted into the storm drain system.

Infiltrated stormwater recharges the shallow aquifers in a manner similar to natural processes. The infiltration helps augment groundwater elevations and sustains groundwater contributions to stream baseflow that support local fish habitats. A complicating factor in implementing LID projects in the Scotts Valley area is that there is no centralized stormwater collection system, which limits the ability for large-scale projects to implement groundwater augmentation in the most beneficial areas.

Figure 2-7 shows the location of the LID facilities in relation to surface geology and the area where Santa Margarita Sandstone directly overlies Lompico Sandstone due to the absence of the less permeable Monterey Formation. All three LID facilities are located where Santa Margarita Sandstone overlies the Monterey Formation; therefore, there is less potential for the LID facilities to recharge the Lompico Sandstone. Monitoring equipment is installed to assess the performance of the facilities. The total amount of stormwater infiltrated at the 3 LID facilities is summarized in Table 2-7.

Table 2-7. SVWD Low Impact Development Infiltration Volumes

Water Year	Volume Infiltrated, AF			
	Transit Center	**Woodside HOA**	**Scotts Valley Library**	**Total**
2018	1.75	17.30	3.39	22.44
2019	3.08	31.17*	6.11*	40.38
2020	1.50*	14.97*	2.94*	19.42*

* estimated because dataloggers were not recording correctly

Transit Center LID

SVWD obtained grant funding through a County Prop 84 grant from the SWRCB for the planning, design, and construction of an LID retrofit at the Scotts Valley Transit Center site (Figure 2-7). The design included construction of a vegetated swale, a below-ground infiltration basin, and pervious pavement. Construction began in October 2016 and was completed in May 2017. In 2020, SVWD recorded a total of 1.5 acre-feet of infiltrated stormwater at this location (Montgomery & Associates, 2021).

Woodside HOA LID

As part of the Prop 84 grant match, SVWD worked with a local developer to install a stormwater recharge facility at the Woodside HOA along Scotts Valley Drive (Figure 2-7). This facility includes a large below-ground infiltration basin. Stormwater is routed from the development to the basin where it can percolate down into the groundwater. Initial hydrology reports estimated recharge on the order of 20 to 40 AFY might be achieved (Ruggeri, Jensen and Azar, 2010). In 2020, a total of 15 acre-feet of stormwater infiltrated at this location (Montgomery & Associates, 2021).

Scotts Valley Library LID

This LID was an earlier grant-funded project that installed a below-ground infiltration basin at the Scotts Valley Library (Figure 2-7). In 2020, a total of 3 acre-feet of stormwater infiltrated at this location (Montgomery & Associates, 2021).

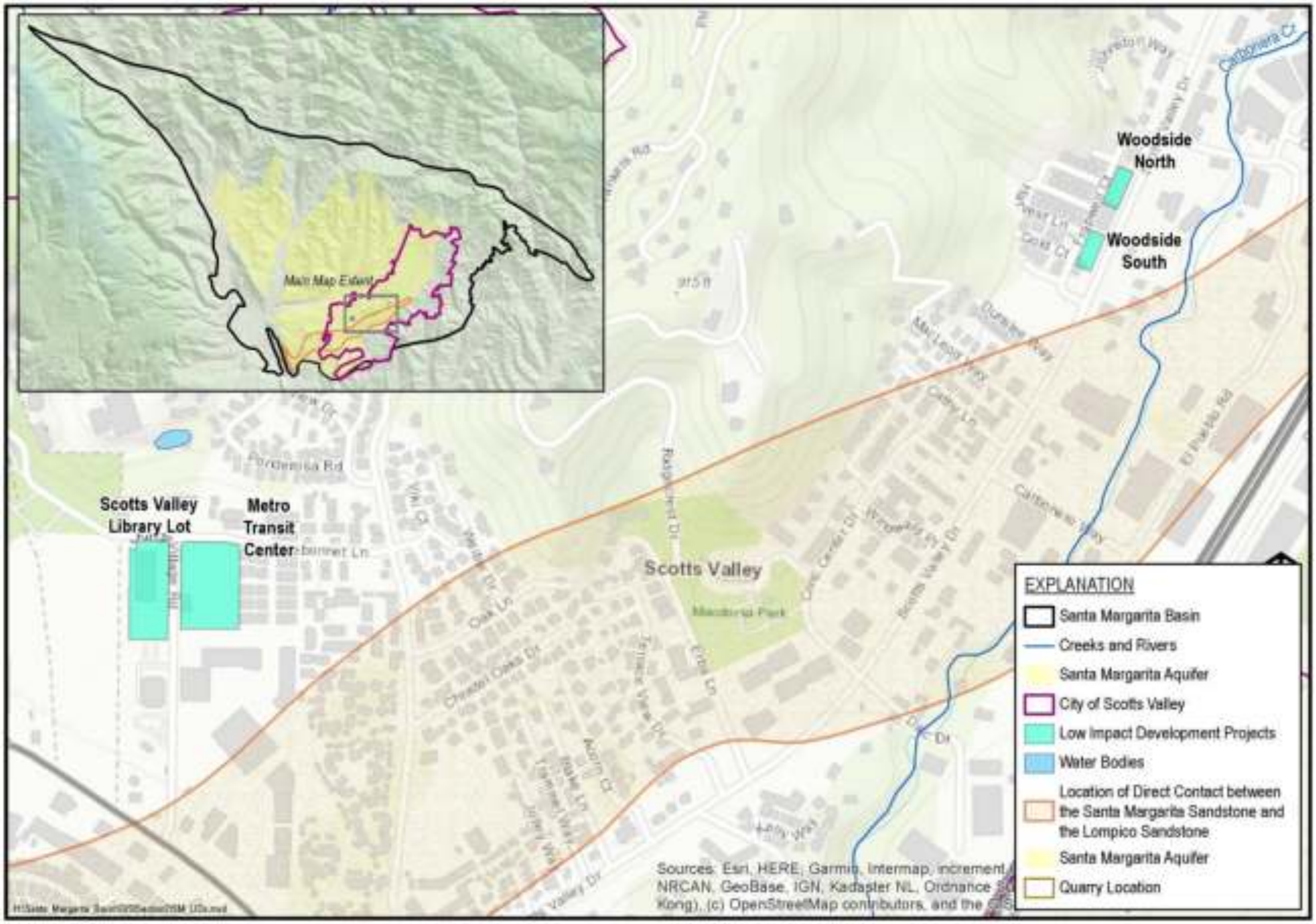


Figure 2-7. Location of SVWD Low Impact Development Projects

In addition to the large LID projects described above, SVWD was part of the Strategic and Technical Resources Advisory Groups for Ecology Action's regional sponsorship of the Prop 84 LID Incentives Grant. SVWD staff provided input on rating criteria for the landscape certification program and the structure of the grant reporting. Through 2018, 32 SVWD customers were awarded grant incentives for making stormwater management improvements to their properties, with strategies such as rainwater harvesting, lawn and hardscape removal, and stormwater retention methods, such as swales and rain gardens. According to SVWD staff records, the program provided 31,733 square-feet (0.73 acres) of permeable recharge area.

2.1.3.4.6.4 Diversions to Storage

SLVWD has limited storage capacity in their distribution system other than natural groundwater stored in the aquifers. In total it has 26 AF of storage within its service area. Of that total storage capacity, 21.8 AF is in 33 tanks serving the North System, 1.3 AF in 5 tanks serving the South System, and 2.9 AF in eight tanks serving the Felton System. Both pumped groundwater and diverted surface water are stored in these facilities. Bennett Spring is designated as a surface water source not permitted to be stored.

SVWD uses tanks to store up to 1.8 AF of recycled water and 13.3 AF of treated groundwater.

The City of Santa Cruz created the Loch Lomond Reservoir in the early 1960s by impounding Newell Creek with construction of the Newell Creek Dam. The reservoir is supplied by runoff from the Newell Creek watershed, as well as by flows diverted from the San Lorenzo River that are pumped up from the Felton Diversion Dam to the Loch Lomond Reservoir. It is the City's only reservoir and raw water storage facility. This makes it an integral part of their water system as it provides water supply for peak season demands and as a drought reserve. When full, the reservoir holds approximately 8,600 AF (or 2.8 billion gallons).

Private individuals who have riparian water rights for surface water diversion in the Basin are not permitted to store surface water.

2.1.3.4.6.5 Water Conservation and Use Efficiency

San Lorenzo Valley Water District Conservation Activities

SLVWD customers continue to demonstrate commitment to ongoing proactive conservation efforts. Currently, they are maintaining at least a 15-22% reduction in yearly water usage from 2013 consumption levels. According to SLVWD's 2020 Urban Water Management Plan (UWMP), its 2025 target water use is 85 gallons per capita per day (GPCD). The population served by SLVWD has met the 85 GPCD target during the latter part of the 2012-2015 drought and from 2018 to 2020. Since 1995, per capita water usage varied from a high of 104 GPCD in 2006 to a low of 70 GPCD in 2015.

SLVWD actively pursues incidents of water waste by investigating, recommending corrective action, and providing follow-up documentation of resolution. The water waste prevention ordinance (106) was most recently revised in May 2018 (Water Shortage Emergency Ordinance 106).

All SLVWD service connections are currently metered, and customers are billed by monthly volume of usage. As of July 2016, SLVWD's Board of Directors approved the Badger Meter project with the goal of installing the advanced metering technology at all meters. As of April 2020, about 20% of the meters have been upgraded. The new meters, combined with the Badger Eye on Water engagement portal, allow customers to view hourly usage history, setup leak detection alerts, and receive high bill notifications.

The majority of SLVWD's customer accounts are residential; therefore, they target indoor and outdoor water savings programs toward these customers. Residential water conservation is promoted by disseminating technical information on methods to reduce indoor and outdoor water use and by offering credits on customer bills for installation and/or replacement of appliances and lawns with approved water saving appliances and plantings. In Fiscal Year 2017/2018, SLVWD issued 46 rebates with an estimated water savings of 630,044 gallons.

SLVWD conducts a variety of public education activities such as a dedicated Water Use Efficiency Page on its website, e-Newsletters, billing inserts, and Instagram and Facebook postings. As a member of the Santa Cruz Water Conservation Coalition (watersavingtips.org), SLVWD contributes to presentations to the general public and professional organizations, and informational workshops.

In compliance with SB555, SLVWD has been conducting and submitting water loss audit reports to DWR. The SLVWD audit score was consistently between 49 and 51 in 2016 to 2019.

Scotts Valley Water District Water Use Efficiency Activities

SVWD recognizes that using water efficiently is an integral component of a responsible water management strategy and is committed to providing education, tools, and incentives to help its customers understand and manage the amount of water they use. SVWD's water demand has already shown significant decline in recent years, which is attributed to SVWD's ongoing water use efficiency activities in conjunction with the expansion of recycled water use for landscape irrigation. Since 2010, SVWD's water demand has been lower than its SB X7-7 2020 target of 154 GPCD (WSC & M&A, 2021). In December 2015, with the continuance of the drought and the Governor's Emergency Drought Regulations, SVWD potable demand was reduced to 93 GPCD. SVWD's calculated GPCD for 2020 is 96 GPCD. Since 2015, SVWD's annual potable demand has averaged 96 GPCD, ranging between 93 and 100 GPCD.

SVWD actively pursues incidents of water waste by investigating, recommending corrective action, and providing follow-up documentation of resolution. A water waste prevention ordinance was first adopted in 1983 and most recently revised in June 2020 (Policy P500-15-1).

All potable and recycled water use in SVWD is metered, and customers are billed by volume of usage on a bimonthly basis. An increasing block rate structure for residential customers has been in place since 1992 incentivizing the efficient use of water.

In 2017, the SVWD Board of Directors approved the advanced metering infrastructure (AMI) project with a goal of installing advanced metering technology at all meters. As of April 2021, all but less than 10 meters in the District have been upgraded. The new meters, combined with the WaterSmart customer engagement portal, allow customers to view hourly usage history, receive leak alerts and high-bill notifications, explore water saving actions and apply for rebates.

SVWD conducts a variety of public education activities such as a dedicated Water Use Efficiency Page on its website, regular ads in the local newspapers, e-newsletters, billing inserts, Instagram, and Facebook postings. SVWD's Water Use Efficiency Coordinator also makes presentations to the general public and professional organizations, conducts informational tours and is available for free water-wise house calls.

In response to the 2012-2015 Statewide drought, SVWD created a Think Twice Water Efficiency Campaign comprised of a customer scorecard, bumper stickers, lawn signs, 2-day per week watering schedule, enhanced rebates, hotel and food service placards, and a direct toilet replacement program. Customer response to the campaign was very positive and resulted in a 24% drop in potable water demand. The trend of efficient water use has continued with no significant bounce back in consumption since 2016.

SVWD continues to use the Think Twice Program, which has been slightly modified since the 2012-2015 drought. The 2020 Program comprises the following components:

1. Education and outreach,
2. Rebates,
3. Water waste policy, and
4. Water targets for potable landscape accounts.

https://www.svwd.org/sites/default/files/documents/reports/Program_Think_Twice.pdf

The Rebate Program is reviewed annually, and components are changed to achieve optimal use of ratepayers' dollars for incentivizing the efficient use of water. The 2020 Rebate Program includes nine categories: lawn or impervious hardscape replacement, spray irrigation replacement, spray to rotator nozzle replacement, greywater irrigation, rainwater cistern, downspout diversion, pressure regulator, toilet replacement, and urinal replacement. An example of the benefit of this program is demonstrated in estimated water savings of 950,00 gallons from 133 rebates in WY2019 and 923,000 gallons from 133 rebates in WY2020. These are estimated annual savings which carry over into subsequent years and realize cumulative savings as more rebates are added every year.

An additional conservation effort by SVWD, in compliance with SB555, involves conducting and submitting annual water loss audit reports to DWR. SVWD's audit score has improved every year: from 51 in 2016 to 53 in 2017 to 60 in 2019.

County of Santa Cruz Conservation Activities

The County of Santa Cruz is not a water purveyor and therefore does not have ratepayers that typically form the backbone of a water conservation rebate program. Despite this, they promote water conservation throughout the County in several ways. The County participates in the Water Conservation Coalition of Santa Cruz County (watersavingtips.org) to provide outreach and education to residents, and to offer trainings to specialists such as landscapers. The County requires source metering and reporting of monthly usage on all public water systems with 5 or more connections. County staff offer well soundings to private well owners who want to see if their water levels have changed.

The County's water conservation program includes the following elements:

- Enforcement of an ordinance on all residential users prohibiting wasteful uses of water
- Requirement for replacement of inefficient toilet and showerheads at time of property sale
- Implementing building code requirements for efficient fixtures for all new construction and remodels
- Requiring water conservation forms as part of any new well permits for wells expected to use over 2 AFY

2.1.3.4.6.6 Recycled Water

The City of Scotts Valley owns and operates the Scotts Valley WRF and Tertiary Treatment Plant. Influent to the WRF is sourced entirely from within the City of Scotts Valley. The recycled water is used by SVWD to augment its water supply and to offset its groundwater extraction for non-potable uses. Recycled water has been used in the Basin since WY2002. Recycled water use increased quickly over the first nine years of its use, and since 2011 use has been between 160 to 200 AF per year. From WY2002 through WY2020, approximately 2,670 AF of recycled water has been used in the Basin (Figure 2-8).

The following specific recycled water programs are implemented by the City of Scotts Valley and SVWD and discussed in more detail in Section 2.1.1.4.3:

- The City of Scotts Valley has an order mandating use of recycled water for irrigation for new construction when permissible and economically feasible.

- Recycled Water Fill Station was activated in 2016-2018 and 2021 to offer free recycled water to District customers and City residents for permitted uses.
- In 2016, the City of Scotts Valley and Pasatiempo Golf Club, located outside of the Basin, reached an agreement for the City of Scotts Valley to provide treated wastewater to the golf course for irrigation. This allows Pasatiempo Golf Club to reduce its reliance on potable water from the City of Santa Cruz during peak-use months when irrigation demand is high. In support of this regional effort, SVWD released 10% of its total recycled water allocation in exchange for compensation that can be applied toward funding future projects. SVWD did not have a current identified use for the amount of recycled water that it supplied to the golf course.

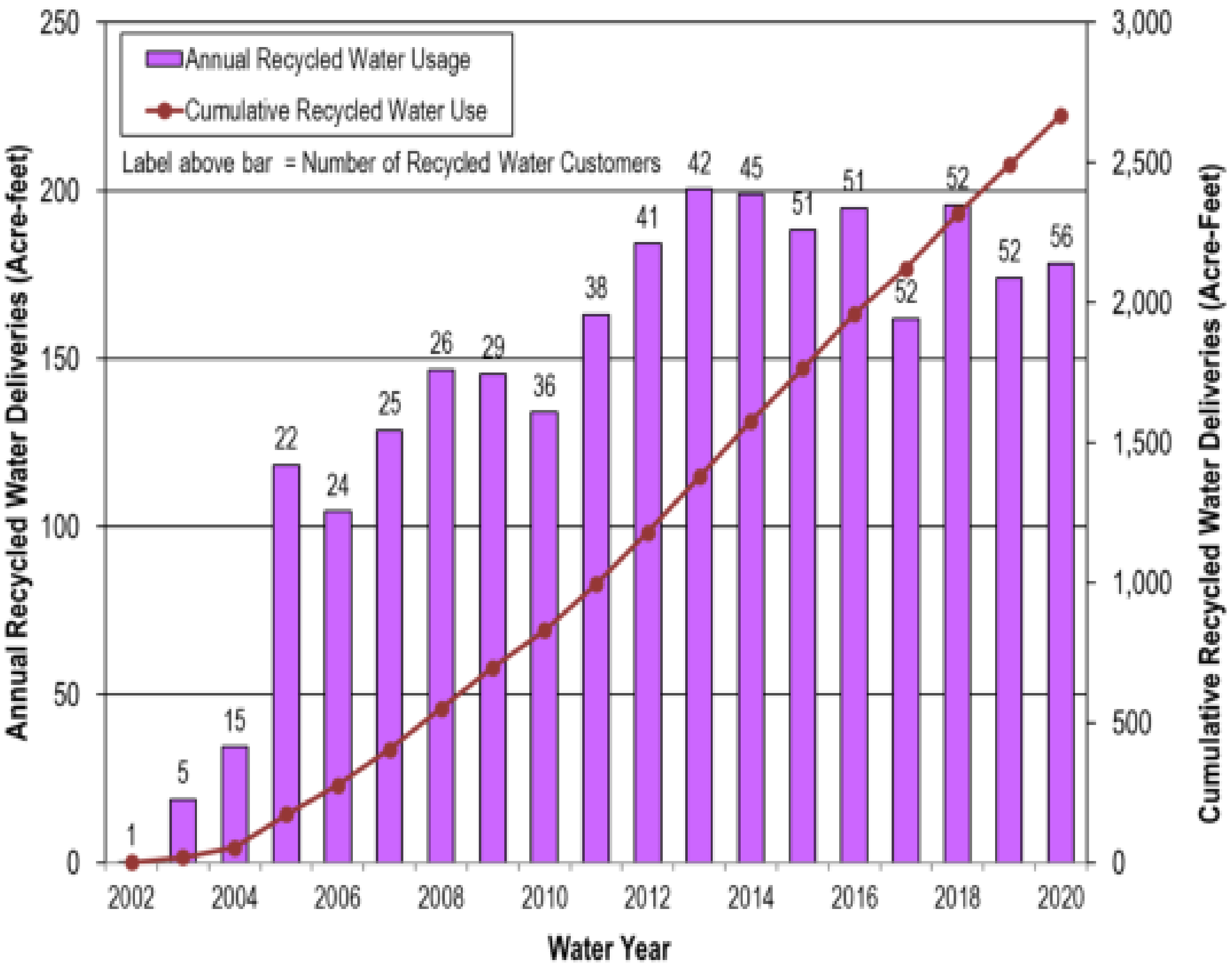


Figure 2-8. SVWD Reycled Water Deliveries, 2002-2020

2.1.3.4.7 Relationships with State and Federal Regulatory Agencies

Section 2.1.2 includes a description of monitoring and management programs that involve coordination with state and federal agencies. The SMGWA coordinated with representatives from the DWR throughout the GSP development. The following state and federal agencies were consulted during the preparation of this GSP:

- California Department of Fish and Wildlife (CDFW)
- California Department of Water Resources (DWR)
- Central Coast Regional Water Quality Control Board (CVRWQCB)
- National Marine Fisheries Service (NMFS, formerly NOAA Fisheries)
- State Water Resources Control Board (SWRCB)
- US Fish and Wildlife Service (USFWS)

As discussed in Section 2.1.4.1.1.2, the SMGWA established a Surface Water Technical Advisory Group that included local resource area experts, non-governmental organizations with extensive resource management and protection experience, and state and federal resource and regulatory agencies. The purpose of this group was to gather experts to discuss the resources, agency mandates, and best available science to develop recommendations for the SMGWA Board to consider when developing its depletion of interconnected surface water sustainable management criteria for the GSP.

In addition to working with various resource management agencies during the development of the GSP, SMGWA member agencies including the County of Santa Cruz, SLVWD, and SVWD have all established long-term working relationships with the resource management agencies identified above. Ongoing coordination and collaboration with these agencies focus on planning for and managing utility and resource protection programs and projects, utility operations, and development and construction of capital improvement projects.

2.1.3.4.8 Land Use Planning Related to Potential Risks for Groundwater Quality or Quantity

The land use change that could potentially affect groundwater quantity would be an expanded suburban population and accompanying increase in municipal groundwater demand. Commercial and suburban residential land development can increase paved surfaces in the Basin, which potentially decrease recharge if not offset with onsite infiltration of runoff. Decreased recharge in areas underlain by the Santa Margarita aquifer could potentially cause reduced quantity and quality of groundwater in that aquifer. Current planning by SVWD, SLVWD, and the County does not anticipate a large increase in the Basin's population. SVWD population is projected to increase annually by 0.87% from 2020 to 2045 and SLVWD's population is projected to increase annually by 0.15% over the same time period (WSC & M&A, 2021). Current CCRWQCB stormwater policies require that all new development and redevelopment include measures to maintain runoff and infiltration rates at pre-development levels (City of Scotts Valley, 2017). Furthermore, projects and management actions to be implemented and included in Section 4 of this GSP increase water supply resiliency and achieve sustainability while considering anticipated future water demands related to population growth.

An increase in the Basin's rural population, most of whom are served by septic systems rather than by municipal wastewater systems, may also affect groundwater quantity and quality by increasing groundwater use and potentially leaching nitrate and other organic compounds to groundwater. There is no expected expansion of communities on septic systems according to the County. Any new rural development using septic systems in the sandy soils of the Basin requires use of enhanced treatment to reduce nitrogen and other constituents prior to wastewater dispersal.

There are several sand quarry sites in the Basin that are now either closed or not operating at full capacity. A land use change at these sites, either to a recurrence of mining or to another land use, has the potential to impact groundwater quality by mobilizing contaminants present on site. Permitting by SCEH should identify and mandate solutions to groundwater quality issues at these sites.

2.1.3.4.9 Impacts on Groundwater Dependent Ecosystems

The SGMA legislation identified protection of GDEs as 1 of the goals of sustainable groundwater management. Per the definitions in the GSP Regulations § 351(m), GDEs refer to "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface." Interconnected surface water is defined by § 351(o) 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."

Impacts to GDEs within the Basin have yet to be identified. The groundwater model shows a Basin-wide reduction in streamflow from pumping, but without GDE monitoring data, a quantifiable correlation has yet to be established. On-going programs such as Santa Cruz County's Juvenile Steelhead and Stream Habitat Monitoring Program have monitored steelhead density and stream habitat since 1994. No correlation between the amount of creek baseflow and fish density or habitat availability has been identified, perhaps because other factors, both anthropogenic and naturally occurring, can affect habitat abundance. GDE data collected per the monitoring plan in Section 3 is anticipated to provide the necessary data to establish whether there is a connection between groundwater conditions and the abundance of GDE habitat and priority species.

2.1.4 Notice and Communication

2.1.4.1 Communication and Engagement

2.1.4.1.1 Decision-Making Process

2.1.4.1.1.1 SMGWA Board of Directors

The JPA between SVWD, SLVWD, and the County of Santa Cruz (included as Appendix 1B) that created the SMGWA requires the GSA to hold public meetings at least quarterly. The meetings are required to be noticed and meet all of the requirements of the Ralph M. Brown Act for transparency in California government. To hold a valid meeting, the SMGWA must have a quorum of the Board of Directors, which consists of an absolute majority of directors plus 1 director. With these requirements in mind, the SMGWA:

- Holds board meetings on a regular schedule (every month)
- Provides written notice of meetings with meeting agenda and meeting materials available at least 72-hours prior to the meeting time
- Sends email meeting reminders to SMGWA's contact lists that includes approximately 345 unique email addresses
- Posts meeting agenda at the meeting location prior to the meeting as required

Under SGMA, the SMGWA Board of Directors is responsible to approve a GSP and submit it to DWR on or before January 31, 2022. Once a quorum is present, most SMGWA decisions require a simple majority of all appointed directors participating in the vote. If a director is disqualified from voting on a matter before the Board because of a conflict of interest, that director shall be excluded from the calculation of the total number of directors that constitute a majority.

There are certain matters that come before the SMGWA Board of Directors that require a unanimous vote of all SMGWA member agency directors participating in the vote. These include approval of any of the following:

- Capital expenditures estimated to cost $50,000 or more
- Annual budget
- GSP for the Basin or any future amendments
- Levying of assessments or fees
- Issuance of indebtedness
- Stipulations to resolve litigation concerning groundwater rights within or groundwater management for the Basin

SMGWA agendas include general public comments at the beginning of each board meeting. General comments allow community members to raise any groundwater related issue that is not on the agenda. Public comment time is also given prior to a vote on all agenda items to ensure public opinion can be incorporated into SMGWA Board of Director decisions. The public may also make submissions to the board for inclusion in the meeting packet.

The SMGWA Board directs agency staff to fulfill the various requirements of SGMA. To do this, SMGWA staff provides the Board with research and recommendation staff reports, work plans, technical summaries, budgets, and other work products as required to support Board decision-making.

2.1.4.1.1.2 Surface Water Technical Advisory Group

Representatives from the following organizations and agencies participated in 2 technical Surface Water Technical Advisory Group (TAG) meetings to assist with development of sustainable management criteria:

- California Department of Fish and Wildlife
- California Department of Water Resources
- City of Santa Cruz Water Department
- County of Santa Cruz Environmental Health
- Environmental Defense Fund
- Land Trust of Santa Cruz County
- National Marine Fisheries Service (formerly NOAA Fisheries)
- The Nature Conservancy
- Resource Conservation District of Santa Cruz County
- San Lorenzo Valley Water District
- Santa Margarita Groundwater Agency
- Scotts Valley Water District
- U.S. Fish and Wildlife Service

The 2 meetings held on August 14, 2020, and February 24, 2021, provided the TAG background information on the hydrogeological setting of the Basin, City of Santa Cruz habitat conservation planning, Santa Cruz County fish monitoring, potential conjunctive use opportunities for SLVWD, water budget, and current understanding of the relationship between surface water and groundwater. Based on the background information available, the technical team shared potential approaches for developing SMC for the depletion of interconnected surface water and plans for

GDE monitoring. The TAG was asked to provide specific input on the SMGWA Board's statement of significant and unreasonable, potential SMC approaches, and GDE monitoring plan. Their expert input was taken into account in the development of SMC and the GDE monitoring plan.

2.1.4.1.2 Communication and Engagement Plan

A Stakeholder Communication and Engagement Plan (C&E Plan) has been developed to assist the SMGWA in its efforts to disseminate and receive feedback on relevant information and to engage the public, including groundwater beneficial users, regarding the development and implementation of SMGWA's GSP with a particular focus on fulfilling and exceeding the requirements of § 354.10 Notice and Communication of the SGMA). The C&E Plan, included as Appendix 2A, is a work plan to ensure sufficient opportunities for public participation are included in the GSP process.

The C&E Plan also provides SMGWA board members and staff a guide to ensure consistent messaging about SGMA requirements and other related information. It establishes a roadmap for GSP development that identifies how and when beneficial users and other stakeholders can provide timely and meaningful input into GSA decision-making. Additionally, the C&E Plan ensures beneficial users and other stakeholders in the SMGB are informed of milestones and offered opportunities to participate in GSP development and implementation.

The C&E Plan covers a 4-phase approach that includes ongoing communication efforts, GSP development, GSP rollout, and future efforts following GSP submission in January 2021 and beyond as the GSP is implemented.

Stakeholder involvement and public outreach is critical to GSP development and implementation because it helps promote the plan development based on input and broad support. Some essential elements of public outreach are providing timely and accurate public reporting of planning milestones through the distribution of outreach materials and posting of materials on the SMGWA website, securing quality media coverage and utilizing social media.

The phased approach to outreach allows opportunities to assess the program and evaluate how the C&E Plan is performing against its goals and objectives. Assessment is conducted by the cooperating agency staff and reviewed by Board members during quarterly communications updates to the Board.

Ongoing activities in the GSP implementation phase starting in 2022 are expected to include: maintenance of the SMGWA website; continued social media presence through Facebook and Instagram; email newsletter; youth engagement efforts; promoting and conducting community meetings, workshops and events; coordination with member agencies to share information; and developing print materials as necessary.

2.1.4.2 Beneficial Users of Groundwater

As part of the GSP process, beneficial users of groundwater in the Basin are identified by the SMGWA based on categories described in the SGMA and codified in CWC §10723.2. Beneficial users of groundwater in the Basin include municipal well operators, agricultural users, private domestic well owners, small water systems, local land use planning agencies, surface water users, environmental users of groundwater, California Native American Tribes, disadvantaged communities (DACs), protected lands (including recreational areas), public trust uses (including wildlife, aquatic habitat, fisheries, recreation, and navigation), and entities engaged in monitoring and reporting groundwater elevations.

CWC §106.3 recognizes that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." The Human Right to Water extends to all Californians, including disadvantaged individuals, groups, and communities in rural and urban areas. When developing this GSP, the SMGWA considered impacts on all beneficial uses and users, including domestic well owners and DACs. By addressing all beneficial uses and users, the GSP has addressed California's Human Right to Water

2.1.4.2.1 Municipal Water Agencies

The primary groundwater extractors in the Basin are the 2 municipal water agencies described in Sections 2.1.1.4.2.1 and 2.1.1.4.2.2: SLVWD and SVWD, respectively. Figure 2-9 shows the locations of active municipal water supply wells used by the 2 water districts, and Figure 2-33 shows their historical annual extractions relative to other groundwater extractors. Where the municipal water agencies' source of water supply is groundwater, their customers are beneficial users of groundwater.

The City of Santa Cruz and its customers are indirect user of groundwater in the Basin. Since surface water is interconnected with groundwater in the Basin, the City of Santa Cruz is an indirect groundwater user because the surface water it diverts from the San Lorenzo River for municipal use partially comprises baseflows supported by Basin groundwater discharge to creeks. The City owns property, which is partly located in the Basin, associated with water supply use and construction of the Loch Lomond Reservoir.

2.1.4.2.2 Mount Hermon Association

The Mount Hermon Association (MHA) is located near Bean Creek upstream from the confluence with the San Lorenzo River (Figure 2-9). MHA is a year-round conference center and camp that serves more than 60,000 guests each year and a community of approximately 1,300 people living in 450 homes. Groundwater is the sole source of potable water supply for the conference center and surrounding homes. MHA's water supply is from 2 wells located on MHA property. Figure 2-33 shows MHA's historical annual extractions relative to other groundwater extractors. Average groundwater extracted since MHA started using groundwater in 1991 is 172 AFY. Over the past 5 years pumping has been reduced to around 140 AFY due to increased water conservation awareness in the community. The Joint Powers Agreement (JPA) provides that MHA has 1 representative on the Board.

2.1.4.2.3 Small Water Systems

There are 12 small water systems (SWS) supplying water to 5 or more residential connections within the Basin, serving a population of approximately 1,000. Most SWS use groundwater, but some have water rights to divert surface water as their water source (Table 2-8).

Table 2-8. Small Water Systems in the Santa Margarita Basin

Small Water System	Number of Connections	Water Source
Fern Grove Water Club	67	groundwater
Fernbrook Woods Mutual Water Company	10	groundwater
Forest Springs	126	supplied water from outside the Basin
Hidden Meadow Mutual Water Company	17	groundwater
Karls Dell	8	groundwater
Love Creek Heights Mutual Water Association	7	groundwater
Mission Springs Conference Center	118	groundwater
Moon Meadows Water Company	5	groundwater
Quail Hollow Circle Mutual Water Company	7	spring
Roaring Camp	non-community	groundwater
Vista Robles Association	21	groundwater
Zayante Acres Mutual Water Company	8	spring

Source: State Water Resources Control Board, Division of Drinking Water

2.1.4.2.4 Private Domestic Pumpers

In areas where there is no municipal or small water system supply, private individuals extract groundwater for residential purposes from wells they own or share ownership with fewer than 5 other homes. It is estimated that the population of the Basin depending on private water supply is approximately 3,000. The approximate locations of private domestic pumpers are shown on Figure 2-9. Typically, these users extract less than 2 AFY. Under the SGMA, domestic use less than 2 AFY is called *de minimis* use and is exempt from metering by the SMGWA.

2.1.4.2.5 Disadvantaged Communities

There are 2 DAC Census Block Groups, both of which are partially located within the Basin (Figure 2-9). Within the Basin, the DACs include part of the Census Designated Places of

Boulder Creek, Brookdale, and Ben Lomond. These communities were severely impacted by the CZU Complex wildfires in August 2020. Some of the DAC residents receive their water from SLVWD, but there are also many that rely on private domestic wells as shown on Figure 2-9. All parcels within the DACs are on septic or a small community wastewater disposal system.

Unlike many DACs throughout California, these Block Groups are not a cohesive community. They are generally made up of small parts of several disparate larger communities that have been grouped together by the Census. The Block Group also provides an artificial boundary within which to focus special attention. In all of the communities located within the Basin, there are people who meet the income requirements considered “disadvantaged”, but they are not concentrated together in a defined location. Communities within the Block Group are grouped into beneficial user types under their source of water supply, which is either municipal water or privately pumped (Figure 2-9).

2.1.4.2.6 Agricultural Irrigators

Of the approximately 18 acres of agriculture-zoned parcels in the Basin, only less than 0.2 acres are being irrigated. This irrigation is at a vineyard currently owned by Skov Winery. A vineyard has existed here since 1972. Currently, there are no official records of cannabis cultivation and its irrigation in the Basin. In future updates to the GSP, cannabis irrigation should be considered when records are available.

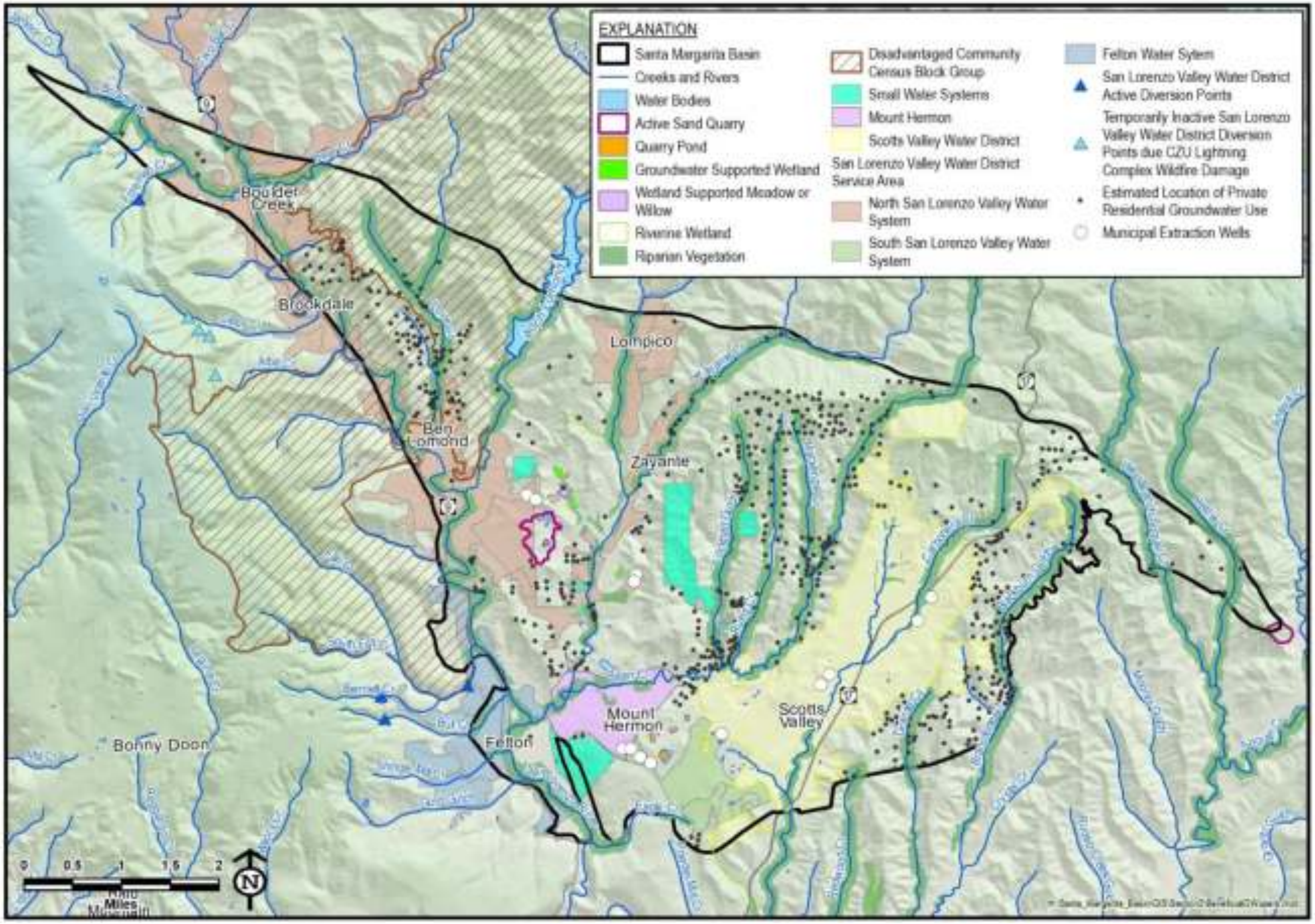


Figure 2-9. Benefical Users of Groundwater in the Santa Margarita Basin

2.1.4.2.7 Industrial Users

Groundwater pumping for industrial use in the Basin is currently minimal. Historically, more groundwater was pumped by the operators of the 3 sand quarries (Hanson Quarry, Olympia Quarry, and Quail Hollow Quarry) for process water and dewatering. Hanson and Olympia Quarries ceased operations in the early 2000s and are undergoing restoration. Quail Hollow is still an active quarry, though concurrent reclamation efforts are underway in some areas where mining has ceased.

2.1.4.2.8 Ecological Users

Groundwater dependent ecosystems in the Basin support many different species, some of which are listed as priority species by either the federal Endangered Species Act of 1973 (U.S.C. §1531 et seq.; USFWS, 2021) or the California Endangered Species Act of 1970 (Fish and Game Code § 2050 et seq.; CDFW, 2021). For example, Central California Coast coho salmon and Central California Coast steelhead trout are federally listed as endangered and threatened, respectively. Other priority species that depend on instream flows for sustenance including lamprey, California red-legged frog, western pond turtle, and California giant salamander.

The San Lorenzo River is an important river for local fisheries. Historically, the river supported the largest coho salmon and steelhead trout fishery south of San Francisco Bay. While coho salmon are critically endangered in the San Lorenzo Watershed (and Santa Cruz and San Mateo counties, in general), the federal recovery plan identifies the San Lorenzo Watershed as an "independent watershed" and critical for recovery within the Central California Coast evolutionary significant unit. Coho salmon successfully reproduced in the San Lorenzo Watershed in 1981, 2005 and 2008 in limited areas. In addition, adult coho salmon have been observed in the lagoon and in Felton during other years. Coho salmon do have the capacity for recovery, as shown by their new intermittent (i.e., not every year) population in Laguna Creek. As required by SGMA, the GSP should conform with existing management plans such as federal recovery plans.

The San Lorenzo River has been designated as a fully appropriated stream during the summer months to maintain environmental flows in the river to support fish habitat. While these bypass flows produce important instream benefits in riverine environments, they produce equally important benefits for the San Lorenzo River estuary/lagoon that provides critical habitat for rearing of juvenile steelhead.

Critical species in the Basin that likely rely on GDEs are compiled from the California Natural Diversity Database and information available from the California Department of Fish and Wildlife (CDFW) and The Nature Conservancy (TNC; CDFW, 2020a; TNC, 2021). The priority species, and their locations either known or thought to be found in the Basin are summarized in Table 2-9. GDEs in the Basin are discussed in more detail in Section 2.2.4.9. Additional species that should be considered but are not listed as priority species are presented in Table 2-10 lists species that are co-beneficiaries of the priority species; if the habitat requirements of the priority species are met then the habitat requirements of the co-beneficiary species are also met. The co-beneficiaries are currently not listed threatened or endangered species.

Table 2-9. Groundwater Dependent Species Identified for Priority Management

Species Common Name	Type of Species	Occurrence Frequency	Location(s)
California Giant Salamander	Amphibian	Frequently present	Probably distributed widely in basin. Bean Creek, Lockhart Gulch, Ruins Creek, Zayante Creek, Lompico Creek, San Lorenzo River
California Red-Legged Frog	Amphibian	-	Bean Creek, Mountain Charlie
Coho Salmon	Fish	Rare	Bean Creek, Zayante Creek, San Lorenzo River
Lamprey	Fish	Occasional to Common	Bean Creek, Zayante Creek, Newell Creek, San Lorenzo River
Steelhead	Fish	Common	Bean Creek, Zayante Creek, Lompico, Mackenzie, San Lorenzo River, Newell Creek, Love Creek, Boulder Creek
Western Pond Turtle	Reptile	Rare	Zayante Creek, Newell Creek, San Lorenzo River

Species with no quantified frequency marked with "-"

Table 2-10. Groundwater Dependent Species Identified as Co-Beneficiaries of Priority Species

Species Common Name	Type of Species	Occurrence Frequency
Belted Kingfisher	Bird	Occasional
California Dipper	Bird	Rare; feeds in streams
California Newt	Amphibian	-
California Roach	Fish	Common
Coastrange Sculpin	Fish	Common
Common Merganser	Bird	Uncommon
Dace	Fish	Common
Deceiving Sedge/Santa Cruz Sedge	Plant	-
Downy Woodpecker	Bird	Common
Marsh Sandwort	Plant	-
Mount Hermon June Beetle	Insect	-
Prickly Sculpin	Fish	Common on Newell Creek
Rough Skinned Newt	Amphibian	-
Sacramento Sucker	Fish	Common
Santa Cruz Black Salamander	Amphibian	-
Slender Salamander	Amphibian	-
Swamp Harebell	Plant	-

Species Common Name	Type of Species	Occurrence Frequency
Tidewater Goby	Fish	Rare
Warbling Vireo	Bird	Uncommon
Western Bumble Bee	Insect	-
Western Pearshell	Bivalve (Mussel)	-
Western Red Bat	Mammal	CA species of special concern
Western Sycamore	Plant	-
Western Wood-Pewee	Bird	Uncommon

Species with no quantified frequency marked with "-"

The City of Santa Cruz has reached a level of agreed flows in the San Lorenzo River and will be formalizing those flows through its pending water rights action. Current regulatory instream flow requirements exist on Fall Creek upstream of its confluence with the San Lorenzo River (see Figure 2-5 for location), Newell Creek below Loch Lomond Reservoir, and the San Lorenzo River at Felton. For Fall Creek, the minimum November through March bypass flow is 0.75 cubic foot per second (cfs) for dry years, and 1.5 cfs for other years; April through October bypass flow is 0.5 cfs for dry years, and 1.0 cfs for other years. Dry years are defined based on cumulative flow volume in the San Lorenzo River at Big Trees from the beginning of the water year. On Newell Creek below Loch Lomond Reservoir, a flow of 1.0 cfs must be maintained year-round to provide adequate depths for fish passage and spawning. On the San Lorenzo River at Big Trees, if flows fall below monthly minimum rates of 10.0 cfs in September, 25.0 cfs in October, or 20.0 cfs November through May, diversions from Fall and Bull Creeks must be terminated (Exponent, 2019).

While these are currently the only locations with mandated flows in the Basin, there are many resources available to evaluate instream flows if a basin-wide approach is warranted. North Coast Instream Flow Policy (R2 Resource Consultants, Inc and Stetson Engineers, 2008) provides guidelines for maintaining instream flows to protect anadromous salmonids. In general, summer rearing flows are just as critical, if not more so than spawning and passage flows. Summer rearing flows when the creek flow mostly comprises baseflows fed by groundwater are more impacted by groundwater extraction than spawning and migration flows, which are primarily influenced by rainfall and runoff.

Table 2-11 lists minimum stream depth and dates for passage, and Table 2-12 lists dates, minimum stream depths, favorable velocities, and useable substrate for spawning.

Table 2-11. Steelhead and Coho Minimum Passage Criteria

Species	Dates	Minimum Passage Depth Criterion (feet)
Steelhead	November 1 to March 31	0.7
Coho	October 1 to February 28	0.6

Table 2-12. Steelhead and Coho Spawning Criteria

Species	Dates	Minimum Depth (feet)	Favorable Velocities (feet/second)	Useable Substrate D_{50} (mm)
Steelhead	December 1 to March 31	0.8	1.0-3.0	12-46
Coho	November 1 to February 28	0.8	1.0-2.6	5.4-35

A variety of other methods and models can be used to estimate instream flow requirements that provide the minimum depths required for fish passage or spawning:

- 1-D and 2-D hydraulic models to assess flow depths and velocities for streams with available topographic data.
- Physical Habitat Simulation developed by the USGS combines both biologic and hydraulic inputs to simulate the relationship between streamflow and physical habitat to establish instream flow requirements (USGS, 2012).
- Regression equations are another option when site-specific topographic data are absent, but streamflow data are available (R2 Resource Consultants, Inc and Stetson Engineers, 2008). These equations were developed by establishing a relationship between cross-sectional data with mean annual flow for unimpaired gaged.
- Field-based approaches such as the Wetted Perimeter Method can also be used by performing repeat transects at various flow rates at known hydraulic bed controls (CDFW, 2020b).

Understanding the biological response of priority species to available habitat is another important consideration. Santa Cruz County's Juvenile Steelhead and Stream Habitat Monitoring Program measures the density of juvenile steelhead and assesses habitat conditions for steelhead and coho salmon in 4 watersheds of Santa Cruz County including the San Lorenzo River watershed. Presence/absence data are collected for select species of fish, amphibian, and reptiles including all the priority species listed in Table 2-9. Habitat data are also collected in select stream reaches. The species and habitat data are compiled into an annual report and a geodatabase for spatially referenced information. This work is ongoing and has occurred in every fall since 1994 (Beck et al., 2019), and can be used to establish links between streamflow, groundwater conditions, GDE habitat, and presence or absence of priority aquatic species.

The City of Santa Cruz is currently in the process of preparing or implementing 3 different Habitat Conservation Plan(s) [HCP(s)] that will help protect environmental beneficial users of groundwater (City of Santa Cruz, 2011 and 2020). An HCP is a planning document required as part of an Incidental Take Permit under the Endangered Species Act. The HCP describes effects of City activities that may result in any harm or damage to threatened and endangered species (incidental take), and how those effects will be tracked, avoided, minimized, and mitigated.

Multiple species are covered by 3 different HCPs for City activities:

- Administrative draft Anadromous Salmonid HCP submitted to the National Marine Fisheries Service (NMFS) and CDFW on July 10, 2020
- Administrative draft USFWS HCP for 10 species that are state or federally listed as threatened, endangered, or species of special concern is currently in final review
- Low Effect Mount Hermon June beetle HCP currently being implemented

The City of Santa Cruz has agreed with NMFS and CDFW on long-term minimum streamflows (Agreed Flows). The City of Santa Cruz plans to complete the Anadromous Salmonid HCP with NMFS and an Incidental Take Permit with CDFW by 2023.

2.2 Basin Setting

2.2.1 Overview

The Santa Margarita Groundwater Basin lies in the north central portion of Santa Cruz County (Figure 2-1) in the Santa Cruz Mountains. The Basin is a geologically complex area that was formed by the same tectonic forces along the San Andreas fault zone that created uplift of the Santa Cruz Mountains and the rest of the California Coast Range.

The Basin consists of a section of sandstone, siltstone, and shale/mudstone overlying a basement of granitic and metamorphic rocks, all of which have been folded into a geologic trough called the Scotts Valley Syncline. The sedimentary rocks are divided into numerous formation based on the types of rock and their relative ages, as determined by field mapping and paleontological studies performed by the United States Geological Survey (Clark, 1981; Muir, 1981; Brabb et al, 1997; McLaughlin et al, 2001). The sandstone formations make the best aquifers due to their large porosity and permeability. Three serve as the primary aquifers that are pumped to supply much of the Basin's water demand: Butano Sandstone, Lompico Sandstone, and Santa Margarita Sandstone.

2.2.2 Topography

In general, surface elevation within the Basin increases to the north and east. Elevations within the Basin range from approximately 300 feet above mean sea level (amsl) in the vicinity of the San Lorenzo River at the southern end of the Basin, to more than 1,500 feet amsl along the northern boundary of the Basin at the peak of Mount Roberta. Figure 2-10 is a topographic map for the Basin.

At its northern margin, the Basin is characterized by a series of ridges and peaks running roughly parallel to the Zayante-Vergeles Fault. Named peaks include Mount Roberta (~1,500 ft amsl) and Eagle Dell Peak (~1,400 ft amsl). The rugged terrain of the northern part of the Basin is comprised of north-south trending, steep ridges alternating with V-shaped valleys. The topography is gentler and rolling in the southern and central parts of the Basin where the weakly consolidated Santa Margarita Sandstone occurs at the surface. At the south end of the Basin a relatively low-lying area stretches from Scotts Valley to Felton, where it joins the San Lorenzo River Valley. The San Lorenzo River Valley crosses the entire Basin near its western margin. Similarly, low-elevation valleys contain Newell Creek, Zayante Creek and Bean Creek, which are tributaries to the San Lorenzo River. The varied topography in the Basin is illustrated in a 3-dimensional rendering in Figure 2-11.

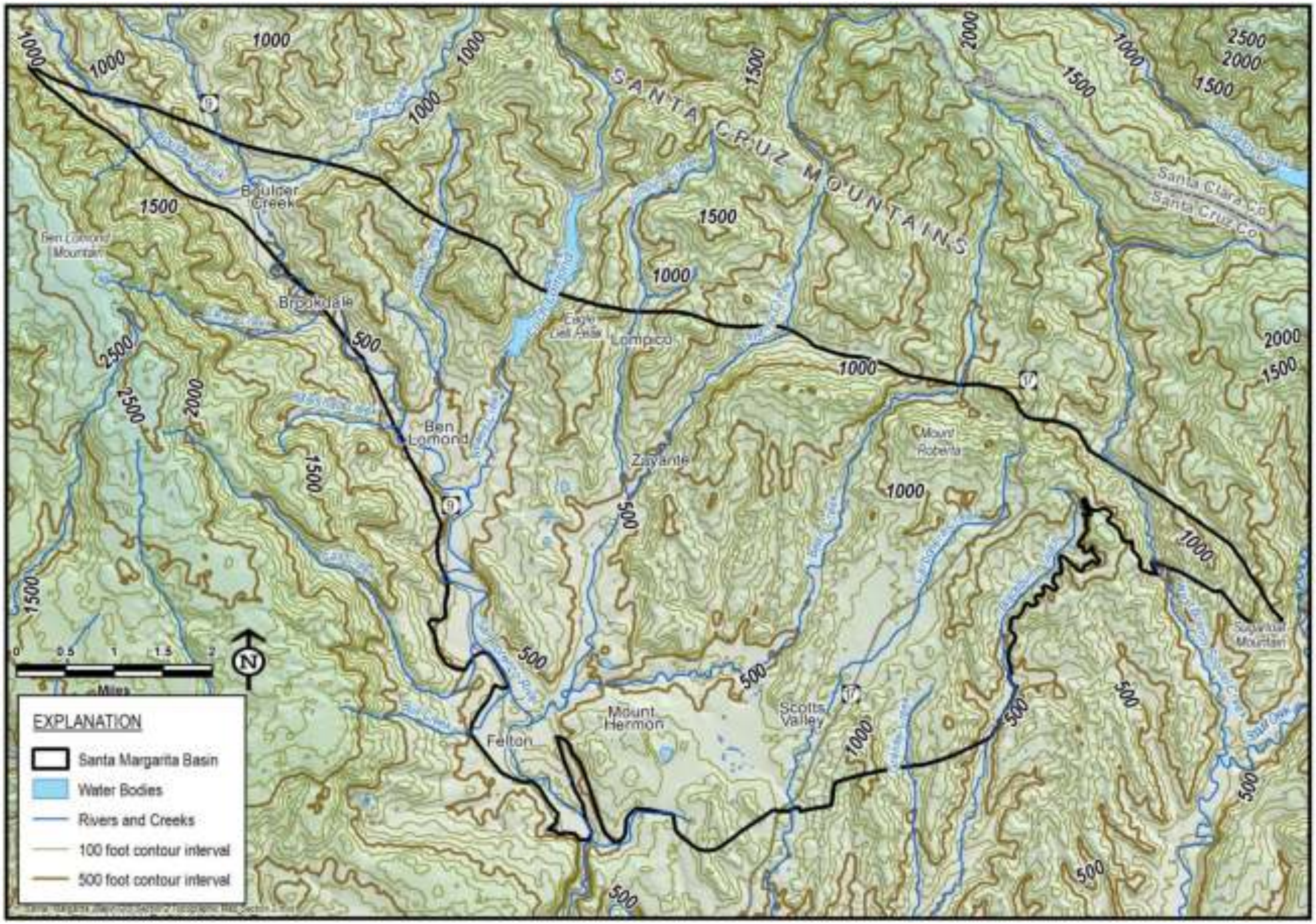


Figure 2-10. Santa Margarita Basin Topography

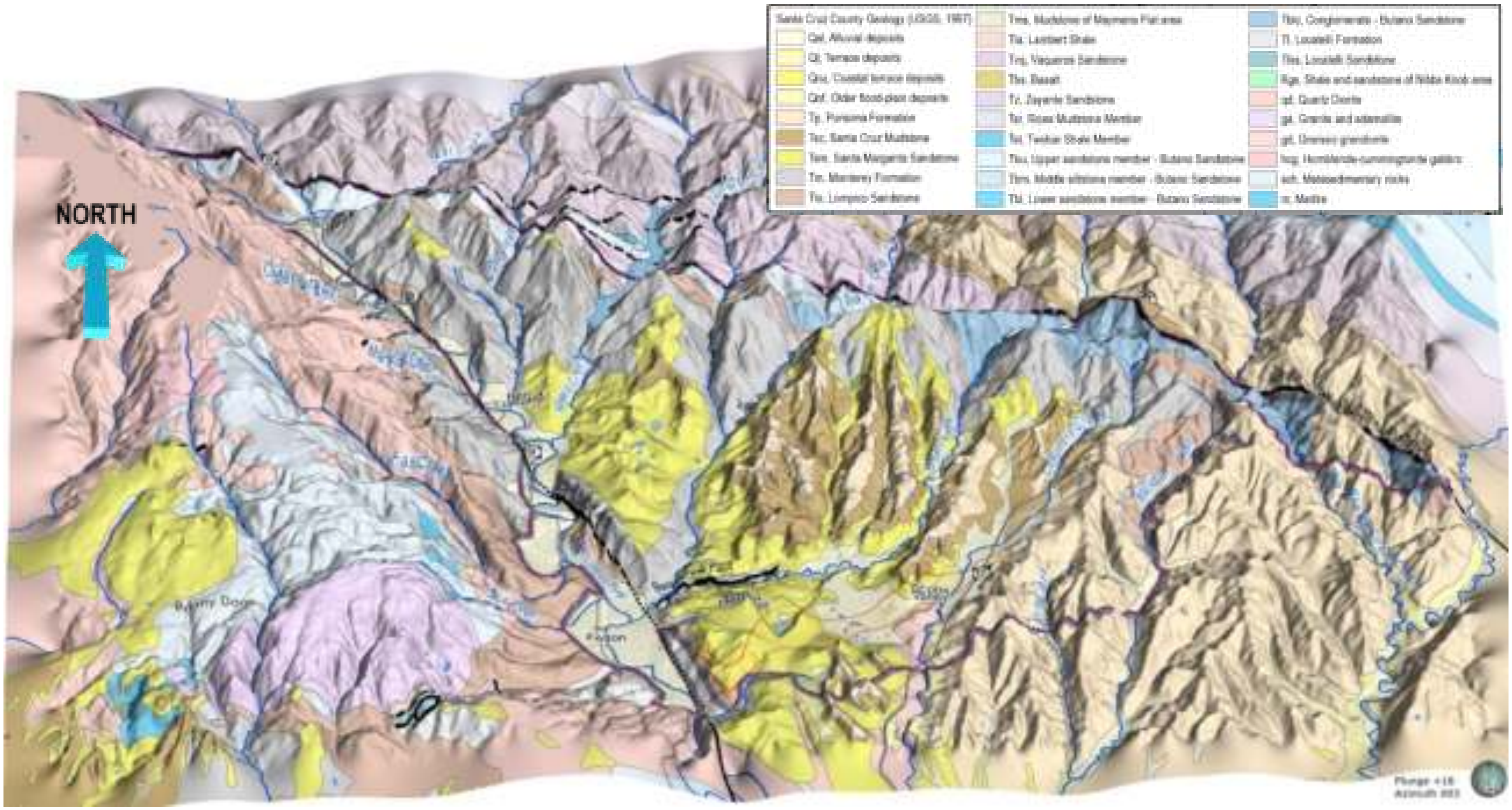


Figure 2-11. Three-Dimensional Topography of the Santa Margarita Basin with Surface Geology (3x exaggeration)

2.2.3 Climate

2.2.3.1 Historical Climate

The climate in Santa Margarita Basin is classified as Mediterranean, characterized by distinct rainy and dry seasons, warm summers, and mild winters (Kennedy/Jenks Consultants, 2015b). In an average year, almost all the Basin's precipitation occurs from November through April. Almost all precipitation is rainfall, though occasionally snow falls at the higher elevations. Precipitation increases across the Basin east to west from about 42 inches per year to 52 inches per year due to increased elevation and the orographic effect of Ben Lomond Mountain west of the Basin. The distribution of precipitation across the Basin from 1981-2010 is displayed on Figure 2-12.

Precipitation and temperature are measured at the El Pueblo Yard weather station in Scotts Valley (elevation ~580 feet above mean sea level [amsl]) and at the Boulder Creek weather station in downtown Boulder Creek (elevation ~508 feet amsl). Station-specific precipitation range, average, and annual departure from the average for the period between 1947 and 2018 are provided on Figure 2-12 and Figure 2-13. Average annual precipitation at the El Pueblo Yard station is 42 inches, with a maximum of 86 inches in WY1983, and a minimum of 20 inches in WY2014 (Table 2-13). Average annual precipitation at the Boulder Creek station is 52 inches, with a maximum of 112 inches in WY1983, and a minimum of 19 inches in WY1986 (Table 2-13). The temperature record is similar at the 2 stations. The average minimum and maximum temperatures are about 32ºF and 77ºF, respectively. In the warmer dry season, from May to October, average minimum and maximum monthly temperatures are around 41ºF and 95ºF, respectively.

Water year type is determined using the City of Santa Cruz water year classification. This classification is based on total annual runoff in the San Lorenzo River measured at the USGS Big Trees gauge, just south of its confluence with Bean and Zayante Creeks. The water year types are displayed on most of the hydrographs in this GSP.

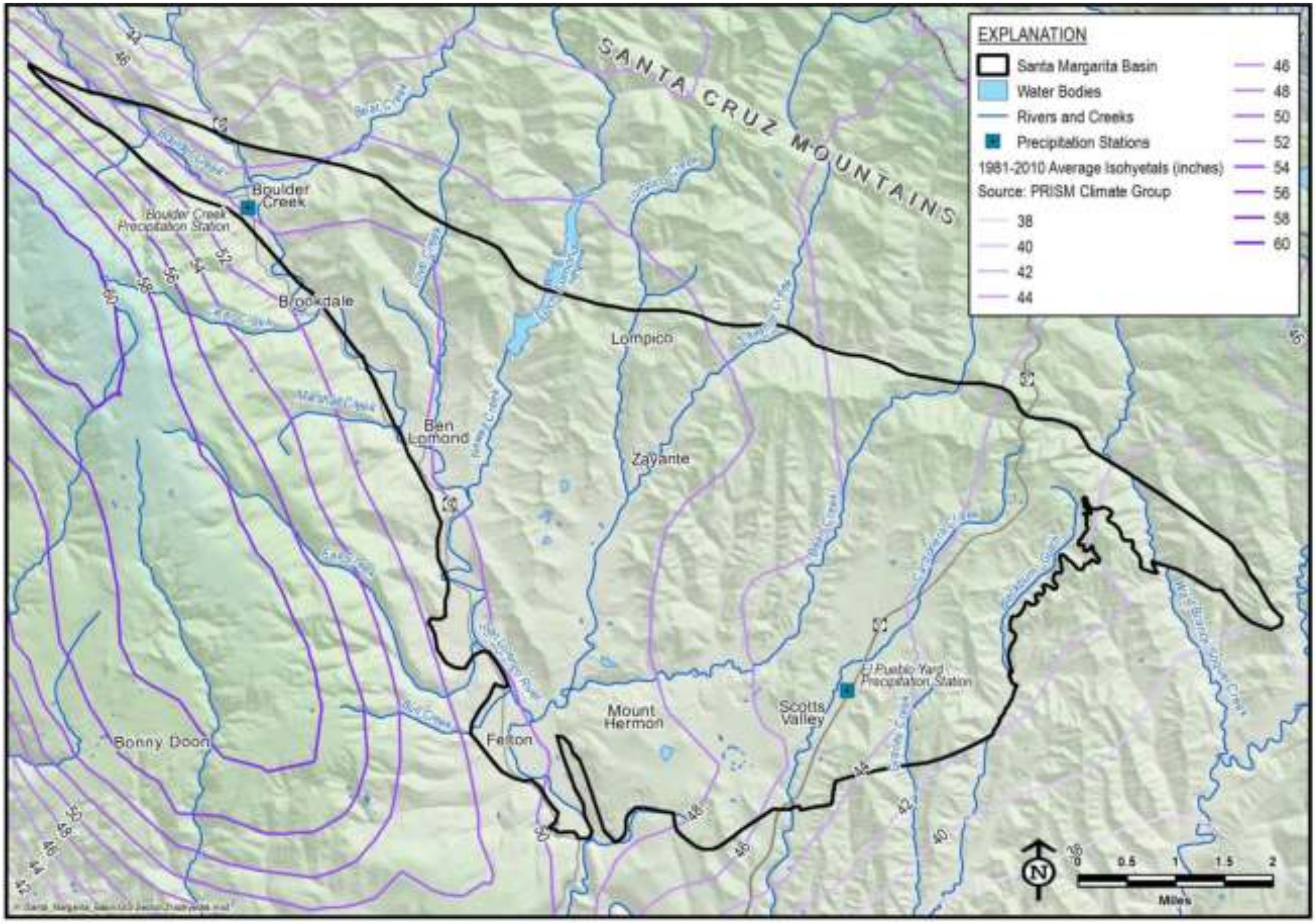


Figure 2-12. Distribution of Precipitation Across the Santa Margarita Basin

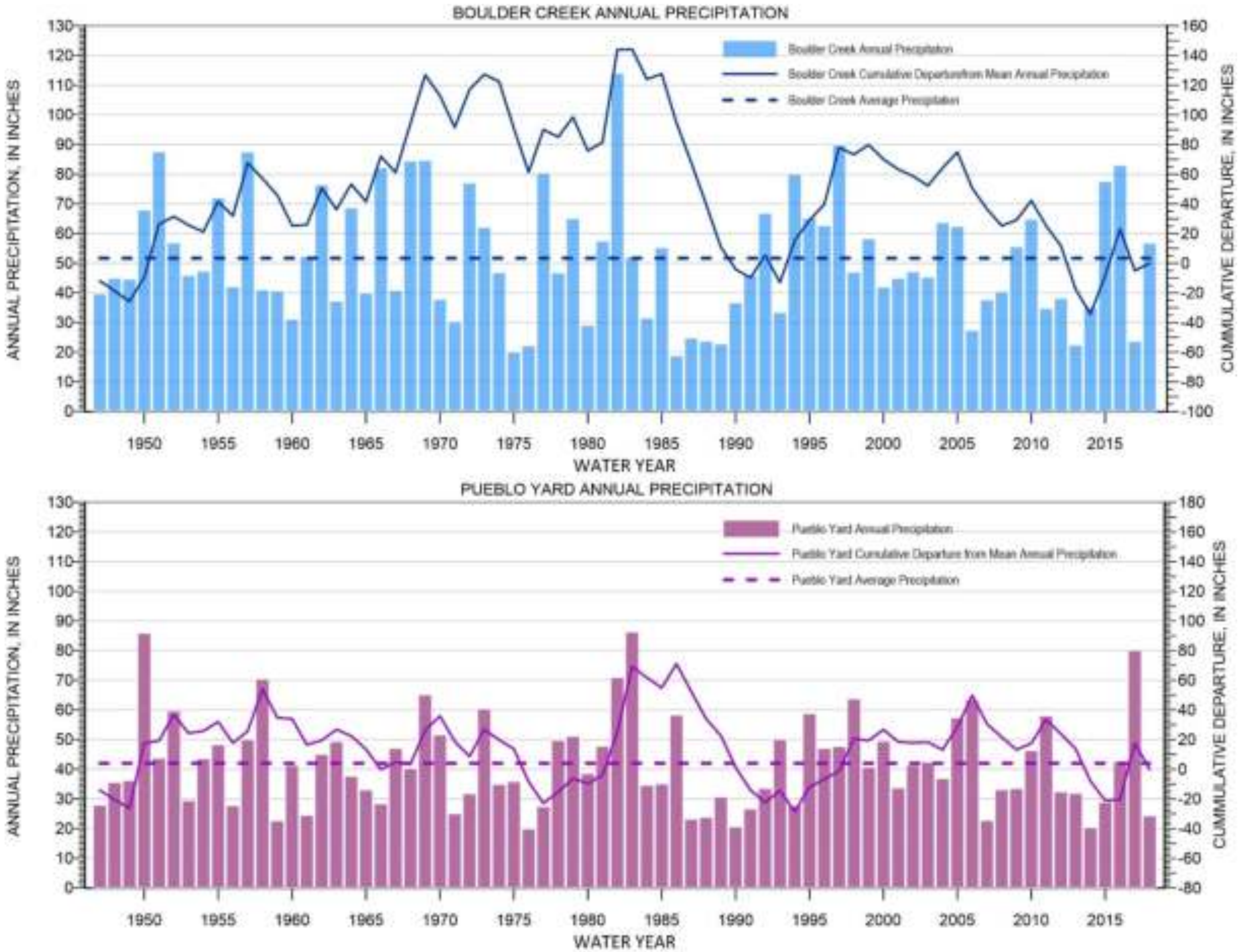


Figure 2-13. Annual Precipitation and Cumulative Departure from Mean Annual Precipitation in the Santa Margarita Basin

Table 2-13. Santa Margarita Basin Monthly Climate Summary

Month	Boulder Creek (SLVWD)			El Pueblo Yard (SVWD)		
	Average Rainfall (inches)	Average Monthly Minimum Temperature (ºF)	Average Monthly Maximum Temperature (ºF)	Average Rainfall (inches)	Average Monthly Minimum Temperature (ºF)	Average Monthly Maximum Temperature (ºF)
January	10.4	29.3	71.6	8.7	31.3	73.4
February	10.0	32.2	71.5	7.6	30.2	72.9
March	7.3	32.3	81.6	6.1	34.3	80.6
April	2.9	37.6	85.6	2.9	37.9	85.7
May	1.1	40.2	85.5	0.9	41.3	85.9
June	0.2	42.2	97.3	0.2	45.2	96.9
July	0.0	47.7	101.9	0.1	14.4	96.5
August	0.1	48.3	100.8	0.1	50.1	94.6
September	0.2	40.7	102.1	0.4	44.2	100.0
October	2.0	37.6	87.0	2.1	41.5	89.8
November	5.6	31.8	82.4	5.1	34.3	83.2
December	9.3	30.4	66.2	7.8	30.4	69.0

Sources:
SVWD rainfall data based on measurements from 8/1946 – 9/1/2019,
temperature data based on measurements from 10/2016 – 7/2020
SLVWD rainfall data based on measurements from 10/1980 – 9/2019,
temperature data based on measurements from 1/2017 – 12/2019

2.2.3.2 Projected Climate

Climate change is expected to impact the Basin in the future because of a rise in atmospheric greenhouse gases such as carbon dioxide and methane. Projecting climate change is a challenging task that has inherent uncertainty regardless of the method selected. The DWR provides 1 set of assumptions that can be used for GSP development, but the SMGWA elected to use a slightly different approach that better suited the groundwater model already developed for the Basin. The method described below was selected for use in the GSP projected scenario because it is based on the best available science, is consistent with other regional planning efforts, and provides a conservative estimate of future conditions in the Basin.

The DWR provides projected climate change data sets for use in GSP development that incorporate a single set of assumptions about future temperature, evapotranspiration, precipitation, and hydrology in 2 future years (2030 and 2070). Generally, DWR anticipates future regional climate conditions to be warmer than current conditions, with greater evapotranspiration, and more variable precipitation and streamflow (DWR, 2018). In part because this steady-state approach is not directly applicable to transient groundwater models where model inputs vary over time (i.e. the Santa Margarita GSP groundwater model), the DWR guidance document on climate change states that other climate change approaches can be used for developing projected water budgets in the GSP. The DWR climate change guidance states:

> *Local considerations and decisions may lead GSAs to use different approaches and methods than the ones provided by DWR for evaluating climate change. For example, the use of a transient climate change analysis approach may be appropriate where local models and data have been developed that include the best available science in that watershed or groundwater basin.*

The climate projection approach used for the GSP, described generally below and in more detail in the groundwater model description in Appendix 2D Section 7.1, is a transient climate projection developed based on an ensemble of 4 commonly used and scientifically defensible global climate models. The approach is similar to that being used by the City of Santa Cruz to develop their recent HCPs. The climate projection generally results in more variable precipitation (i.e., longer and more extreme droughts with fewer but more extreme rainfall events), slightly lower total precipitation, and warmer temperatures in the future in comparison to current conditions. Projected trends for the 4-model ensemble projection are compared against historical data and other climate models on Figure 2-14. Streamflow and evapotranspiration are simulated based on the precipitation and temperature projections. Figure 2-15 shows projected reference evapotranspiration controlled by temperature. It is important to note that the set of assumptions used in the climate projection used in developing this GSP is 1 scenario selected to be representative of the region, is consistent with other regional planning efforts, and is conservative about future climate change. There are many other equally likely climate scenarios that could also occur.

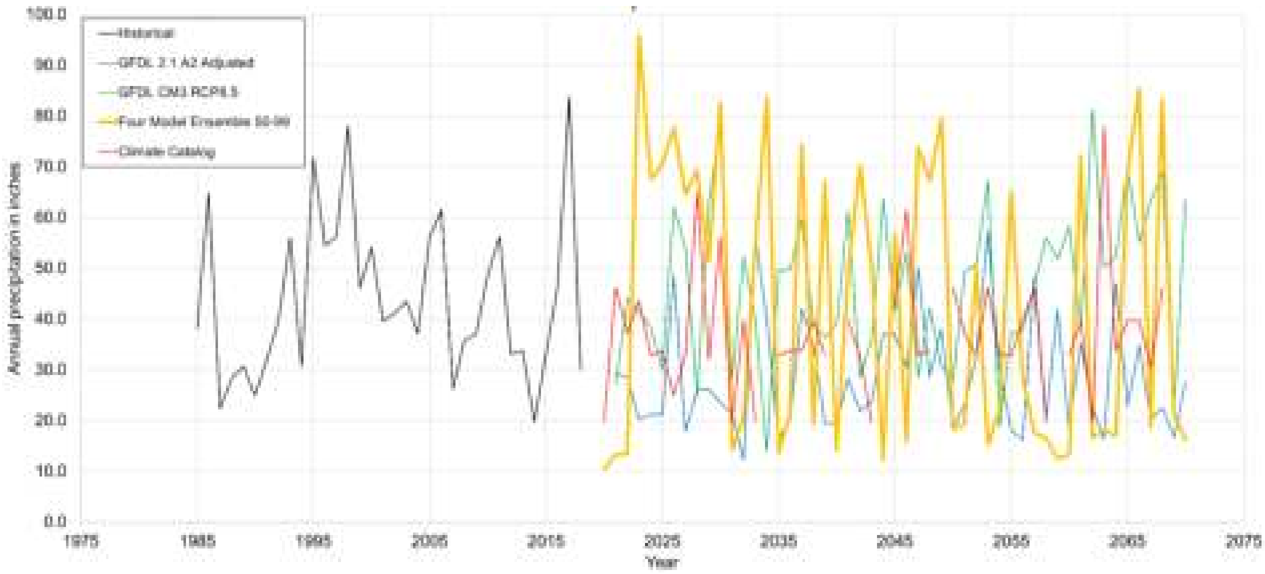


Figure 2-14. Precipitation Variability between Climate Models

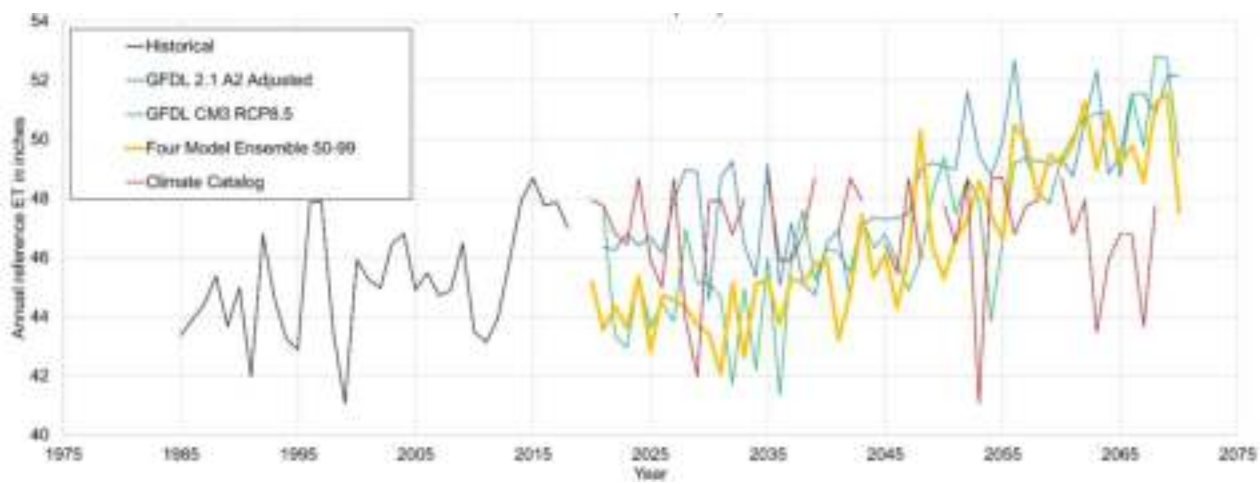


Figure 2-15. Variation of Annual Reference Evapotranspiration Betweeen Climate Models

2.2.4 Hydrogeologic Conceptual Model

This subsection describes the Hydrogeologic Conceptual Model (HCM) of the Basin, including its boundaries, geologic formations and structures, and principal aquifer units. Also described is general Basin groundwater quality, interactions between groundwater and surface water, and generalized groundwater recharge and discharge areas. The HCM primarily relies upon previously published studies:

- Nicholas M. Johnson (2009) San Lorenzo Valley Water District Water Supply Master Plan
- Kennedy/Jenks Consultants (2015b) Santa Margarita Basin Groundwater Modeling Technical Study

- SVWD annual groundwater management program reports (2008 – 2019)

2.2.4.1 Basin Boundaries

The Basin forms a roughly triangular area that extends from Scotts Valley in the east, to Boulder Creek in the northwest, to Felton in the southwest (Figure 2-16). Sedimentary rocks within the Basin include, from oldest to youngest, the Tertiary-aged Butano Sandstone, Lompico Sandstone, Monterey Formation, and Santa Margarita Sandstone. The sandstone formations form the Basin's principal aquifers. The Basin is bounded on the north by the Zayante trace of the active, strike-slip Zayante-Vergeles fault zone, on the east by a buried granitic high that separates the Basin from Santa Cruz Mid-County Basin, and on the west by the Ben Lomond fault except where areas of alluvium (previously designated as the Felton Basin lie west of the fault). The southern boundary of the Basin with the West Santa Cruz Terrace Basin is located where the Tertiary sedimentary formations thin over a granitic high and give way to young river and coastal terrace deposits.

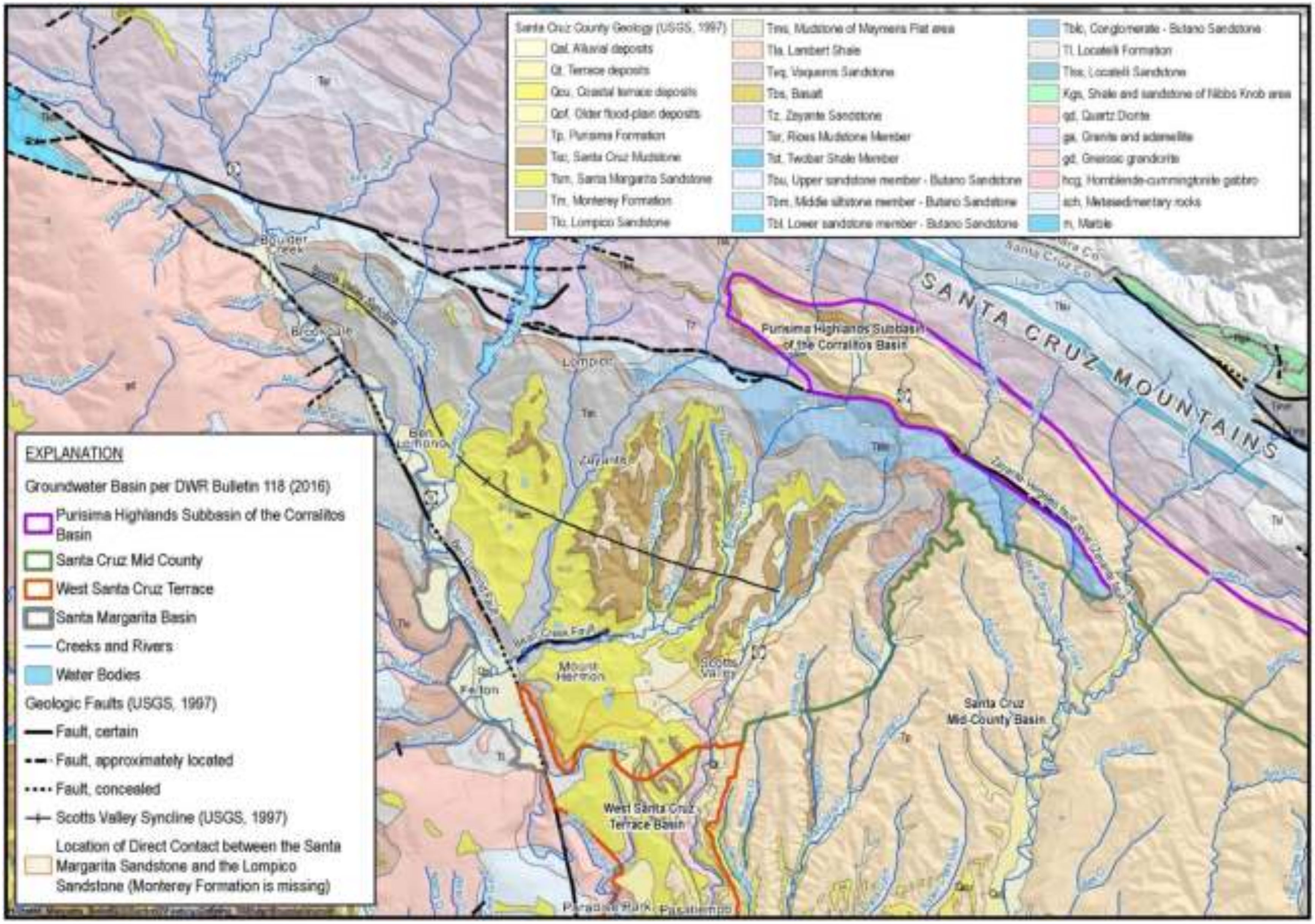


Figure 2-16. Features Defining the Santa Margarita Basin Boundaries

2.2.4.2 Basin Stratigraphy

Figure 2-17 is a generalized stratigraphic column for the Basin that shows the age relationships of geologic units and the thicknesses of the sedimentary formations. The thick section of Tertiary-age sedimentary formations does not represent a continuous marine depositional sequence. Episodes of deformation and uplift combined with changes in global sea level led to erosion that resulted in 4 unconformities, or gaps, in the geological record represented by wavy lines on the stratigraphic column. These episodes of folding followed by erosion account for the thickness variations across the Basin of the sedimentary layers or their local absence, with important consequences for the hydrogeologic conceptual model.

The subsections below describe the stratigraphic units from oldest to youngest and indicate where they occur in the Basin as depicted in the geologic map shown on Figure 2-18.

Era	Period	Series	Geologic Formation	Lithology	Maximum Thickness in Basin (feet)
Cenozoic	Quaternary	Pleistocene-Holocene	Alluvium (Qal) and	Alluvium – unconsilidated, moderately sorted silt, sand and gravel	40
			Terrace Deposits (Qt)	Terrace Deposits – weakly consolidated, poorly sorted sandy gravel to medium-grained sands	60
	Tertiary	Pliocene	Purisima Formation (Tp)	Very thickly bedded tuffaceious and diatomaceous siltstone with thick interbeds of semi-friable andestic sandstone	200
		Miocene	Santa Cruz Mudstone (Tsc)	Medium- to thick-bedded and faintly laminated pale siliceous mudstone with scattered speriodal dolomite concretions; locally graded to sandy siltsone	250
			Santa Margarita Sandstone (Tsm)	Very thick bedded and thickly crossbedded friable arkosic sandstone	450
			Monterey Formation (Tm)	Medium- to thick-bedded and laminated subsiliceous organic mudstone and sandy siltstone with few thick dolomite interbeds	2,000
			Lompico Sandstone (Tlo)	Thick-bedded to massive arkosic sandstone	400
		Eocene	Butano Sandstone – Upper (Tbu)	Thin- to very thick-bedded medium arkosic sandstone with thin interbeds of siltstone	3,000
			Butano Sandstone – Middle (Tbm)	Thin- to medium-bedded nodular pyritic siltstone	250 – 750
			Butano Sandstone – Lower (Tbl)	Very thick bedded to massive arkosic sandstone with thick to very thick interbeds of sandy pebble conglomerate in lower part	1,500
		Paleocene	Locatelli Formation (Tl)	Nodular micaceous siltstone; micaceous arlosic sandstone locally at base	800
Mesozoic	Cretaceous		Crystalline Basement	Metasedimentary rocks intruded by granodiorite and quartz diorite	

unconformity

principal aquifer

Modified after Johnson (2009) and Kennedy/Jenks Consultants (2015b)

Figure 2-17. Santa Margarita Basin Stratigraphic Column

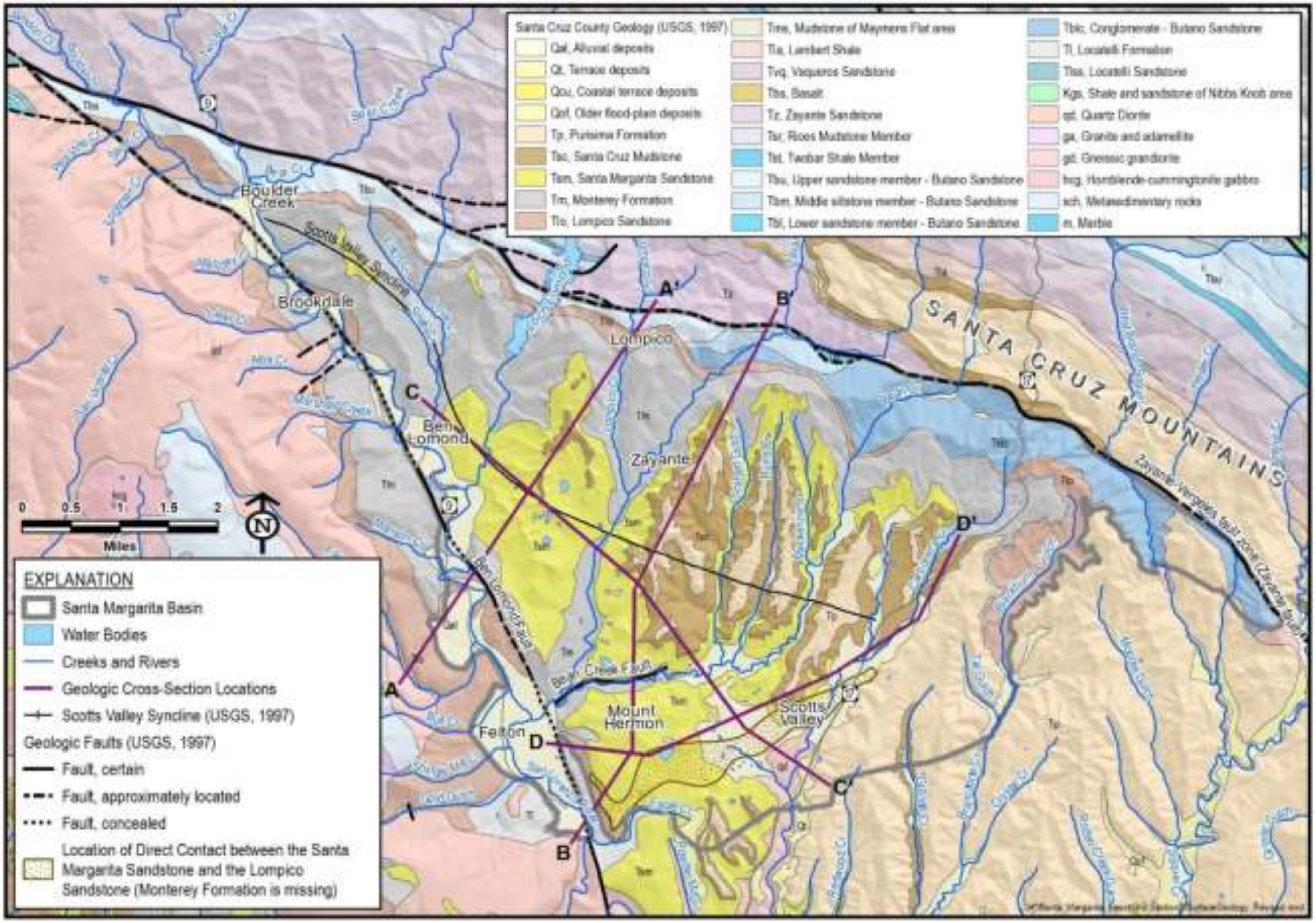


Figure 2-18. Surface Geology of the Santa Margarita Basin

2.2.4.2.1 Granitic Basement

The local basement for the Basin consists of metasedimentary rocks (including marble) that have been intruded by quartz diorite and granodiorite of Cretaceous age. The basement rocks are exposed only at the southernmost margin of the Basin, along Carbonara Creek; however, they underlie the southern part of the Basin at shallow depths. A buried high of basement rocks is defined by DWR as the boundary that separates the Basin from the Santa Cruz Mid-County Basin to the east.

The basement rocks are part of the Salinian Block, which constitutes a continental terrain that originated more than 1,200 miles south of its present location and collided with the North American plate prior to Eocene time. Since about 20 million years ago, the Salinian Block has been transported northward along the San Andreas Fault Zone as a part of the Pacific Plate. It was profoundly eroded prior to the Eocene, accounting for the limited occurrence of Paleocene sediments like the Locatelli Sandstone. It also means that sedimentary units Eocene and younger in age were deposited on an irregular erosional surface, which results in some of the near-shore sedimentary units like the Lompico Sandstone and the Santa Margarita Sandstone showing a range of original depositional thicknesses across the Basin.

2.2.4.2.2 Locatelli Sandstone

The Paleocene Locatelli Sandstone (Tl on Figure 2-18) is a grey sandy siltstone with a thin basal sandstone. It is exposed at the southern margin of the Basin, on both sides of the San Lorenzo River, where it is lapping onto the basement. It is, however, present widely in the subsurface, with a thickness as great as 800 feet thick (Kennedy/Jenks Consultants, 2015b).

2.2.4.2.3 Butano Sandstone

The Eocene Butano Sandstone is a thick sedimentary unit that was deposited in deep water (Clark, 1991) in an environment analogous to where modern-day shelf sediments are swept down submarine Monterey Canyon to be deposited off the continental shelf in the Monterey submarine fan.. It has 3 defined members defined on Figure 2-18: an upper sandstone member (Tbu), a middle siltstone member (Tbm), and a lower massive sandstone with conglomerate near its base (Tbl) (Clark, 1981). The middle member is more fine-grained and contains pyrite, making it unsuitable as an aquifer, but the upper and lower sandstone units are important aquifers in the Basin

The Butano Sandstone is exposed in the south-dipping limb of the Scotts Valley syncline at the northern margin of the Basin in a band parallel to the Zayante-Vergeles fault (Figure 2-18). The upper, middle, and lower members outcrop from northwest to southeast across this band, respectively. The thickness of the Butano Sandstone varies across the Basin, from several hundred to as much as 5,000 feet thick (Clark, 1982; Kennedy/Jenks Consultants, 2015b).

2.2.4.2.4 Lompico Sandstone

The Miocene Lompico Sandstone (Tlo on Figure 2-18) is a thick-bedded to massive, fine- to medium-grained arkosic sandstone that was deposited on the continental shelf at moderate depths (Clark, 1991). The Lompico Sandstone has a relatively uniform thickness of up to 400 feet, though it is slightly thinner and finer grained in the northern and eastern areas of the Basin (Kennedy/Jenks Consultants, 2015b). As is the case for the underlying Butano Sandstone, the Lompico Sandstone outcrops as a strip parallel to the Basin's northern boundary (Figure 2-18). The width of this outcropping strip ranges from approximately 2,000 feet in the northwest near Boulder Creek to 100 feet in the southeast, where it joins up with another significant outcrop alongside the headwaters of Blackburn Gulch near the Basin's boundary with the Santa Cruz Mid-County Basin (Figure 2-18). Although the Lompico Sandstone has limited surface exposure, it is present throughout the Basin in the subsurface, making it an important aquifer.

2.2.4.2.5 Monterey Formation

The Miocene Monterey Formation (Tm on Figure 2-18) is composed mostly of medium- to thick-bedded and organic mudstone and shale with sandy siltstone interbeds. It represents deposition in a deeper-water continental-shelf environment as sea level rose following deposition of the Lompico Formation (Clark, 1991). The Monterey Formation is thickest near the center of the Basin, where it is more than 2,000 feet thick. It is absent near the southeastern margin of the Basin (see the brown stippled area on Figure 2-18). The absence of Monterey Formation in this area has important consequences for the hydrogeologic conceptual model, as the Lompico aquifer and the overlying Santa Margarita aquifer are in direct contact, allowing for greater recharge of the Lompico aquifer through the Santa Margarita aquifer than in areas where the Monterey Formation aquitard intervenes.

The Monterey Formation is not a principal aquifer, but because it is exposed widely in the Basin, it is utilized in many private wells. These generally tap sandy intervals in the lower part of the formation for relatively small volumes of water

2.2.4.2.6 Santa Margarita Sandstone

The Miocene Santa Margarita Sandstone (Tsm on Figure 2-18) is a massive, fine- to coarse-grained, moderately sorted arkosic sandstone containing lenses of gravel and cobbles. It formed in a near-shore, high-energy environment as indicated by fossils of shallow marine organisms as well as fossils of terrestrial animals swept in by rivers (Clark, 1991) This poorly consolidated and easily erodible formation can be observed in natural and quarried cliffs around Scotts Valley and forms the basis of the distinctive Sand Hills ecosystem. It is often referred to as "white sand" in drillers' logs. In areas where the Santa Margarita Sandstone directly overlies the Lompico Sandstone, the two sandstones can be difficult to distinguish from one other, although the Lompico Sandstone is typically finer grained and more cemented (Johnson, 2009).

The Santa Margarita Sandstone is thickest along the axis of the Scotts Valley Syncline between the community of Ben Lomond and City of Scotts Valley; it thins and becomes more fine-grained to the northeast (Clark, 1981). In the Quail Hollow and Olympia areas, it is as much as 450 feet, though much has been removed by quarrying (Johnson, 2009). In the Scotts Valley area, it is up to about 350 feet thick. The relatively easily eroded sandstone is incised, in some areas, through its entire thickness by overlying creeks, forming several isolated areas within the Basin.

2.2.4.2.7 Santa Cruz Mudstone

The Miocene Santa Cruz Mudstone lies conformably atop the Santa Margarita Sandstone, indicating a deepening of the marine depositional environment (Clark, 1991). The Santa Cruz Mudstone makes up the upper slope of the ridges between Zayante Creek and Carbonera Creek (Tsc in Figure 2-18) and can be up to 250 feet thick (Johnson, 2009). The medium- to thick-bedded and faintly laminated pale siliceous mudstone restricts surface recharge where present.

2.2.4.2.8 Purisima Formation

East of Zayante Creek, the shallow marine sediments of the Purisima Formation are discontinuously exposed along ridge tops separated by streams (Tp on Figure 2-18). It has a maximum thickness of about 200 feet within the Basin but thickens considerably west of Carbonera Creek and into the Santa Cruz Mid-County Basin where it is one of the principal aquifers (Johnson, 2009).

2.2.4.2.9 Coastal Terrace Deposits

There are small outcrops of marine coastal terrace deposits in the southernmost part of the basin along Carbonera Creek and Powder Mill Creek (Qt on Figure 2-18). Present as isolated outcrops no thicker than 50 feet, these superficial deposits are not considered an aquifer and contain no known water supply wells.

2.2.4.2.10 Alluvium

Quaternary alluvium consisting of unconsolidated sands and silts associated with the Basin's rivers and creeks valleys occurs locally along the San Lorenzo River, portions of Bean and Carbonera Creeks, the length of the West Branch of Carbonera Creek, and in an ancestral drainage near Camp Evers (Qal on Figure 2-18). Ranging in thickness from less than 10 to 40 feet thick, these alluvial deposits are generally too thin to constitute a major aquifer; however, they may play a part in the connection between surface water in the river and creeks with underlying Santa Margarita and Lompico Sandstones (Johnson, 2009).

2.2.4.3 Geologic Structure

2.2.4.3.1 Tectonic Setting

The geologic structure of the Basin is a reflection of its location along the boundary between the North American and Pacific tectonic plates. The Pacific plate is moving northward with respect to the North American plate an average of about 2 inches per year, with much of this motion distributed over a number of fault strands within the greater San Andreas fault zone. The Basin is bound on the north by one of these: the Zayante-Vergeles fault which has active seismicity.

Although the overall motion along the plate boundary is right-lateral, the local details are more complicated. There is a slight bend in the San Andreas fault east of the Santa Cruz Mountains. This bend interferes with the plates slipping past one another; this so-called restraining bend causes local compression in the rocks that causes them to fold or to break along high-angle fault planes in which one side of the fault moves up and over the rocks on the other side of the fault. The M7.1 1989 Loma Prieta earthquake occurred along the restraining bend and exhibited this type of behavior: there was 4.3 feet of vertical motion along the fault as well as 6.2 feet of right-lateral motion (Plafker and Galloway, 1989). Analysis of global positioning system data along with geochronological studies show that there is currently a component of compression along the San Andreas fault in the Santa Cruz Mountains, and that the contraction that causes folding and uplift along faults in an otherwise strike-slip setting (Burgmann et al., 2006; Gudmundsdottir et al., 2008) are the cause of the complicated fault geometries in the region, including the Zayante-Vergeles and Ben Lomond Mountain fault zones.

This transpressive regime may have started when there was a reorganization of Pacific Plate motion about 5 million years ago (Engebretson et al., 1985). Since that time, folding and faulting have resulted in the uplift that created the California Coast Range.

2.2.4.3.2 Faults

Faults can be barriers to groundwater flow in 2 ways:

(1) As rocks on either side of a fault slide past each other, mineral grains along the fault are ground and transformed into a fine-grained, clay-rich, impermeable material referred to as gouge. Zones of gouge impede the lateral flow of groundwater, and may deflect the water upwards, where it can emerge at the surface as springs.

(2) Translation of rock layers along a fault can juxtapose a rock layer that is an aquifer against one that is an aquiclude, blocking groundwater flow.

The Basin is bounded by 2 regional faults, the Zayante-Vergeles fault zone to the north and the Ben Lomond Fault to the west. Figure 2-18 shows the location of these faults with respect to the Basin.

The Zayante-Vergeles fault zone, which forms the northern Basin boundary, is a major northwest-striking structural element of the Santa Cruz Mountains restraining bend of the larger San Andreas fault zone. It is a major right-lateral reverse-oblique-slip fault with late Pleistocene and possible Holocene displacement with an estimated vertical slip rate of 0.2 millimeters per year (Bryant, 2000). The easternmost end of the fault is currently seismically active; the section that is the northern boundary of the Basin is not.

Areas south of the Zayante-Vergeles fault zone are underlain primarily by granitic and metasedimentary basement rock, while in contrast, areas north of the fault zone are underlain by gabbroic basement rock and overlain by sedimentary formations not present within the Basin. The juxtaposition of these continental (90-million years ago) and oceanic (165-million years ago) crustal formations illustrates the significant displacement associated with the movement of the fault zone, reflects the long-term right-lateral translation of the Salinian block along the San Andreas fault system, and marks the fault zone as a major feature of this system..

In contrast, the Ben Lomond Fault, which is the western boundary of the Basin, has more limited, largely vertical motion. It extends from northwest of the community of Boulder Creek, where it merges with the Zayante-Vergeles fault zone, through the communities of Ben Lomond and Felton, and south to the coast, where it continues for a further 2.5 miles offshore (Johnson et al., 2016). The steep eastern face of Ben Lomond Mountain reflects the presence of the fault, as does the course of the San Lorenzo River, which exploited shattered, easily eroded rocks in the fault zone in making its way southward to the coast.

Movement along the near-vertical Ben Lomond fault has uplifted the basement rocks of Ben Lomond Mountain with respect to the sedimentary formations of the Basin by about 600 feet (Stanley and McCaffery, 1983). Evidence for lateral motion is lacking. This steep reverse fault is best interpreted as a minor fault in the complex fault geometry that results from the restraining bend in the San Andreas fault zone in the Santa Cruz Mountains.

The Ben Lomond fault is not currently seismically active. Stanley and McCaffery (1981) argued that most of the movement on the fault took place during the deposition of the Santa Margarita Sandstone, as this unit thickens against it. Small offsets of the Purisima Formation and uplift in marine terraces suggest that at least some slip occurred in Pleistocene time. A minor fault called the Bean Creek Fault is aligned along the lower reach of Bean Creek where the Monterey Formation outcrops in the Bean Creek valley (Figure 2-18). It is unknown if this fault impacts the movement of groundwater in the Basin (Johnson, 2009).

2.2.4.3.3 Folding and Geologic Structure

Caught between faults of the Santa Cruz Mountain restraining bend of the San Andreas fault zone, the sediments of the Santa Margarita Basin have been folded and uplifted several times, resulting in synclines and anticlines in and around the Basin. The dominant feature defining the

Basin is the Scotts Valley syncline, a geologic trough whose northwest-southeast-trending axis roughly bisects the Basin (Figure 2-18). This folding of the sedimentary rocks is illustrated in 4 geologic cross sections (Figure 2-19 through Figure 2-22) constructed along lines of section shown on the geologic map (Figure 2-18). The cross sections were developed as part of SLVWD's water supply master plan (Johnson, 2009).

The southwest-northeast trending cross sections in section A-A' (Figure 2-19) and section B-B' (Figure 2-20) cross through the area of the Quail Hollow and Olympia well fields, respectively. Constructed approximately perpendicular to the axis of the Scotts Valley syncline, these cross sections illustrate the syncline and the location of the deepest part of the Basin beneath the wellfields, some 4,000 feet deep (Figure 2-20). They also show the prominent influence of the Ben Lomond fault as a boundary to the Basin, displacing the Lompico Sandstone by just under 400 feet, and juxtaposing aquicludes against aquifers. These cross sections also illustrate the steep dips of the Butano Sandstone, Lompico Sandstone, and Monterey Formation at the northern end of the basin, due to deformation near the Zayante-Vergeles fault zone. It is these steep dips that result in the relatively narrow strips of surface exposure of the Butano Sandstone and Lompico Sandstone (Figure 2-19 and Figure 2-20), the only places where they can receive direct recharge from infiltrating precipitation and percolation through creek beds, thereby limiting the amount of direct recharge these aquifers can receive.

The northwest-southeast-trending cross-section C-C' (Figure 2-21) is constructed approximately parallel to the axis of the Scotts Valley syncline. This cross section illustrates how the Basin's sedimentary rocks were folded against a basement highland forming the eastern margin of the Basin. Thus, the sedimentary rocks constitute a structural "bowl" across much of the Basin, making it hydrologically isolated from other basins. It also illustrates the shallowing of the granitic basement that forms the eastern margin of the Basin.

The southwest-northeast-trending cross section D-D' (Figure 2-22) is constructed to pass through the Mount Hermon, Pasatiempo, Camp Evers, and the southern and northern Scotts Valley well areas. The deepest wells in the Basin are in the northern Scotts Valley area, where they tap down to the deepest aquifer, the Butano Sandstone.

The Monterey Formation is present widely in the Basin and in most places forms a thick aquitard between the Santa Margarita aquifer and the Lompico aquifer as shown in section A-A' (Figure 2-19). There is a narrow, southwest-northeast-trending area running from Pasatiempo to Scotts Valley (shown as a stipple pattern on the geologic map in Figure 2-18) in which the Monterey Formation is absent, so that the Santa Margarita Sandstone and the Lompico Sandstone are in direct contact. The cross section in Figure 2-22 illustrates this well in the area of Camp Evers. The hydrogeologic connection between these 2 units in this area affects the quantity and quality of groundwater recharge to the Lompico Sandstone, and so is an important feature in the hydrogeologic conceptual model.

Most of the folding to form the Scotts Valley syncline must have occurred in the time between deposition of the Monterey Formation and the Santa Margarita Sandstone, as the Santa Margarita Sandstone and younger formations are only weakly affected by the folding, as can be seen in Figure 2-19, Figure 2-20, and Figure 2-22.

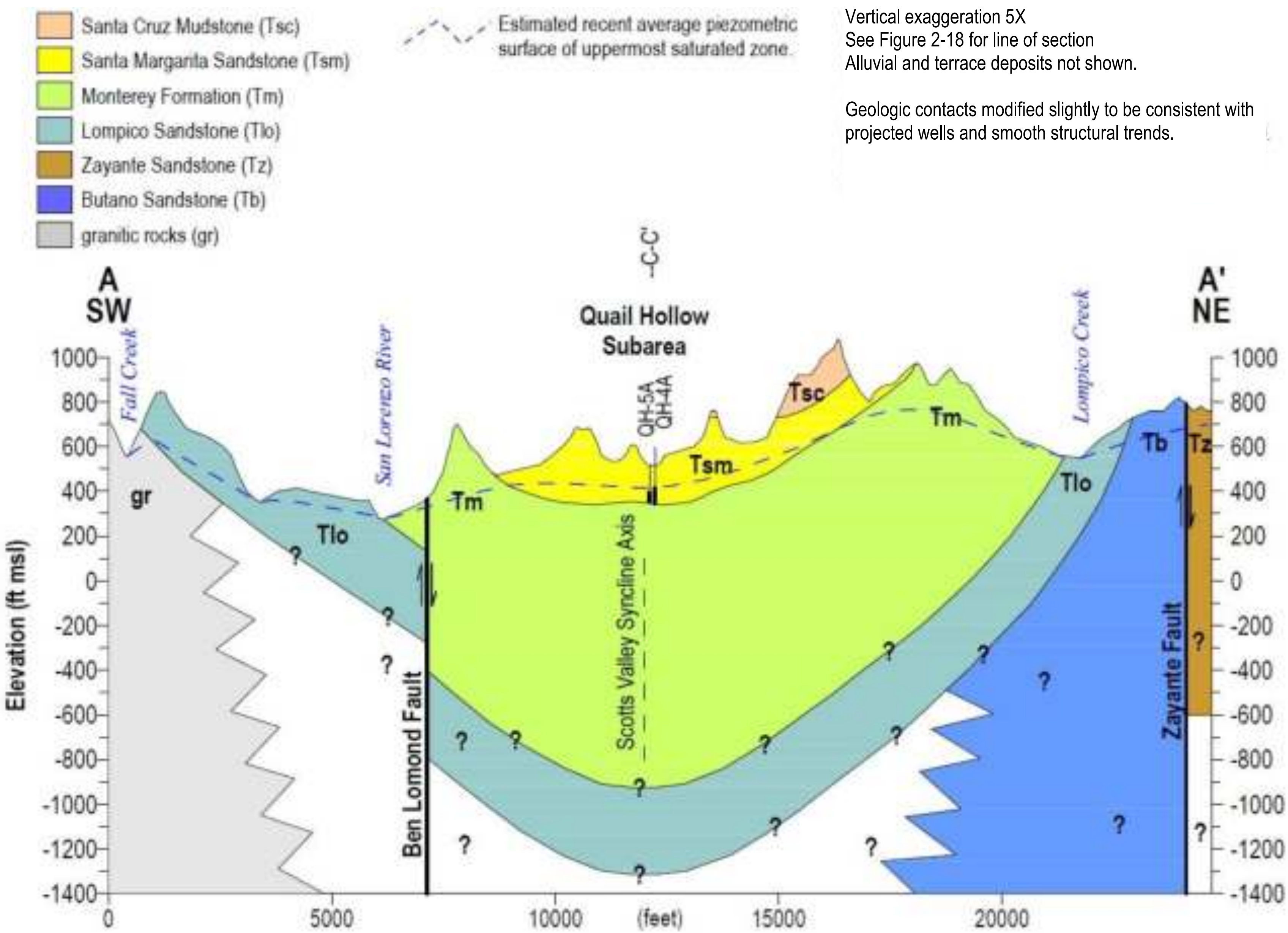


Figure 2-19. A-A' Geologic Cross-Section through the Santa Margarita Basin (Johnson, 2009)

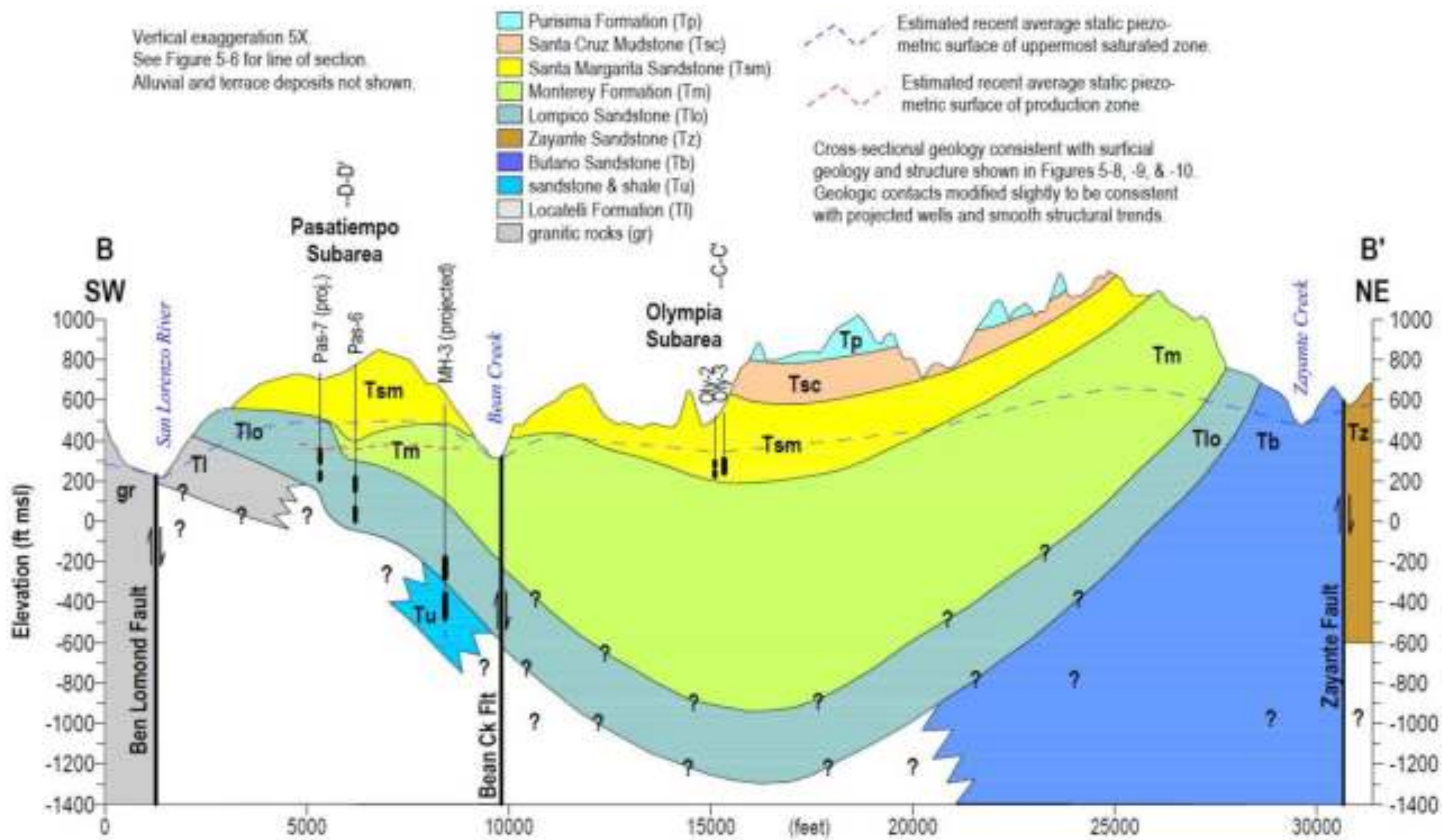


Figure 2-20. B-B' Geologic Cross-Section through the Santa Margarita Basin (Johnson, 2009)

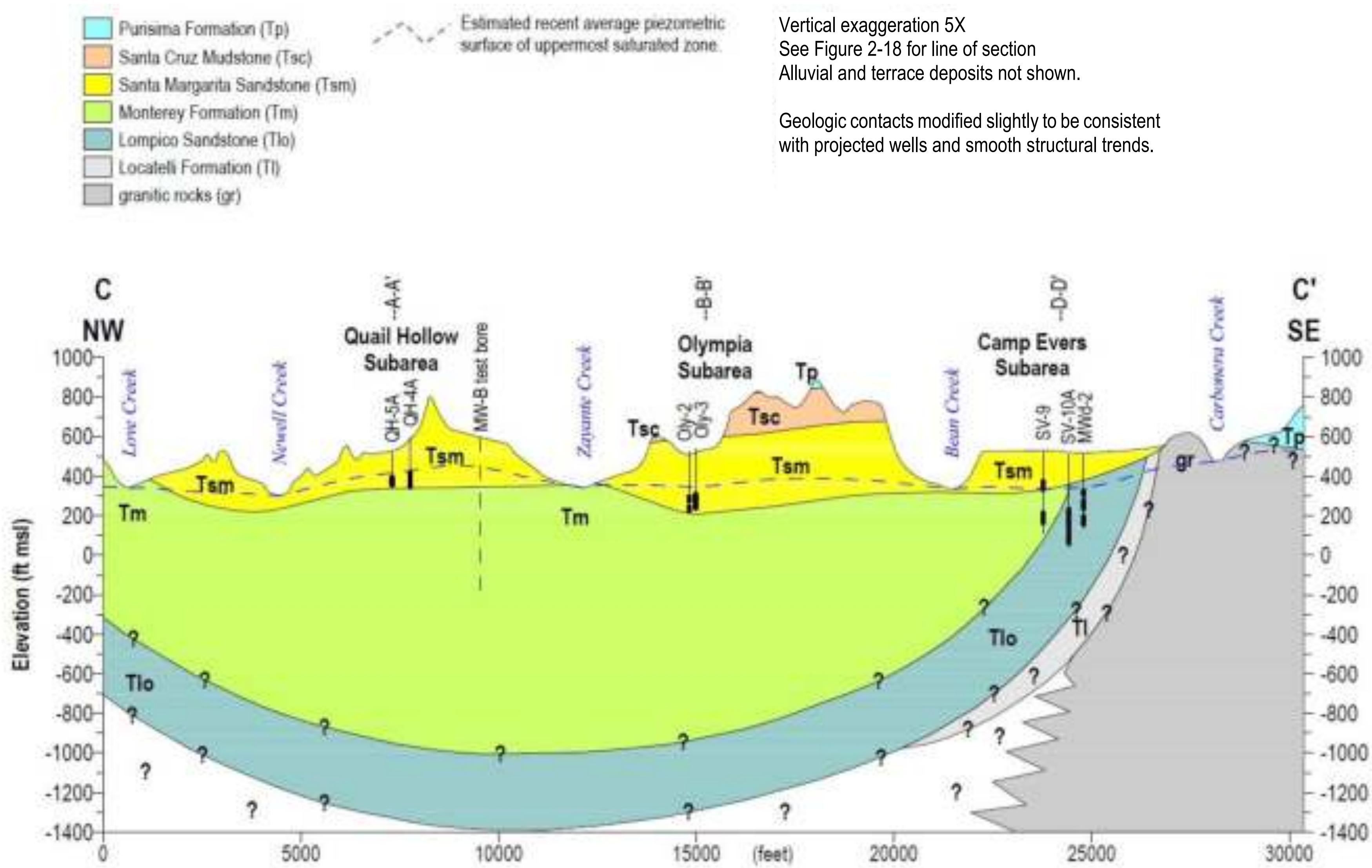


Figure 2-21. C-C' Geologic Cross-Section through the Santa Margarita Basin (Johnson, 2009)

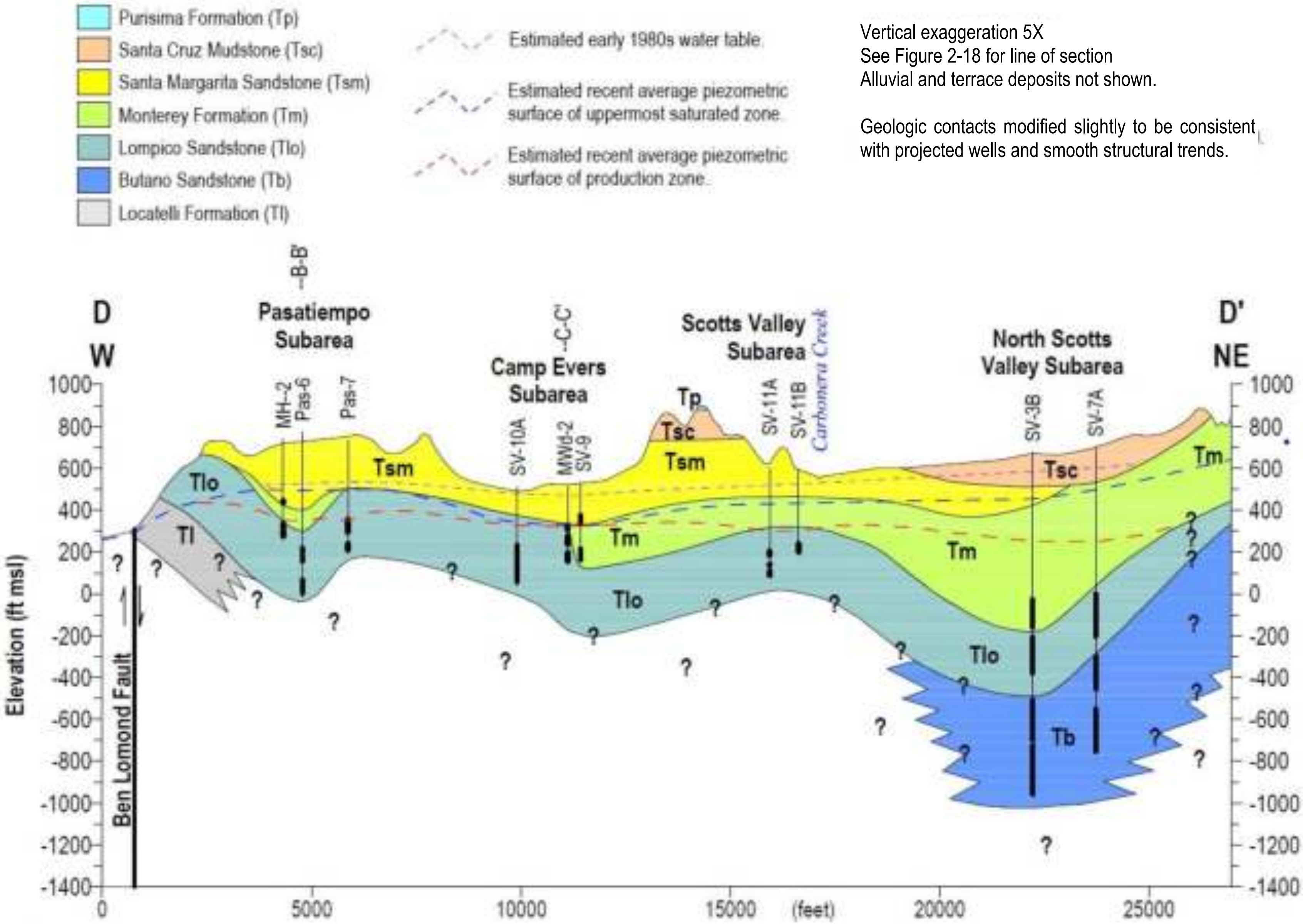


Figure 2-22. D-D' Geologic Cross-Section through the Santa Margarita Basin (Johnson, 2009)

2.2.4.4 Principal Hydrogeologic Units

Sandstone units within the sedimentary rocks of the Scotts Valley syncline supply nearly all the groundwater extracted in the Basin. The Santa Margarita, Lompico, and Butano Sandstones, are the principal aquifers utilized by municipal suppliers.

The Santa Margarita Sandstone, which is the shallowest of the 3 sandstone units, has a long history as a source of water in the Basin, with many water supply wells extracting groundwater from this unit (Muir, 1981). The Lompico Sandstone is currently the principal groundwater producing unit in the Scotts Valley area. Silty and sandy intervals within the otherwise fine-grained Monterey Formation provide smaller volumes of groundwater to domestic pumpers. The subsections below describe these aquifers.

Table 2-14 summarizes representative aquifer hydraulic parameters for these units obtained from aquifer testing and included in reports by Johnson (2009) and Kennedy/Jenks Consultants (2015b). Definitions of the aquifer parameter terminology used in this section are provided below.

Hydraulic Conductivity: Property of geologic materials that controls the ease with which groundwater flows through pore spaces or fractures. Higher hydraulic conductivity allows water to travel faster through geologic media. Units with very low hydraulic conductivity slow or may prevent groundwater flow. Hydraulic conductivity has units with dimensions of length per time (e.g., feet per day).

Transmissivity: A measure of how much water can be transmitted horizontally. It is derived from the hydraulic conductivity of an aquifer unit multiplied by its total thickness. High transmissivity units are very conducive to groundwater flow, very thick, or both. Transmissivity is usually expressed in units of length^2 per time, or occasionally as volume per length per time.

Storativity (or storage coefficient): The volume of water (e.g., cubic feet) released from aquifer storage per unit decline in hydraulic head in the aquifer (e.g., foot), per unit area of the aquifer (e.g., square feet). Storativity is a volumetric ratio and therefore unitless. A large value for storativity implies a highly productive aquifer. Storativity is applied only to aquifers under local or regional confinement; specific yield is a roughly equivalent measure of aquifer productivity in an unconfined aquifer.

Specific Yield: The volume of water released from storage by an unconfined aquifer per unit surface area of aquifer per unit decline of the water table. Specific yield is a volumetric ratio and therefore unitless. Specific yield is used to characterize unconfined aquifers; high specific yield indicates a productive aquifer unit.

Table 2-14. Principal Hydrogeologic Units Hydraulic Properties

Principal Hydrogeologic Unit	Hydraulic Conductivity (feet/day)	Transmissivity (feet²/day)	Storativity[1]	Specific Yield[2]
Santa Margarita Aquifer Entire Basin	2 – 130	430-7,700	0.008 – 0.02	0.02 – 0.25
Santa Margarita Aquifer Quail Hollow/ Olympia	2 – 50	430 – 6,200	0.008 – 0.02	0.12 – 0.25
Santa Margarita Aquifer Central Portion of Basin	3 – 130	2,000 – 7,700	NA	0.02 – 0.13
Santa Margarita Aquifer Scotts Valley Area	12 – 35	1,000 – 1,700	NA	0.02 – 0.13
Monterey Aquifer [3]	0.05 – 6	170 – 1,000	0.00001 – 0.001	0.01 – 0.03
Lompico Aquifer	0.5 – 7	500 – 3,200	0.000001 – 0.001	0.02 – 0.07
Butano Aquifer	0.1 – 6	100 – 1,070	0.000001 – 0.0007	

Adapted from Kennedy/Jenks Consultants (2015b); NA = non-applicable given unconfined conditions
[1] Storativity is the volume of water released from confined aquifer storage per unit decline in hydraulic head in the aquifer per unit area of the aquifer.
[2] Specific yield is the amount of water released from an unconfined aquifer if allowed to drain completely under force of gravity.
[3] The Monterey Formation is not a principal aquifer but is included here as there are aquifer test data available for it, and because its occurrence between 2 principal aquifers plays an important role in the hydrogeology of the Basin.

2.2.4.4.1 Santa Margarita Aquifer

The Santa Margarita Sandstone or Santa Margarita aquifer is the shallowest principal aquifer in the Basin, with widespread surface exposures in the southern and central portions of the Basin. Due to its shallow depth and highly productive lithology, it was the first formation to be developed for municipal and private domestic use (Kennedy/Jenks Consultants, 2015b). The Santa Margarita aquifer is capped in some areas by the Santa Cruz Mudstone and lies unconformably over the Monterey Formation in the north and northwest portions of the Basin. In the southeastern portion of the Basin, in the Pasatiempo and Camp Evers areas, the Monterey Formation has been completely removed by erosion so that the Santa Margarita Sandstone rests unconformably on the Lompico Sandstone, creating a direct groundwater connection between the 2 principal aquifers.

The Santa Margarita aquifer is unconfined, apart from areas in northern Scotts Valley, where it is confined by a few hundred feet of overlying Santa Cruz Mudstone. Due to its wide exposure and high conductivity, the Santa Margarita aquifer responds rapidly to changes in precipitation and recharges quickly, but it also drains relatively rapidly to creeks such that it has little long-term groundwater storage (Kennedy/Jenks Consultants, 2015b).The hydrogeologic properties of the

Santa Margarita Sandstone as a highly transmissive unconfined aquifer reflect its coarse grain size and weak cementing. Estimated hydraulic conductivity ranges from 2 to more than 100 feet/day (Kennedy/Jenks Consultants, 2015b) depending on location within the Basin and specific yield ranges from 0.02 to 0.25, and transmissivity ranges from 430 to 7,700 feet^2/day (Table 2-14; Kennedy/Jenks Consultants, 2015b). Johnson (2009) and Kennedy/Jenks Consultants (2015b) report variations in Santa Margarita aquifer parameters across the Basin that indicate the aquifer is spatially variable in its properties. In particular, aquifer test results from the Camp Evers area indicate the occurrence of highly conductive zones near the base of the aquifer where intervals of conglomerate (gravel-sized particles) occur (Johnson, 2009; Kennedy/Jenks Consultants, 2015b).

2.2.4.4.2 Lompico Aquifer

The Lompico Sandstone is a productive arkosic sandstone aquifer that provides a large proportion of the Basin's municipal supply (Johnson, 2009; Kennedy/Jenks Consultants, 2015b). The Lompico Sandstone is generally uniform, although slightly more fine-grained and cemented towards its base. The restricted exposure of the Lompico Sandstone at the surface, at the northern and northeast margin of the Basin, limits the amount of surficial recharge by precipitation. The Lompico aquifer is primarily recharged via water that percolates through the highly transmissive Santa Margarita Sandstone, where the Santa Margarita and Lompico Sandstones are in direct contact due to the absence of intervening Monterey Formation. The limited exposure of the Lompico Sandstone at the surface and the confined to semi-confined nature of the aquifer makes it relatively slow to respond to rainfall-driven recharge events (Kennedy/Jenks Consultants, 2015b). The Lompico aquifer discharges to the San Lorenzo River at several locations where it is exposed in the riverbed, see cross section B-B' (Figure 2-20). The vertical gradient between the Lompico and Butano aquifers is not known; therefore, it is not known whether there is significant flow between these 2 deeper aquifers.

Available aquifer testing results in the Lompico aquifer reflect a moderately permeable, semi-confined to confined sandstone aquifer. Hydraulic conductivity ranges from 0.5 to 7 feet/day, transmissivity ranges from 500-3,200 feet^2/day, and storativity ranges from 0.000001 to 0.02 (Table 2-14; Kennedy/Jenks Consultants, 2015b). Where the Lompico aquifer is unconfined, specific yield ranges from 0.04 to 0.08. Although generally less conductive than the Santa Margarita aquifer, the transmissivity of the Lompico aquifer, i.e., the amount of groundwater it can produce, is larger due to its much greater thickness (Johnson, 2009).

2.2.4.4.3 Butano Aquifer

The Butano Sandstone or Butano aquifer is composed primarily of arkosic sandstone similar in consistency to the Lompico Sandstone, though with significant mudstone, shale, and siltstone interbeds. The Butano aquifer is recharged primarily by direct infiltration of precipitation and streamflow in the extreme northern portions of the Basin where it outcrops (Figure 2-18).

Review of limited groundwater elevation data indicates that the Butano aquifer groundwater elevations recover more quickly than the Lompico aquifer, suggesting the Butano aquifer is a more actively recharged aquifer likely because of its greater surface exposure area (Kennedy/ Jenks Consultants, 2015b). Since the available Butano groundwater elevation data is collected in wells installed close to where the formation outcrops, and the aquifer is not used extensively as a water supply in the Basin due to its greater depth and lower hydraulic conductivity than the other 2 aquifers, the more stable groundwater elevations in the Butano aquifer may also be related to the location of wells used to characterize the aquifer or a general lack of pumping influence on the aquifer.

Interpretation of limited aquifer tests in the Butano aquifer indicate confined or semi-confined aquifer conditions with moderate hydraulic conductivity. Estimated hydraulic conductivity ranges from 0.01 to 6 feet/day, transmissivity ranges from 100 to 1,070 feet^2/day, and storativity ranges from 0.000001 to 0.0007 (Table 2-14; Kennedy/Jenks Consultants, 2015b).

2.2.4.5 Other Hydrogeologic Units

2.2.4.5.1 Purisima Formation

The Purisima Formation comprises siltstone and sandstone up to 200 feet thick that forms the tops of some of the hills in the Scotts Valley area but is absent over most of the Basin. The more permeable units of the Purisima Formation are principal aquifers in the neighboring Santa Cruz Mid-County Basin to the east. However, in the Santa Margarita Basin, it is not considered a principal aquifer due to its limited thickness and occurrence on ridgetops. No hydraulic property data are available for this formation in the Basin.

2.2.4.5.2 Santa Cruz Mudstone

The Santa Cruz Mudstone is an impermeable layer that locally caps the Santa Margarita Sandstone, limiting recharge to the underlying aquifers where it is present. Slightly higher than normal salinity in Santa Margarita Sandstone groundwater near the Santa Cruz Mudstone indicates that runoff from the mudstone may percolate and recharge adjacent exposures of Santa Margarita Sandstone. No hydraulic property data are available for this formation.

2.2.4.5.3 Monterey Formation

The Monterey Formation is composed primarily of thick mudstone and siliceous shale that form a hydraulic barrier between the Santa Margarita Sandstone and Lompico Sandstone, except where it is missing in the southern portion of the Basin, as discussed above. The Monterey Formation contains sandstone interbeds, especially closer to the base of the formation, that are used for water supply. These interbeds are especially prominent in the southern Scotts Valley area (Kennedy/Jenks Consultants, 2015b). In general, the sandstone interbeds of the Monterey Formation are more hydrogeologically connected to the underlying Lompico Sandstone than to the overlying Santa Margarita Sandstone (Kennedy/Jenks Consultants, 2015b).

Although the Monterey Formation is generally considered an aquitard, the sandstone interbeds and fractured siliceous shales, along with the widespread surface exposure, make the Monterey Formation a locally important aquifer for shallow private domestic wells. Historically, municipal and small water systems pumped from the Monterey Formation, but those wells were not reliable because of low transmissivity.

Similar to the principal aquifers in the Basin, available aquifer test results in the Monterey Formation indicate a relatively large degree of heterogeneity. Reported hydraulic conductivity ranges from 0.05 to 6 feet/day, transmissivity ranges from 170 to 1,000 feet^2/day, storativity ranges from 0.00005 to 0.005, and specific yield ranges from 0.01 to 0.03 (Table 2-14; Kennedy/Jenks Consultants, 2015b).

2.2.4.5.4 Locatelli Sandstone

The Locatelli Sandstone is primarily a sandy siltstone that acts as a local aquitard in the Scotts Valley area; however, it contains a thin basal sandstone that provides water for some wells in the Scotts Valley area. In the northern Scotts Valley area, the Locatelli Sandstone is overlain by 600 feet of Butano Sandstone, whereas in southern Scotts Valley it is unconformably overlain by the Lompico Sandstone. The Locatelli Sandstone is not exposed at the surface within the Basin, and only has a limited outcrop south of the Basin (Figure 2-18). Most recharge to this unit is likely from the overlying Lompico and Butano Sandstones. No hydraulic property data are available for this formation.

2.2.4.5.5 Igneous and Metamorphic Basement Formations

The sedimentary rocks of the Santa Margarita Basin lie unconformably over a basement of igneous and metamorphic rocks. Exposed locally in the southern part of the Basin (e.g., along Carbonara Creek and the San Lorenzo River), the crystalline basement rocks have very low porosities and conductivities so typically behave as aquitards. Where sufficiently decomposed due to long surface weathering or fractured due to proximity to faults, granitic rocks can provide limited volumes of groundwater suitable for private domestic wells (Kennedy/Jenks Consultants, 2015b).

2.2.4.6 Soil Characteristics

The nature of soil and vegetation affect how much precipitation can infiltrate into the soil to recharge the regional groundwater aquifers. The character of the soils of the basin are derived from the exposed geologic formations they are developed on, but is also influenced by other factors such as climate, vegetation, and local relief.

The saturated hydraulic conductivity of surficial soils is a good indicator of its infiltration potential. The map on Figure 2-23 presents the distribution in the Basin of the 4 hydrologic groups defined in the U.S. Department of Agriculture (USDA) Natural Resources Conservation

Service, Soil Survey Geographic Database (USDA, 2007). The soil hydrologic groups are characterized by the water-transmitting properties of the soil, which include hydraulic conductivity and percentage of clay in the soil relative to sand and gravel. The groups are defined as:

- Group A – High Infiltration Rate: water is transmitted freely through the soil; soils typically less than 10% clay and more than 90% sand or gravel.
- Group B – Moderate Infiltration Rate: water transmission through the soil is unimpeded; soils typically have between 10 and 20% clay and 50 to 90% sand.
- Group C – Slow Infiltration Rate: water transmission through the soil is somewhat restricted; soils typically have between 20 and 40% clay and less than 50% sand.
- Group D – Very Slow Infiltration Rate: water movement through the soil is restricted or very restricted; soils typically have greater than 40% clay, less than 50% sand.

The hydrologic group of the soil generally correlates with the hydraulic conductivity of underlying geologic formations. Zones of greater soil hydraulic conductivity occur in areas where the Santa Margarita Sandstone outcrops, and lower soil hydraulic conductivity zones are found where siltstones and mudstones occur at the surface.

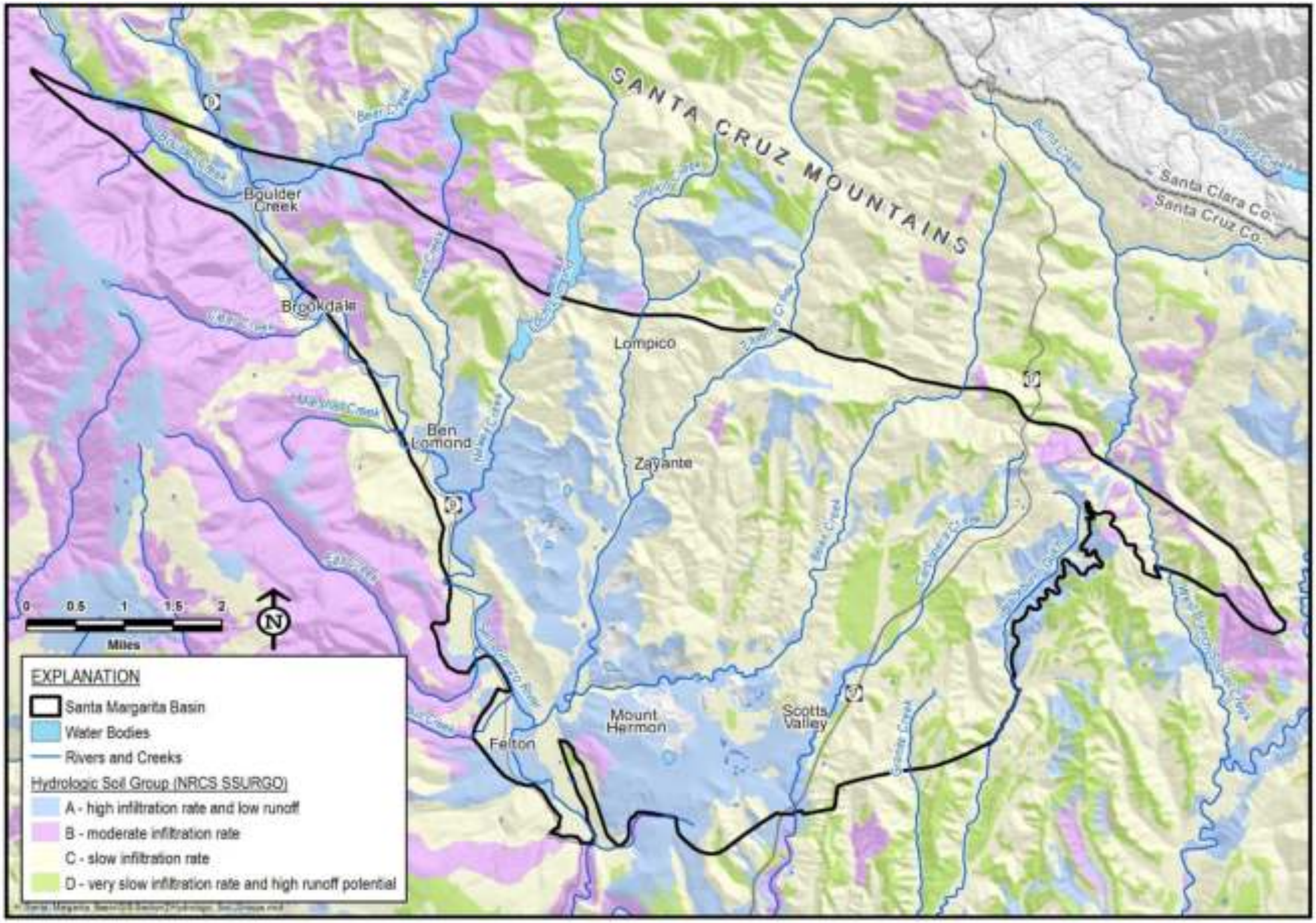


Figure 2-23. Soil Characteristics of the Santa Margarita Basin

2.2.4.7 Recharge Areas

Precipitation is the main source of natural groundwater recharge in the Basin. It enters shallow aquifers either directly by infiltration through the soil or indirectly from streamflow that infiltrates through stream and creek beds. As discussed in Section 2.2.4.9.1, most streams are fed by groundwater that is recharged by precipitation. Reductions in groundwater recharge can occur either naturally or anthropogenically. Natural reduction to groundwater recharge is caused by reduced precipitation or increased evapotranspiration due to changes in climate. Anthropogenic reduction to groundwater recharge is caused by land use changes such as increasing paved impermeable surfaces or changing vegetative cover that increase runoff and evapotranspiration.

Figure 2-24 shows County-mapped recharge areas (brown stipples). Most are areas with soils of high to moderate infiltration capacity developed on productive aquifer units. Areas of higher recharge capacity correspond closely with soils developed on the Santa Margarita Sandstone. Areas of lower recharge capacity are clay-rich soils with slower infiltration rates developed on geologic units with less productive potential: the Monterey Formation and the Santa Cruz Mudstone.

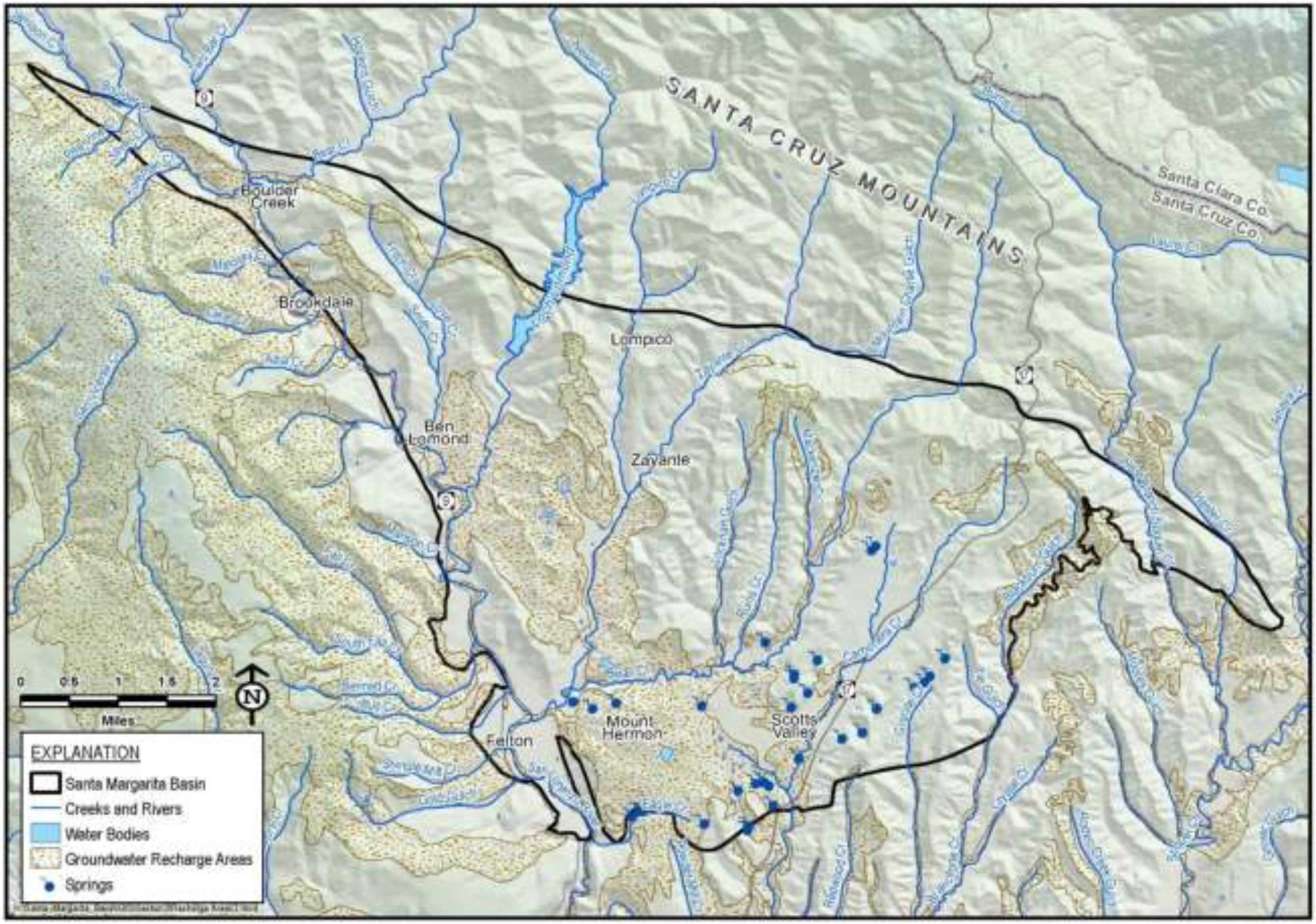


Figure 2-24. Recharge Areas in the Santa Margarita Basin

2.2.4.8 Surface Water

2.2.4.8.1 Rivers and Creeks

Figure 2-25 shows the location of rivers and creeks throughout the Basin. Significant rivers and creeks in the Basin include the San Lorenzo River, Boulder Creek, Love Creek, Newell Creek, Lompico Creek, Zayante Creek, Bean Creek, and Carbonera Creek. Many of these rivers and creeks are home to protected species such as coho salmon and steelhead, as described in Section 2.2.4.9.1.

Previous studies examining streamflow in the Basin concluded that the portion of streamflow that is sustained by groundwater (known as baseflow) peaks around April, at the tail end of the Basin's rainy season. In the dry season, from roughly late May through October, essentially all water flowing in the Basin's streams and creeks is derived from groundwater (Johnson, 2009). This pattern is illustrated on Figure 2-26, originally presented by Johnson in 2009, where representative streamflow hydrographs show streamflow comprised entirely of baseflow from about June through October. From November to May, streamflow is from both baseflow and stormflow. The amount of contribution from baseflow increases through the wet season as a result of rising groundwater elevations.

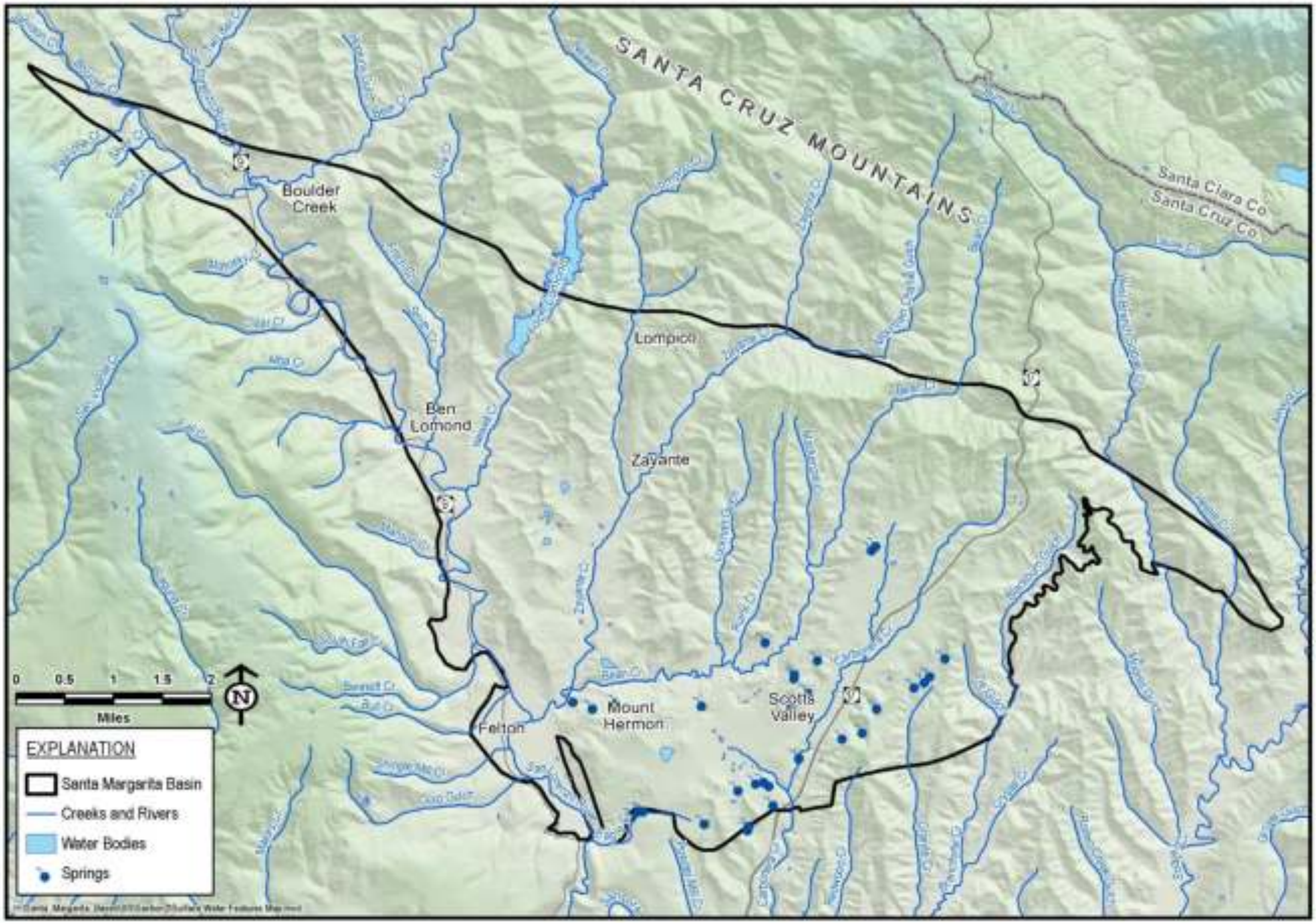


Figure 2-25. Surface Water Features

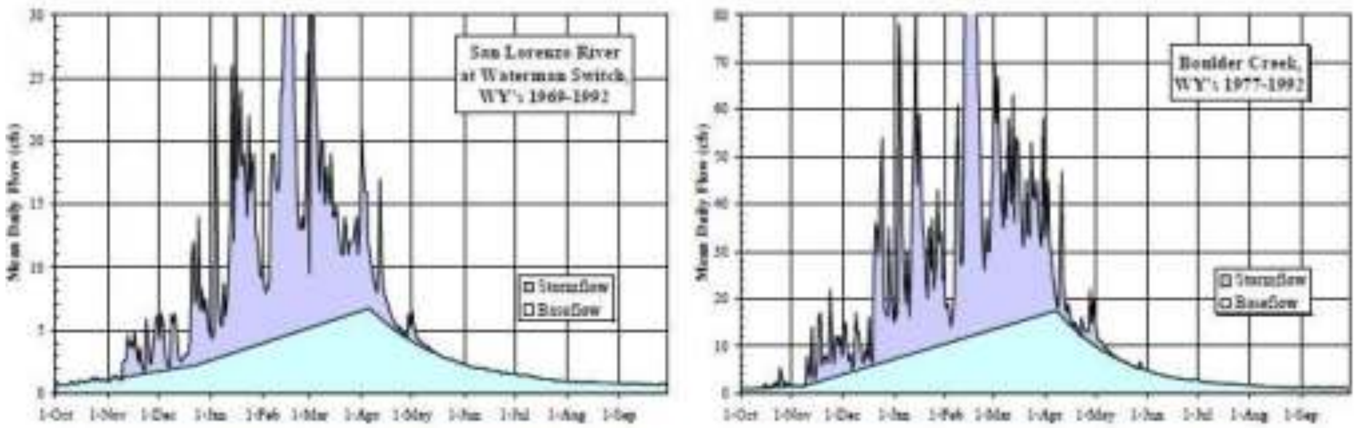


Figure 2-26. Stormflow and Baseflow in San Lorenzo River and Boulder Creek (from Johnson, 2009)

2.2.4.8.2 Water Impoundments

There is 1 permanent surface water impoundment within the Basin operated by the City of Santa Cruz Water Department. The Newell Creek Dam constructed in the early 1960s impounded Newell Creek and formed the Loch Lomond Reservoir (Figure 2-25). The Loch Lomond Reservoir is 2.5 miles long, no more than 1,500 feet wide, and has a maximum storage capacity of approximately 8,600 AF. Water stored in the reservoir is a major supply source for the City of Santa Cruz in summer and during droughts when flowing source availability declines.

There is 1 temporary surface water impoundment in the Basin that is operated rarely by the City of Santa Cruz Water Department. The diversion consists of an inflatable diversion dam on the San Lorenzo River in Felton that allows the City to impound and divert a portion of the streamflow by conveyance pipeline to the Loch Lomond Reservoir for storage. This dam can be inflated during the wet season as minimum bypass flow requirements, water rights, and storage capacity in Loch Lomond allow. If used, the dam is deflated in the dry season when stream flow is low.

2.2.4.8.3 Springs

Springs in the Basin are often important and reliable sources of cold water during summer, support adjacent wetlands, and by definition indicate groundwater levels are at the ground surface. There is a distinction between ‘basal’ and other springs in the Basin. Basal springs emanate from the base of the Santa Margarita Sandstone, where the underlying and much less permeable Monterey Formation of consolidated shales redirects water percolating down through the Santa Margarita Sandstone to the surface through springs, seeps, or other points of discharge.

2.2.4.8.4 Open Water

Lakes and ponds in the Basin are typically man-made or are modifications of natural springs and seeps. Although not usually natural features, lakes and ponds support unique wetland habitats and may be useful indicators of depth to groundwater and nearby rates of groundwater-to-surface water exchange. All open surface water features are included on Figure 2-25.

2.2.4.9 Groundwater Dependent Ecosystems

The GDE analysis in this GSP includes assessment of the extent of GDE indicator vegetation, groundwater elevations in shallow aquifers, and impacts of seasonal surface water and groundwater interaction or accretion. Where groundwater level data are unavailable, the groundwater model is used to identify where surface water and groundwater are likely connected.

Identification of GDEs in the Basin is based primarily on the database of mapping assembled by Natural Communities Commonly Associated with Groundwater dataset [https://gis.water.ca.gov/app/NCDatasetViewer/#]. This database from sources such as the National Wetland Inventory, National Hydrography Dataset, and Classification and Assessment with Landsat of Visible Ecological Groupings includes GDE indicators such as mapped springs, wetlands, and ponds, as well as vegetation types that may rely on shallow groundwater. In addition, several known springs, seeps, or other groundwater-dependent wetlands were identified as likely GDEs.

Types of identified GDEs include springs, open water, riverine/riparian, and other groundwater-supported wetlands. Springs and open water were described in Sections 2.2.4.8.3 and 2.2.4.8.2, respectively. Riverine/riparian and other groundwater supported wetlands are discussed in more detail in the following subsections. Table 2-15 summarizes the four different GDE classifications in the Basin. Figure 2-27 through Figure 2-30 shows the locations of the Basin's mapped GDEs.

Table 2-15. Santa Margariita Basin Groundwater Dependant Ecosystem Classification

GDE Classification	GDE Types	Mapped GDEs
Springs	Basal springs, and non-basal springs	42 sites
Open Water	Lakes and ponds	35 sites
Riverine/ Riparian	Perennial and ephemeral streams, riparian corridors, on-channel ponds, palustrine wetlands	Sites throughout the basin
Other Groundwater-Supported Wetlands	Seep, seep complex, quarry floor, willow vegetation, terrace	5 sites: Quail Hollow, Glenwood Preserve, Lompico (also mapped as a pond), Graham Hill Rd (also mapped as pond), Olympia Quarry floor

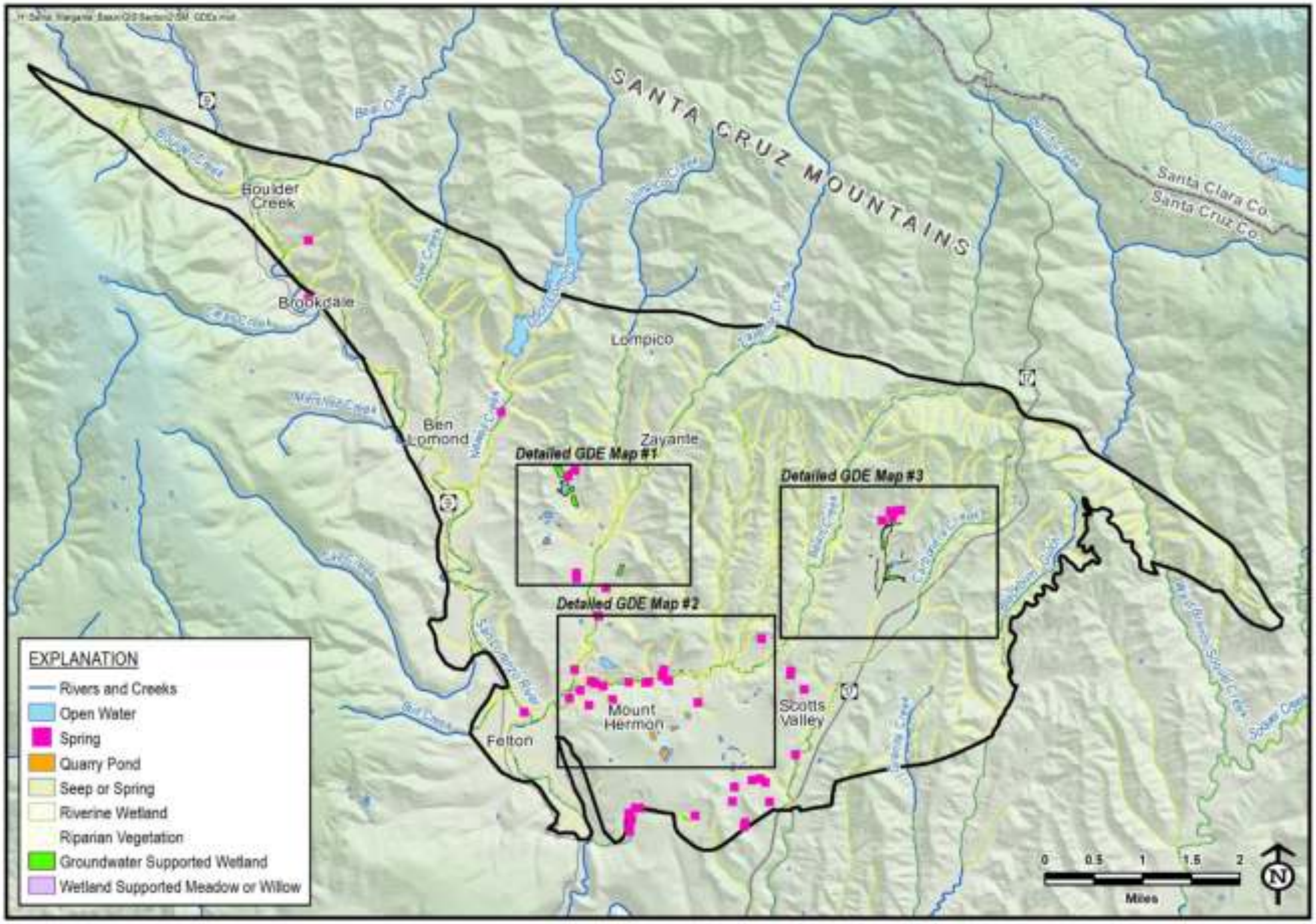


Figure 2-27. Identified Groundwater Dependent Ecosystems in the Santa Margarita Basin

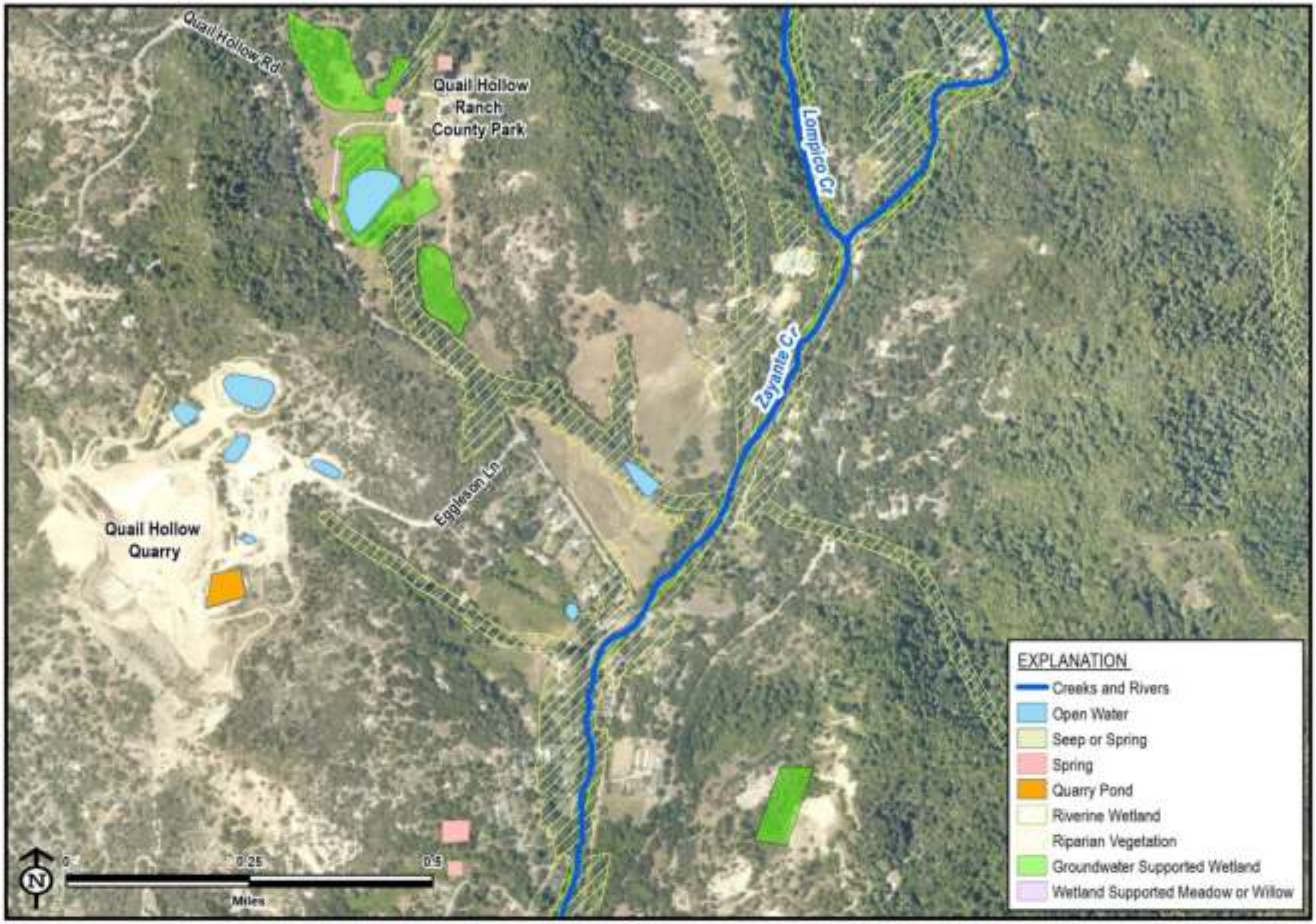


Figure 2-28. Detailed Map #1 of Identified Groundwater Dependent Ecosystems

Figure 2-29. Detailed Map #2 of Identified Groundwater Dependent Ecosystems

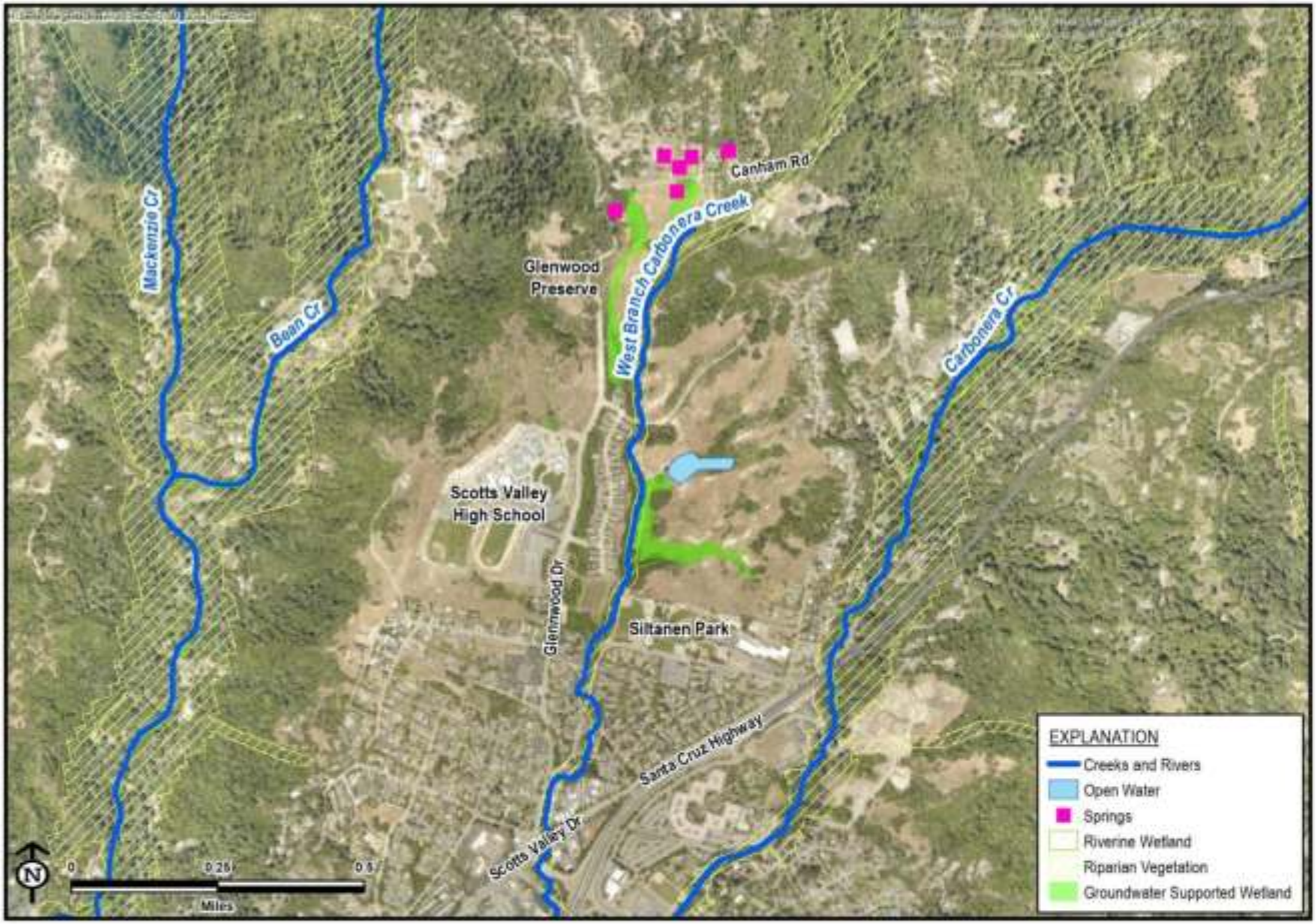


Figure 2-30. Detailed Map #3 of Identified Groundwater Dependent Ecosystems

2.2.4.9.1 Riverine and Riparian GDEs

Riverine and riparian GDEs (including riverine wetlands, on-channel ponds, or other wetland types that occur within the riverine corridor) are distinguished from other GDE types because they have complex interactions with both surface water and groundwater. Riparian vegetation responds to changes in groundwater as well as streamflow, both of which can be influenced by fire, sudden oak death or other infestations, land use changes, and climate change. Further, riparian and watershed vegetation development stage can influence the water budget as older more mature plants have deeper root systems that might access groundwater more efficiently. These complicating factors make correlation of vegetation in riverine and riparian GDEs with groundwater management challenging.

2.2.4.9.2 Other Groundwater-Supported Wetlands

Groundwater supported wetlands in the Basin are a variety of ecologically unique systems. These include spring/seep complexes and quarry floor sites where shallow or emerging groundwater support a variety of wetland vegetation types. Additional investigation is required, but several of these sites are likely supported by local shallow perched groundwater conditions on lower permeability sedimentary deposits as opposed to being supported wholly by baseflow from the high permeability Santa Margarita aquifer.

2.2.4.10 Sources and Points of Water Supply

Almost all water supply within the Basin is derived from local sources. Local water sources in the Basin include groundwater, surface water, and recycled water. Figure 2-31 shows the location of all municipal supply wells, points of surface water diversions, and current service areas of the public suppliers in the Basin. The communities of Forest Springs (126 connections) and Bracken Brae (25 connections) located in the northwesternmost part of the Basin are supplied water from sources within the Boulder Creek watershed but northwest of the Basin through an intertie with Big Basin Water Company.

Figure 2-31 shows the rural areas of the Basin that have no municipal water supply and thus rely on private groundwater wells for domestic and non-domestic water supply. As a requirement per SGMA, Figure 2-32 includes a well density map showing the number of all water supply wells, including municipal, small water systems, private domestic, and industrial, within 1 square mile cells across the Basin.

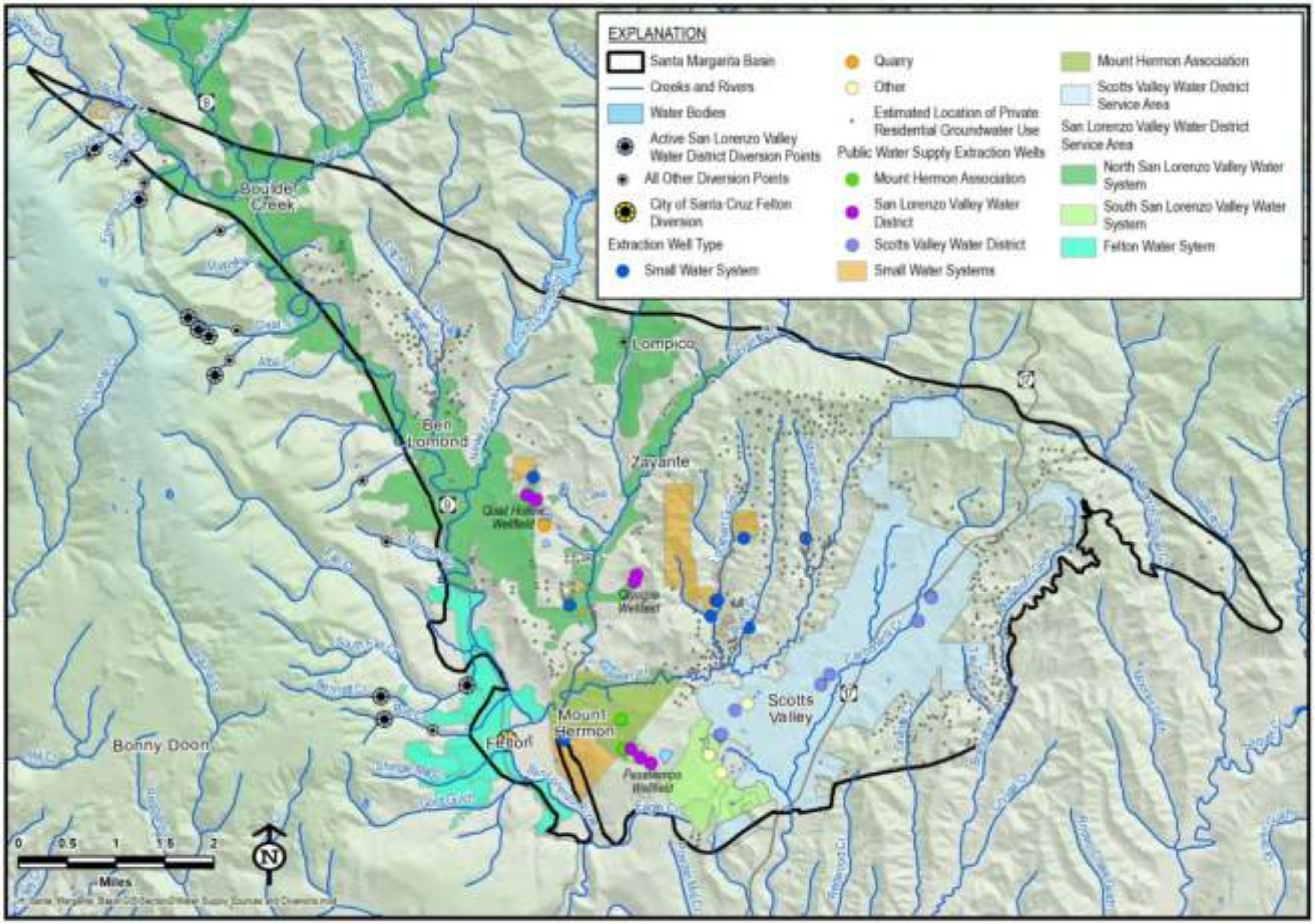


Figure 2-31. Current Water Supply Sources and Service Areas

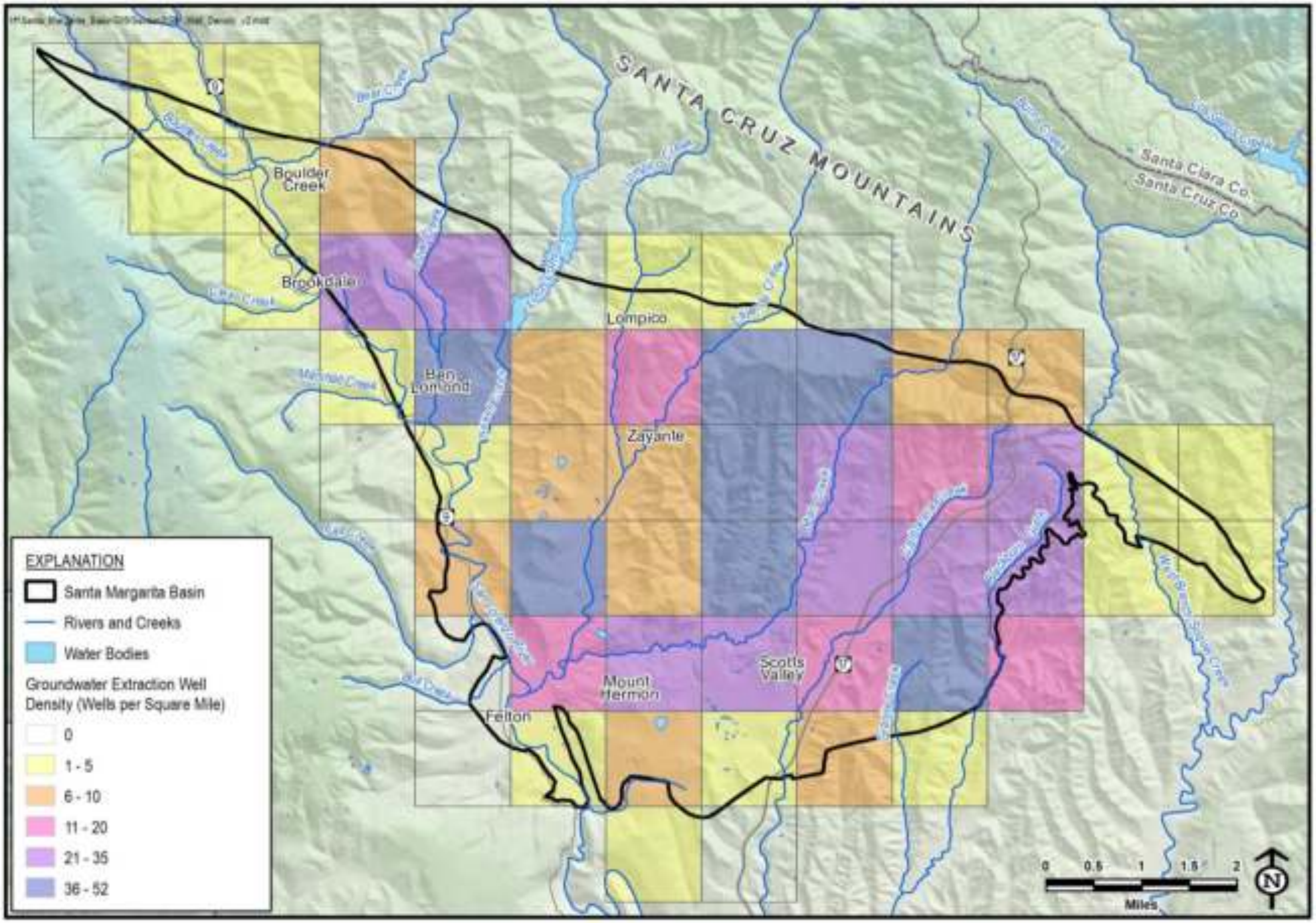


Figure 2-32. Groundwater Extraction Well Density Map for the Santa Margarita Basin

SLVWD uses both surface water and groundwater for its water supply. SLVWD's 9 surface water diversions are shown on Figure 2-31 and listed in Table 2-16. 4 of the 9 points of diversion are currently inactive due to damage sustained in the CZU Lightning Complex wildfire damage in the summer of 2020. It is anticipated that these will be repaired or replaced in 2022/2023. The diversions are all located on tributaries of the San Lorenzo River outside of the Basin. The watersheds of these creeks are also mostly outside of the Basin. Water that is not diverted flows into the San Lorenzo River and is considered a Basin water source. SLVWD appropriative water rights, including pre-1914 appropriative rights on all streams in the San Lorenzo Valley System, are exercised through the active diversions.

Table 2-16. SLVWD Surface Water Diversions

SLVWD System	Points of Diversion	Diversion Status
San Lorenzo Valley System		
Peavine Creek	1	Temporarily inactive
Foreman Creek	1	Active
Clear Creek	3	Temporarily inactive
Sweetwater Creek	1	Temporarily inactive
Felton System		
Fall Creek	1	Active
Bennett Spring	1	Active
Bull Creek	1	Active

Note: gauges that are temporarily inactive were damaged during the CZU Lightening Complex wildfire damage in the summer of 2020

Additionally, SLVWD holds entitlement to a portion of surface water storage in Loch Lomond Reservoir or an equivalent water transfer from the City Santa Cruz Water. SLVWD has not recently exercised its entitlement due mostly to the costly upgrade that would be needed to its Kirby water treatment plant to address the high concentrations of total organic carbon in Loch Lomond raw water.

SLVWD produces stored groundwater from 3 wellfields (Table 2-4 and Figure 2-31). The Quail Hollow and Olympia wellfields extract groundwater from the Santa Margarita aquifer, and the Pasatiempo wellfield extracts from the Lompico aquifer. The 7 active wells are grouped as shown in Table 2-4.

SVWD relies on 5 active groundwater extraction wells for the entirety of its potable water supply (Figure 2-31). These wells extract from the Basin's confined aquifers, namely the Lompico and Butano aquifers. SVWD augments its water supply and offsets its groundwater extraction for non-potable uses with between 160 to 200 AF of recycled water per year. The City of Scotts Valley's WRF treats around 2.9 AF of water daily (or about 1,060 AFY). Influent to the WRF is sourced entirely from within the City of Scotts Valley. Recycled water produced at a Scotts

Valley WRF Tertiary Treatment Plant is used mainly within the city limits but is also available to bulk users outside of city limits.

Groundwater is pumped by private pumpers within the Basin for residential use, and there are some private water rights holders for surface water diversions for non-potable uses. The approximate location of wells used for private use are shown on Figure 2-31.

Other water systems that use groundwater pumped from the Basin as a source of potable water include MHA and 9 small water systems. MHA used springs as their sole water source prior to 1991 (Johnson, 2009) but have since extracted groundwater to meet their full demand. Small water systems primarily use groundwater with several also diverting local surface water to supplement their demand. Section 2.1.4.2.3 provides more information on small water systems.

Table 2-17 summarizes WY2018 water use within the Basin and Figure 2-33 provides annual water use in the Basin from WY1985 through 2018 categorized by water source and user; water year type is shown on the chart (wet, normal, dry, and critically dry; the classification system is described in Section 2.2.3).

The City of Santa Cruz is included in Table 2-17 as it has rights to store and divert surface water in the Basin. The City of Santa Cruz operates the Loch Lomond storage reservoir that impounds water in the Newell Creek watershed that would naturally flow into the Basin. It also operates a diversion on the San Lorenzo River in Felton that conveys water upstream for storage in Loch Lomond. Water diverted and stored in the Basin by the City of Santa Cruz is conveyed out of the Basin by the Newell Creek Pipeline to the City of Santa Cruz water treatment plant.

Table 2-17. Water Year 2018 Santa Margarita Basin Water Use by Source

Water Supplier	Groundwater Use (Acre-Feet)	Surface Water Use (Acre-Feet)	Recycled Water Use (Acre-Feet)	Imported Water Use (Acre-Feet)	Total 2018 Water Use (Acre-Feet)
San Lorenzo Valley Water District (SLVWD)[1]	993	1,166[5]	0	0	2,159
Scotts Valley Water District (SVWD)	1,211	0	196	0	1,407
Mount Hermon Association	129	0	0	0	129
City of Santa Cruz	0	0[6] 1,130[7]	0	0	1,130
Private Domestic Wells[2]	233	0	0	0	233
Other Non-Domestic Private Groundwater Users[3]	145	0	0	0	145
Small Water Systems	79	6	0	48	133
Valley Gardens Golf Course[4]	113	0	0	0	113
Quail Hollow Quarry	25	0	0	0	25
Total	**2,928**	**2,302**	**196**	**48**	**5,474**

Note: The City of Santa Cruz Water Department stores surface water diverted from both the San Lorenzo River and Newell Creek in Loch Lomond Reservoir which is partially within the Basin. Water from Loch Lomond is treated at the City's surface water treatment plant and served to its customers. While SLVWD has a right to a portion of Loch Lomond water to serve to customers within the Basin, this water is currently only delivered to City customers outside the Basin.

[1] includes springs
[2] estimated
[3] other private non-domestic uses include landscape irrigation and water for landscape ponds.
[4] Valley Golf Course closed on December 31, 2018
[5] SLVWD surface water is sourced outside of the Basin in tributaries to the San Lorenzo River
[6] City of Santa Cruz Valley's San Lorenzo River diversion from Felton to Loch Lomond
[7] City of Santa Cruz Valley's San Lorenzo River diversion at Tait Street (5 miles downstream of the Basin) to the City treatment plant

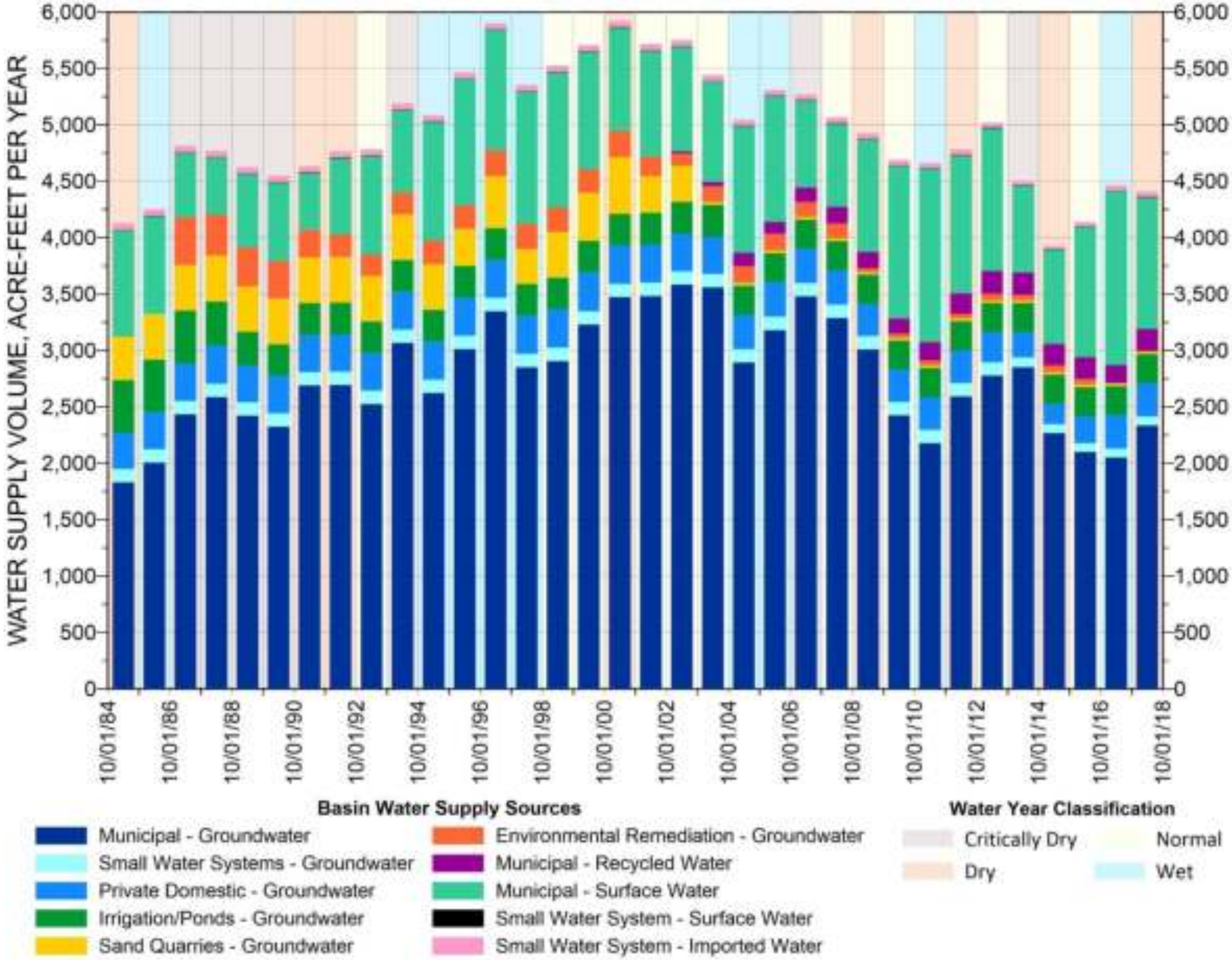


Figure 2-33. Historical Annual Water Use in the Santa Margarita Basin by Source and User

2.2.4.11 Hydrogeologic Conceptual Model Data Gaps

The hydrogeology of the Mount Hermon/South Scotts Valley subarea and portions of the Santa Margarita aquifer in Olympia and Quail Hollow subareas are relatively well understood because of the water supply and monitoring wells that have been drilled, logged, and monitored by SLVWD, SVWD, MHA, and through environmental remediation programs. Areas of the Basin that are lacking these types of data are those that are outside of the jurisdiction of SLVWD, SVWD, and MHA where private domestic groundwater extraction takes place. Additionally, the deep Butano aquifer is poorly understood because it only has 2 dedicated monitoring wells.

These data gaps have led to some uncertainty on how the aquifers interact with each other in parts of the Basin and respond to change in fluxes, such as recharge and groundwater extraction. The 10 new monitoring wells identified and described in Section 3.3.4 will minimize these uncertainties by filling data gaps in the Basin's hydrogeologic conceptual model. These new monitoring wells become part of the overall monitoring network, where implementation of the GSP will ensure ongoing data collection and monitoring that will allow continued refinement and quantification of the hydrogeologic system. Section 5 includes activities to address the identified data gaps and improve the hydrogeologic conceptual model.

2.2.5 Current and Historical Groundwater Conditions

2.2.5.1 Groundwater Elevations

Groundwater has been the primary source of water in the Basin for domestic, municipal, and sand mining users since the early part of the 20th century. The rate of parcel development in the San Lorenzo River watershed between the 1950s and 1980s increased (Figure 2-34) to meet the housing, commercial, and industrial needs of a growing population (Figure 2-35). The parcel development led to increased groundwater demands. Much of the development in this timeframe was in the City of Scotts Valley and the communities of the San Lorenzo Valley (County of Santa Cruz, 2002). Since historical population estimates for all communities within the Basin are not available, Figure 2-35 shows County of Santa Cruz population estimates that can be used as an indication of population growth within the Basin.

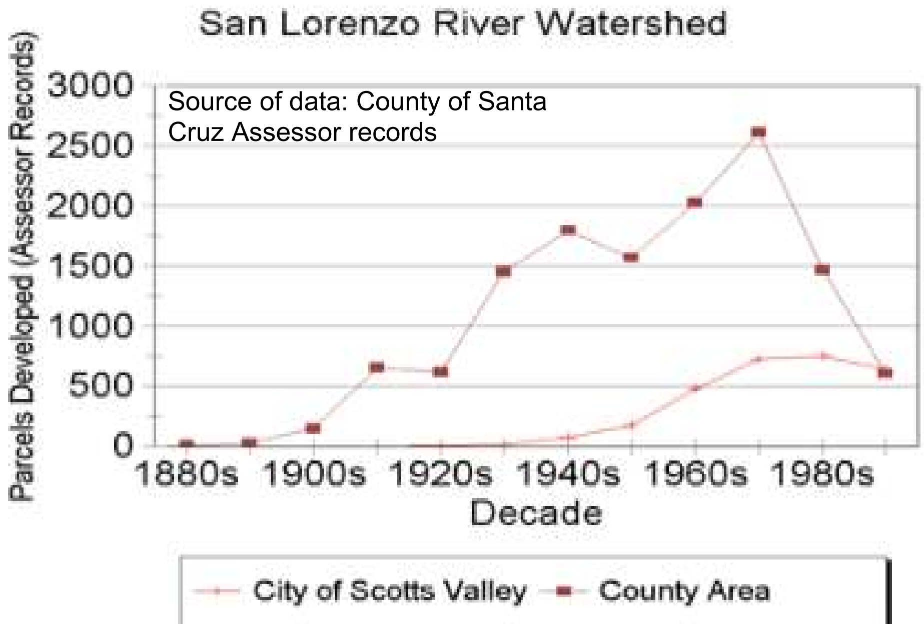


Figure 2-34. County of Santa Cruz Parcel Development in the San Lorenzo River Watershed

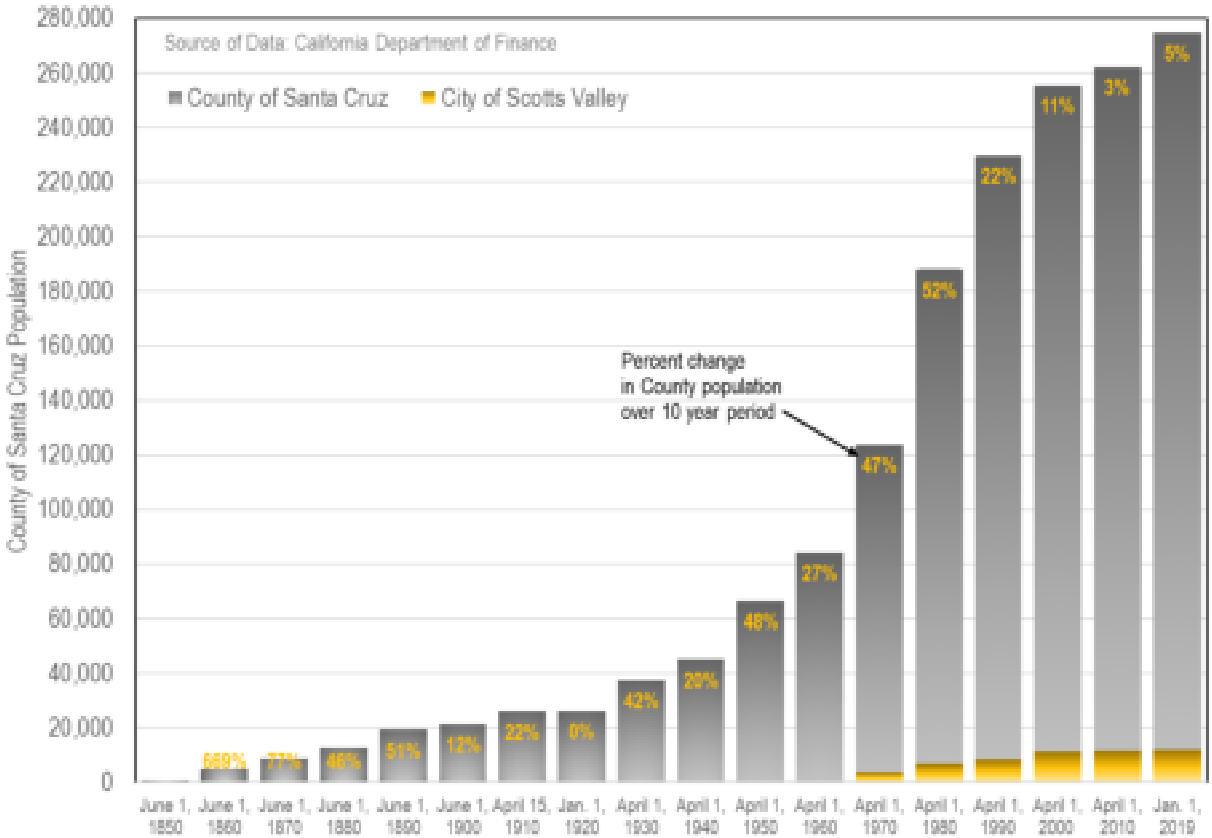


Figure 2-35. County of Santa Cruz Historical Population

The repercussions of historical drought periods, discussed in Section 2.2.6.2.1, and growth in the more developed areas of the Basin has been a decline in groundwater elevations in wells extracting groundwater from the Lompico aquifer. Starting in the 2000s, focused groundwater management and conservation programs by the water districts, reduced environmental remediation pumping, decommissioning of the Hanson and Olympia Quarries, and heightened water use efficiency practices by the Basin's community have largely stabilized groundwater elevations by reducing groundwater extraction to more sustainable volumes (Figure 2-36).

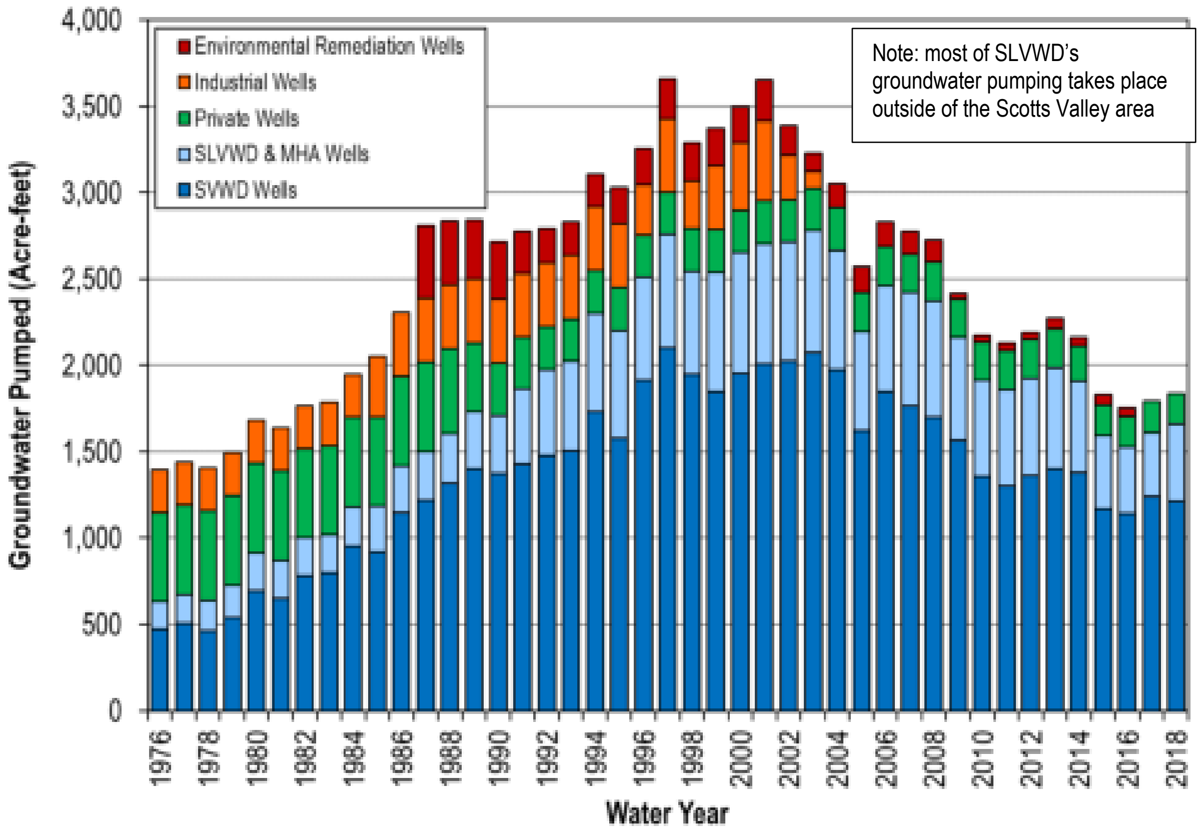


Figure 2-36. Scotts Valley Area (South of Bean Creek) Groundwater Extraction by User Type

2.2.5.1.1 Groundwater Elevation Subareas and Monitoring Wells

The subsections below describe groundwater elevations and gradients by principal aquifers in the Basin). The Monterey Formation is generally an aquitard to flow between the Santa Margarita and Lompico aquifers so is not considered a principal aquifer. To guide discussion in the GSP, the principal aquifers and Monterey Formation are divided into subareas with distinct characteristics.

There are 4 Santa Margarita aquifer subareas shown on Figure 2-37:

1. Quail Hollow
2. Olympia/Mission Springs
3. Mount Hermon/South Scotts Valley
4. North Scotts Valley

The 2 Santa Margarita subareas are generally isolated from each other due to erosion by creeks through the entire thickness of the aquifer are therefore subject to different pumping and recharge regimes (Johnson, 2009). Kennedy/Jenks Consultants (2015b) defined subareas in the Santa Margarita aquifer that are adopted with slight modification for the GSP.

The Quail Hollow area, a roughly 3 square mile hillslope area south of Loch Lomond is largely hydrogeologically separated from other areas of Santa Margarita Sandstone due to erosion and its position on the limb of the Scotts Valley syncline topographically above other outcrops (Johnson, 2009). The only major groundwater pathway between Quail Hollow and the greater Basin is through a narrow bridge of sandstone and stream alluvium beneath Zayante Creek (Figure 2-18). The isolated nature of the Quail Hollow area means that projects and groundwater management actions undertaken in other parts of the Basin are unlikely to influence groundwater conditions in the Quail Hollow area. The other subareas are connected more than Quail Hollow, but still demonstrate unique characteristics due to erosion by creeks.

Subareas are also identified for discussion in the GSP in each of the deeper, more laterally continuous geologic units used for water supply in the Basin. The 3 subareas for the Monterey Formation, Lompico aquifer, and Butano aquifer shown on Figure 2-38 are:

1. North of Bean Creek
2. Mount Hermon/South Scotts Valley
3. North Scotts Valley

The subareas are defined loosely based on the overlying Santa Margarita aquifer subareas, with the subareas south of Bean Creek having identical names and boundaries. Since the majority of the Lompico and Butano aquifer extractions occur in the southern portions of the Basin, there are no monitoring wells in the aquifers and formations in the deeper geologic units in the North of Bean Creek subarea. MHA-MW1, the only Lompico aquifer well north of Bean Creek, is a pilot well that was not completed for extraction and a new addition to the GSP water level monitoring network.

The sections below describe the groundwater conditions measured historically in monitoring wells in the Basin and simulated by the groundwater model. Well locations and the aquifer or formation they are screened in are shown on Figure 2-39. The groundwater elevation contour maps are generated using simulated groundwater model results. The model is calibrated to the groundwater levels in wells and discharge in creeks where data are available and is based on inferences where data are not available.

Appendix 2B contains hydrographs for all wells with current records in the Basin. Note that all hydrographs included in this GSP identify the climatic year type of each water year by different background colors on the graphs (wet, normal, dry, and critically dry; the classification system is described in Section 2.2.3).

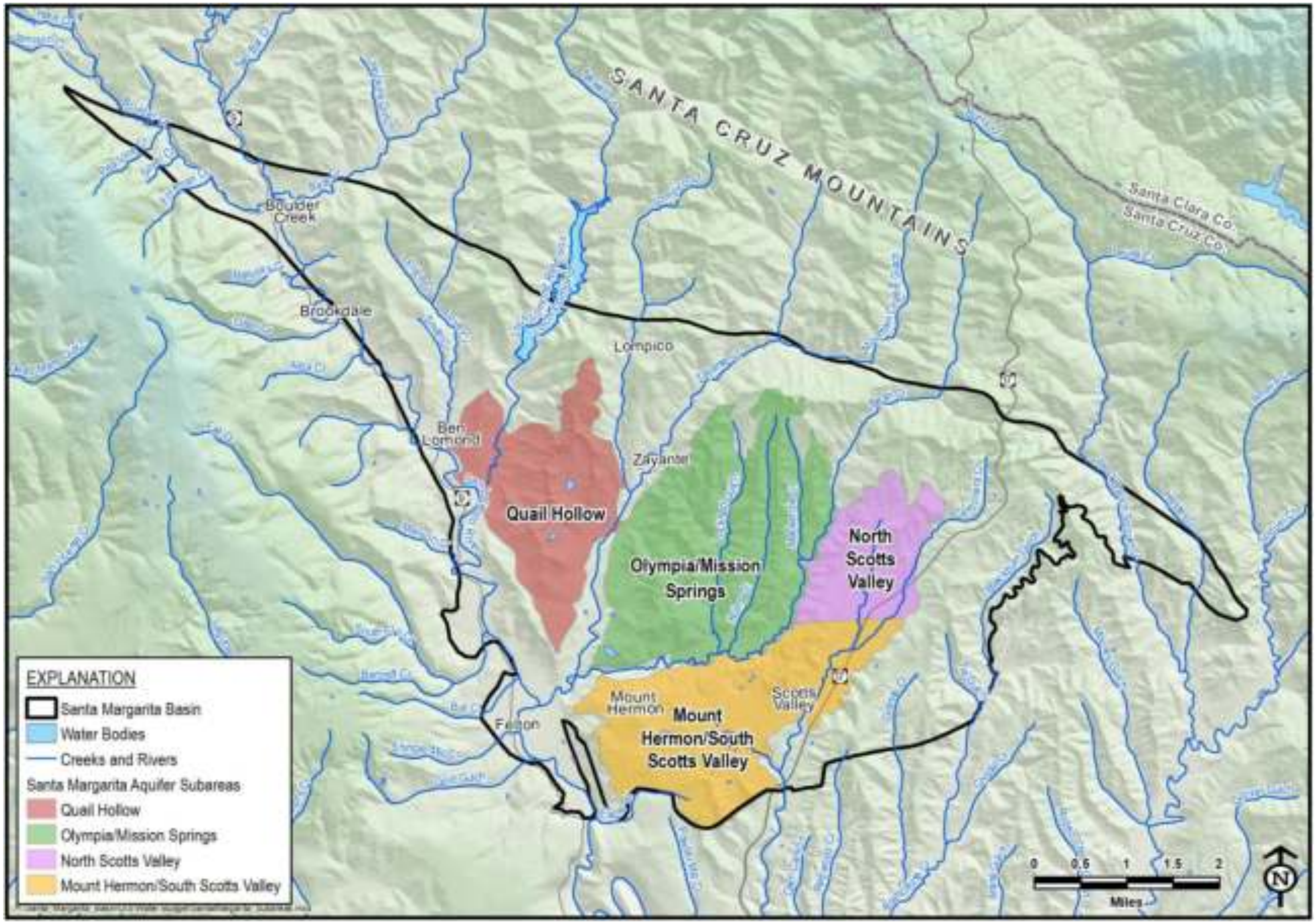


Figure 2-37. Santa Margarita Aquifer Subareas

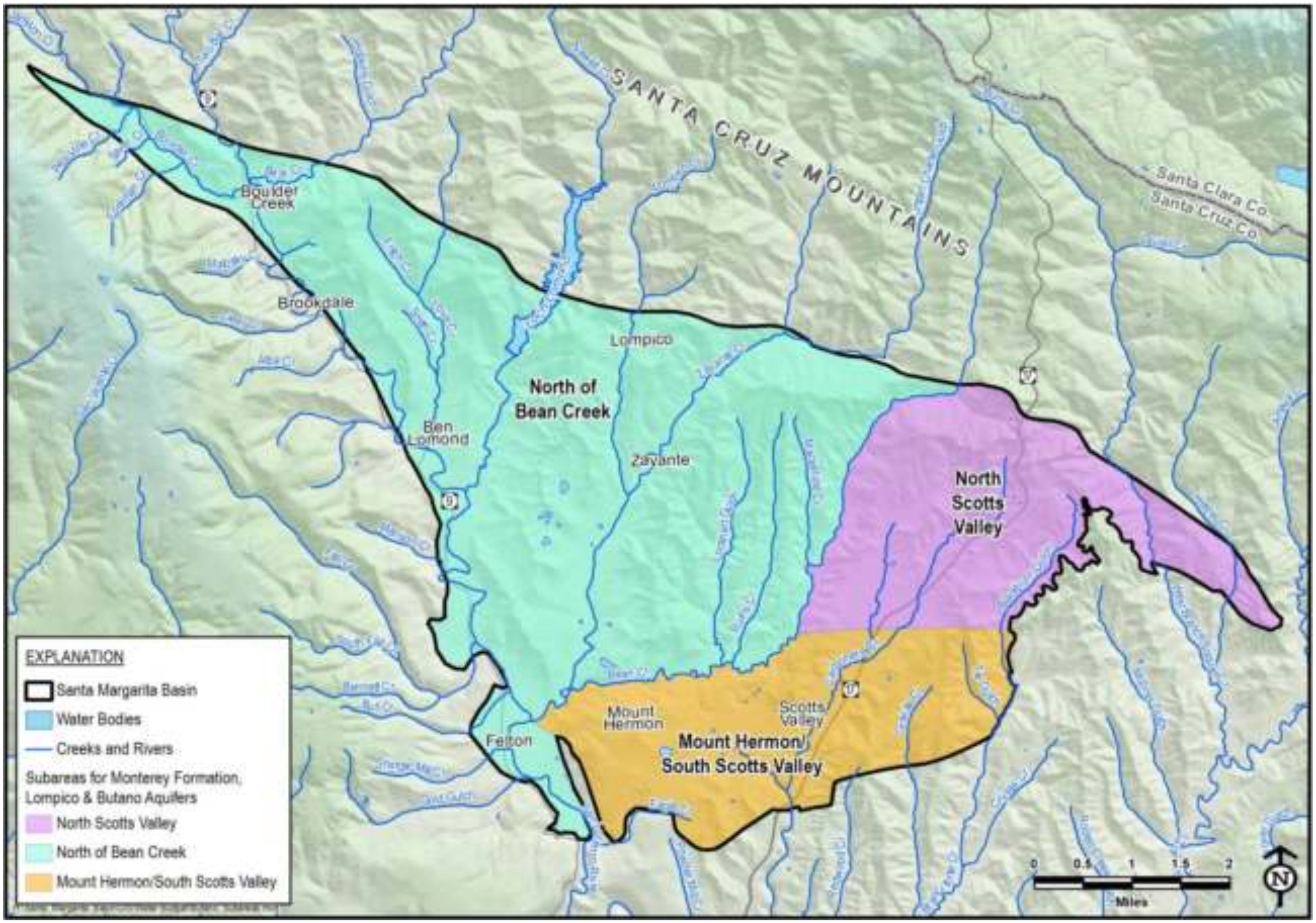


Figure 2-38. Monterey Formation, Lompico Aquifer and Butano Aquifer Subareas

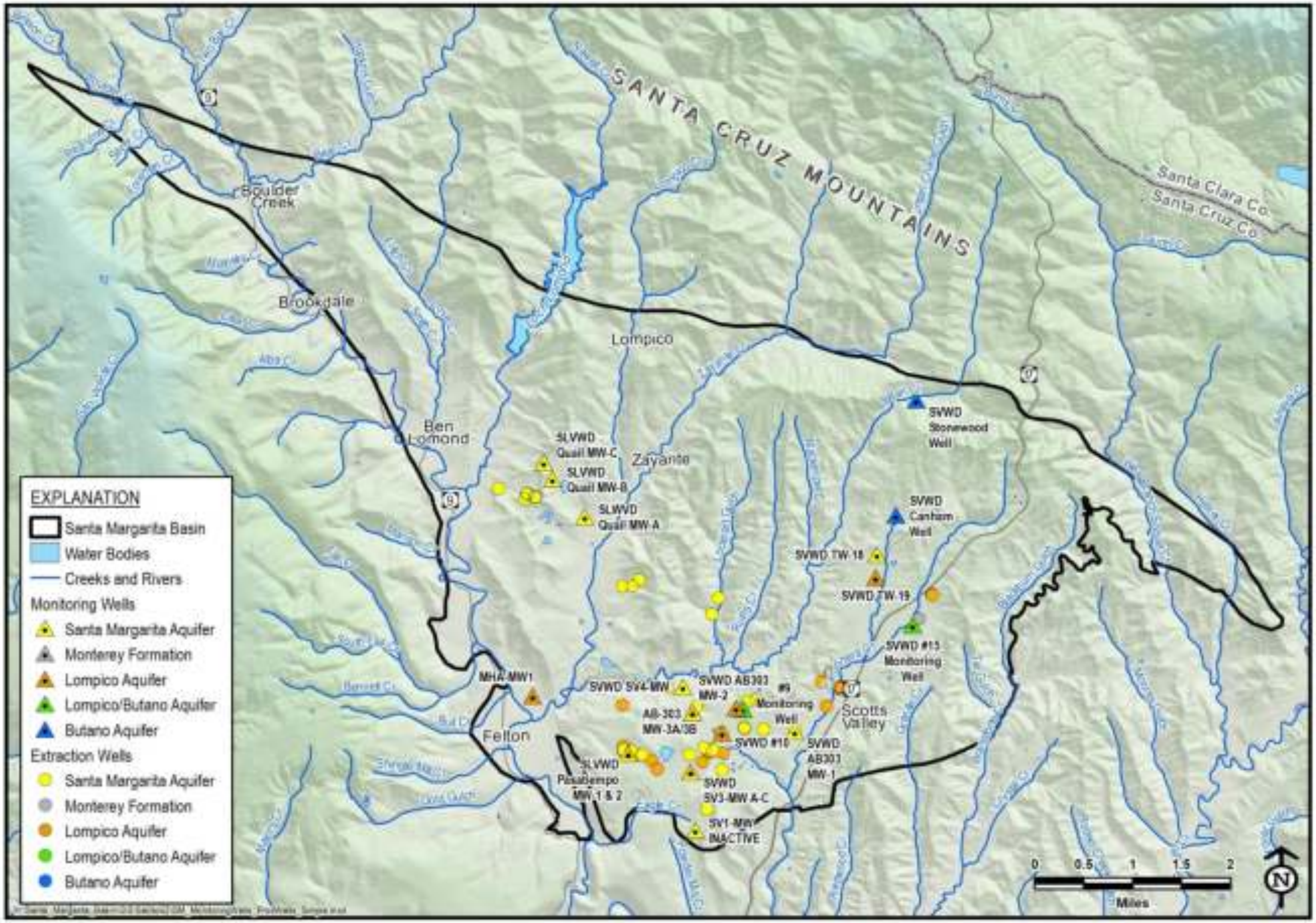


Figure 2-39. Location of Wells Used for Monitoring Groundwater Levels

2.2.5.1.2 Santa Margarita Aquifer Groundwater Elevations

2.2.5.1.2.1 Santa Margarita Aquifer Groundwater Elevations over Time

The Basin's primary unconfined aquifer is the Santa Margarita aquifer as described in Section 2.2.4.4.1. Relatively high hydraulic conductivities and widespread surface exposure result in the Santa Margarita aquifer being one of the most important hydrogeologic units within the Basin for water supply, recharge, and as a source of baseflow for creeks and rivers. The Santa Margarita aquifer's high hydraulic conductivity and extensive surface exposure allow it to recharge quickly after rainfall, but also become dewatered by overpumping in underlying formations as demonstrated on hydrographs in Figure 2-40.

As discussed in Section 2.2.5.1.1, the Santa Margarita aquifer has isolated subareas with distinct groundwater level trends. The groundwater elevations in the Quail Hollow and Olympia/Mission Springs subareas north of Bean Creek demonstrate greater seasonal variability related to groundwater pumping. The Santa Margarita aquifer in the Mount Hermon/South Scotts Valley south of Bean Creek near Pasatiempo and Camp Evers was dewatered in the 1980s by overpumping in the Santa Margarita and underlying Lompico aquifer in an area where the Monterey Formation aquitard is absent. Groundwater elevations have not recovered and as a result, there is no longer groundwater pumping in most of the Santa Margarita aquifer in this portion of the subarea. There is very little pumping in the Santa Margarita aquifer in the North Scotts Valley subarea, resulting in long-term stable groundwater elevations.

This section describes groundwater level fluctuations in representative hydrographs in each subarea. The following section describes the overall groundwater elevations and flow directions for the aquifer in each subarea as simulated by the groundwater model in WY2018.

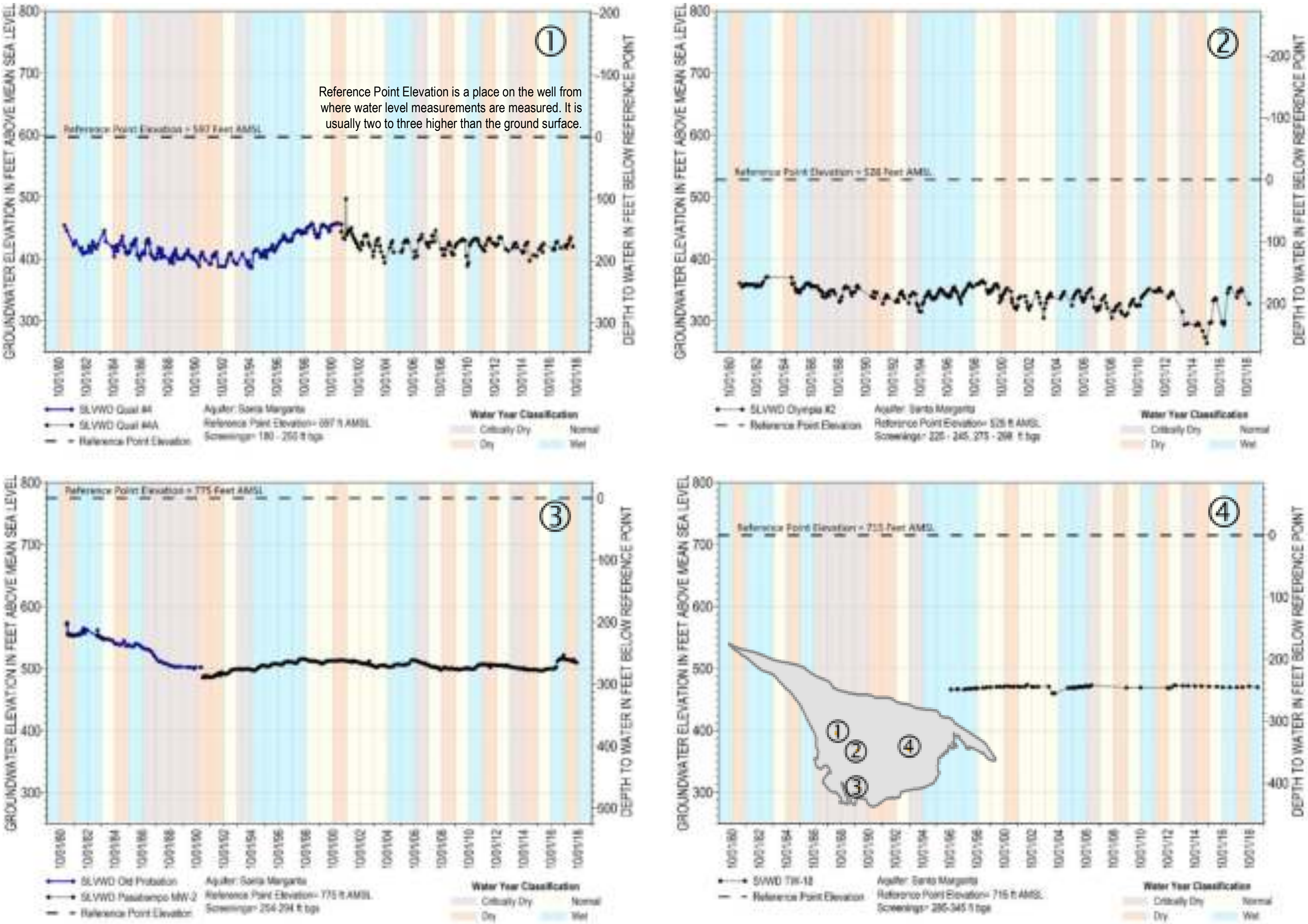


Figure 2-40. Santa Margarita Aquifer Hydrographs

Quail Hollow and Olympia/Mission Springs Subareas

Groundwater elevations in the Santa Margarita aquifer in the Quail Hollow and Olympia/Mission Springs subareas are similar and have remained consistent over time. Groundwater elevations exhibit seasonal fluctuations from pumping and decadal responses to dry and wet periods (Figure 2-40).

The severity of the long-term groundwater level decline that took place in the Basin's deeper confined aquifers over the extended drought in the late 1980s through mid-1990s is not observed in the Santa Margarita aquifer in the Quail Hollow and Olympia areas. The hydrograph for SLVWD's Quail Hollow Well #4 on Figure 2-40 shows that, based on seasonal low elevations, there was a decline of only about 10 feet over that period. Groundwater elevations then recovered 40 feet above pre-drought levels by the end of 4 consecutive wet years that followed the drought. Rapid groundwater elevation recovery is observed during every wet period, as is typical in aquifers that have a high hydraulic conductivity and direct exposure to recharge from rainfall. The 30-foot decline in the Santa Margarita aquifer's Olympia area during the 1987 through 1994 drought was greater than in the Quail Hollow area, as shown on the SLVWD Olympia #2 hydrograph on Figure 2-40. This is probably because there was more pumping from the Olympia well field during this time, especially towards the latter part of the drought.

Mount Hermon South Scotts Valley Subarea

The Santa Margarita aquifer hydrograph for SLVWD Old Probation and SLVWD Pasatiempo MW-2 in the Mount Hermon/South Scotts Valley subarea demonstrate greater groundwater level decline. In the Pasatiempo and Camp Evers area, dewatering of the Santa Margarita aquifer was induced by historical pumping (Johnson, 2009). Dewatering took place because of unsustainable pumping by a combination of users: nearby sand quarry, environmental remediation to clean up contaminated groundwater, and municipal water suppliers. Declining groundwater elevations of up to 200 feet in the deeper Lompico aquifer caused the Santa Margarita aquifer to become unsaturated and eventually completely dewatered in the vicinity of where the Santa Margarita aquifer and Lompico aquifer are in direct contact (Figure 2-18). The combined hydrograph for SLVWD Old Probation and SLVWD Pasatiempo MW-2 on Figure 2-40 shows groundwater elevations in the Santa Margarita aquifer declining 60 feet from the early 1980s to 1989.

In the early 1990s, municipal water supply wells screened in the dewatered Santa Margarita aquifer in this subarea were replaced with deeper wells screened entirely in the Lompico aquifer. As a result of this change in groundwater source, along with reduced environmental remediation and quarry pumping in the Santa Margarita aquifer, by the end of 4 years of above average rainfall ending in 1998, groundwater elevations recovered approximately 25 feet (Figure 2-40). Other than an almost 20-foot increase during the very wet year in 2017, groundwater elevations are stable since 1999. The Pasatiempo and Camp Evers areas currently remain mostly dewatered even though municipal water agencies no longer pump from the Santa Margarita aquifer.

Induced recharge through the aquifer is likely the main reason why it has not completely recovered in dewatered areas. Induced recharge through the dewatered portions of the aquifer generally follows 1 of 2 pathways depending on the underlying formation: 1) infiltration to the top of the underlying low permeability Monterey Formation from where it flows until it emerges as seeps to Bean Creek, and 2) into the Lompico aquifer where it directly underlies the Santa Margarita aquifer. A secondary factor may be reduced local recharge. In the mid-1980s, most septic systems in the Scotts Valley area were converted to a sewer system. Moreover, development over time created increased impervious surfaces. These changes have resulted in less recharge and return flows to the Santa Margarita aquifer in the Scotts Valley area than prior to the 1980s.

North Scotts Valley Subarea

The Santa Margarita aquifer in the North Scotts Valley subarea is not pumped by SVWD. Because this part of the City of Scotts Valley is supplied water by SVWD, there are very few private wells. SVWD TW-18 is the only Santa Margarita monitoring well in the subarea and its groundwater elevations have fluctuated slightly since the start of the monitoring record in 1996 (Figure 2-40). Its trends are notably different than the Quail Hollow and Olympia/Mission Springs subareas, which demonstrate seasonal fluctuations related to groundwater pumping. Since the Monterey Formation underlies the aquifer in the North Scotts Valley subarea, groundwater levels are not influenced by pumping occurring in the deeper Butano and Lompico aquifers in the subarea.

2.2.5.1.2.2 Santa Margarita Aquifer Groundwater Elevation Contours and Flow Directions

Groundwater flow in the Santa Margarita aquifer generally mimics the surface topography. Groundwater flows from areas of higher elevation where the Santa Margarita aquifer is exposed at the surface and can be directly recharged, towards areas of lower elevations where groundwater is discharged. Groundwater discharge occurs in seeps at the contact between the Santa Margarita aquifer and underlying Monterey Formation, in springs, or as baseflow in Bean Creek, Zayante Creek, Newell Creek, and the San Lorenzo River in the Glen Arbor area.

As required per the GSP regulations, seasonal high and fall seasonal low contour maps are provided in this subsection. Figure 2-41 and Figure 2-42 show Santa Margarita aquifer groundwater elevations and flow directions for the spring (seasonal high) and fall (seasonal low) of WY2018, respectively. The groundwater elevations included on the Santa Margarita aquifer and all other aquifer contour maps are both a combination of interpreted contours from measured elevations at wells, and model-simulated elevations in areas where there are no measured data. The contour maps are produced for this and other following sections to show that seasonal groundwater flow patterns are similar at the regional scale despite local groundwater elevation fluctuation during wet and dry seasons. The subsections below describe groundwater elevations and flow for each of the subareas.

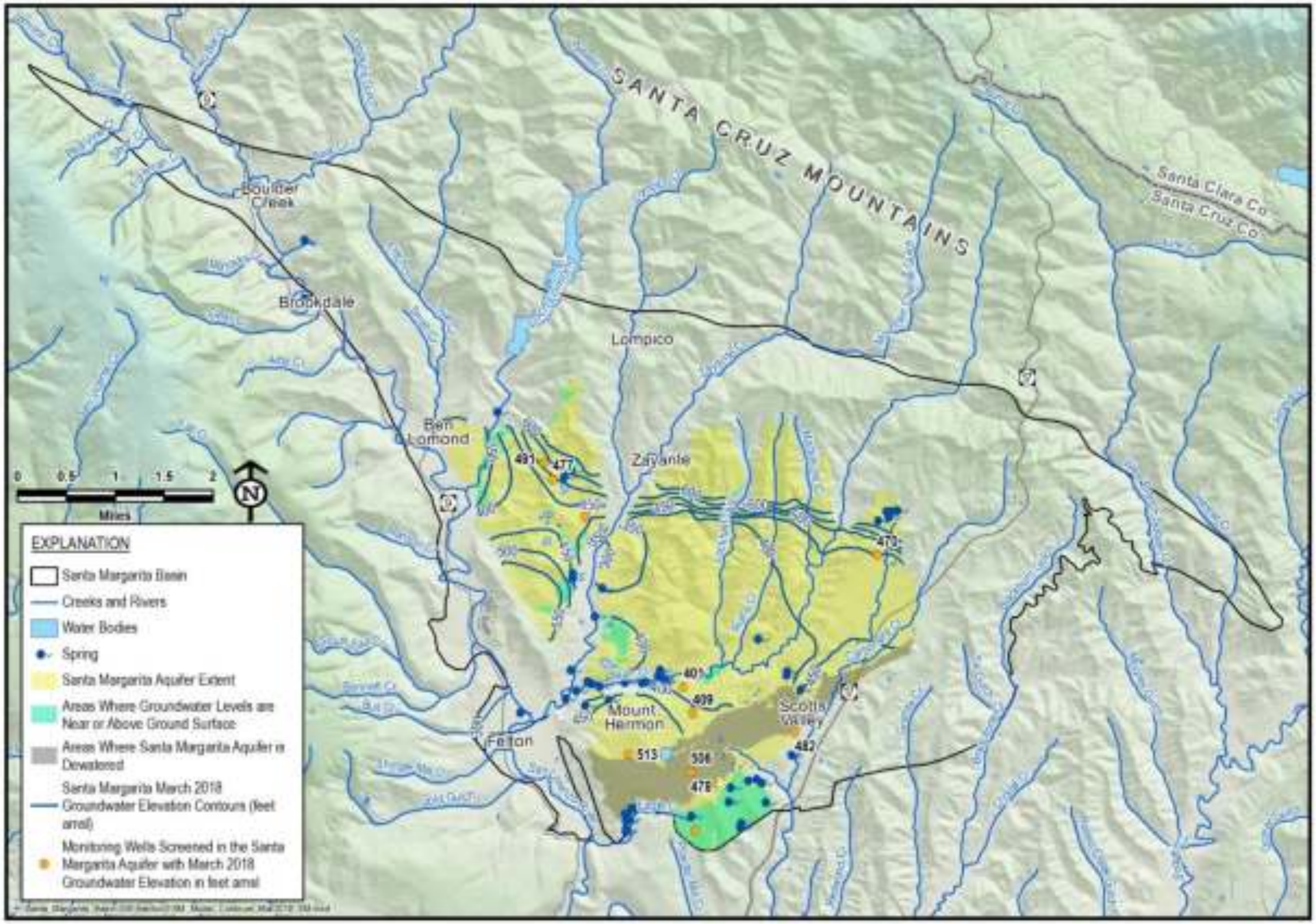


Figure 2-41. Spring (March) Water Year 2018 Groundwater Elevations in the Santa Margarita Aquifer

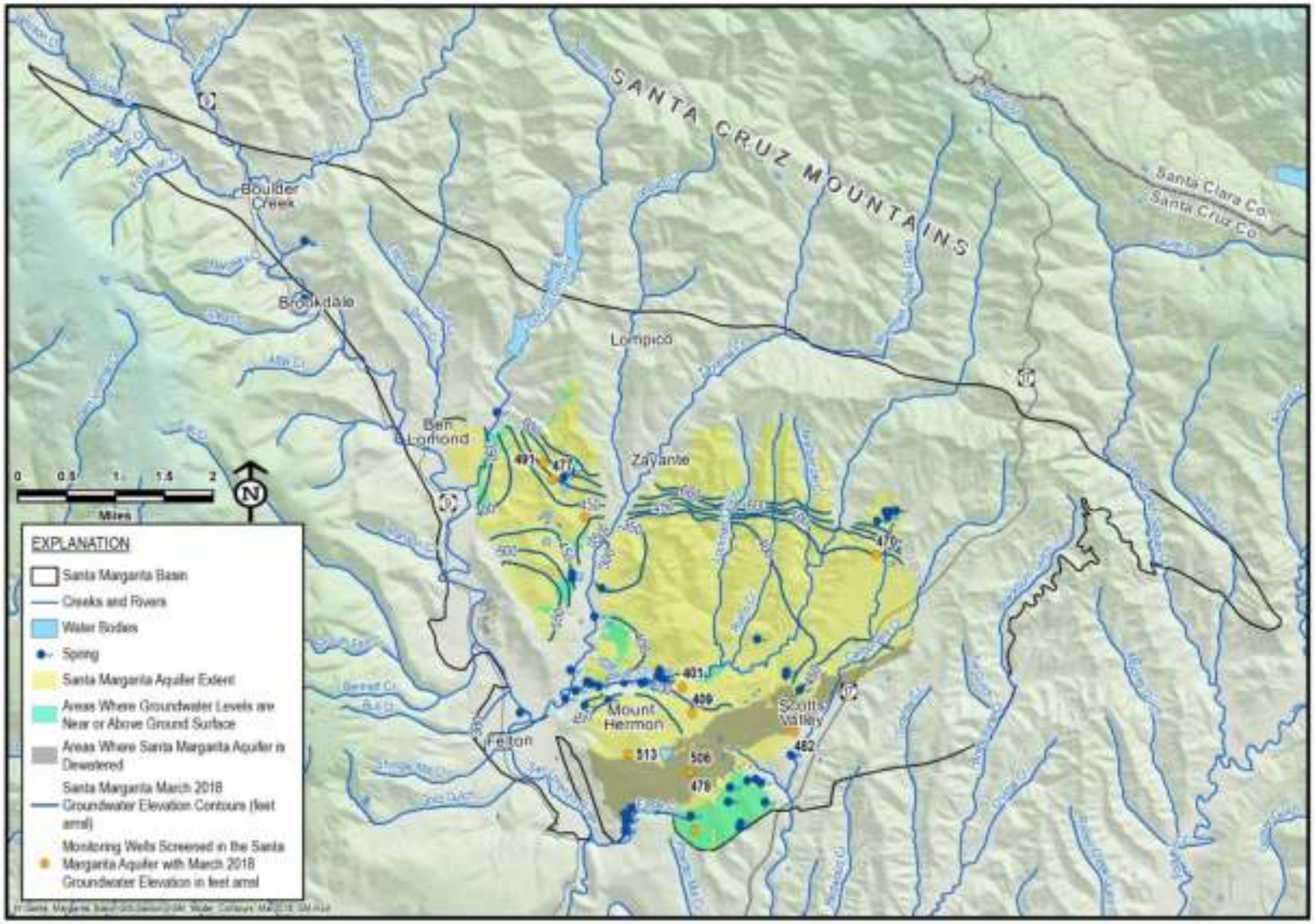


Figure 2-42. Fall (September) Water Year 2018 Groundwater Elevations in the Santa Margarita Aquifer

Quail Hollow Subarea

The Quail Hollow subarea is located in the central portion of the Basin, between the communities of Ben Lomond, Glen Arbor, Felton, Zayante, and Lompico (Figure 2-37). It lies between Love Creek and Lompico/Zayante Creek and is intersected by Newell Creek. Almost the entire subarea has Santa Margarita aquifer exposed at the surface. Groundwater in this subarea is pumped by SLVWD's Quail Hollow wellfield, the Quail Hollow sand quarry, and private domestic pumpers.

Johnson (2009) and Kennedy/Jenks Consultants (2015b) describe the subarea groundwater elevations as mimicking the topography in a subdued manor as a result of mounded recharge beneath hills and ridges and groundwater discharge to downcut streams. Perennial streams and springs are generally an expression of the groundwater table. Under high groundwater table conditions, the saturated thickness of the Santa Margarita sandstone reaches 130 feet thick. During drought conditions, the groundwater surface partially flattens but maintains a similar shape. Groundwater flows toward the center of Quail Hollow from the north and south, east toward Zayante Creek, west toward the Quail Hollow wellfield where there is a localized pumping depression and then toward Newell Creek. Under drought conditions, some groundwater flows west under Newell Creek toward the San Lorenzo River. Springs occur where the groundwater table intersects the ground surface. Most springs in the subarea occur on the northern flank of the lower Zayante Creek valley where the contact between Santa Margarita Sandstone and Monterey Formation outcrops at the surface, forcing groundwater perched above the Monterey Formation to emerge as springs and seeps.

Olympia/Mission Springs Subarea

The Olympia/Mission Springs subarea is north of Bean Creek and lies between the communities of Mount Hermon, Zayante, and Scotts Valley (Figure 2-37). The subarea is a hillslope area where hilltop ridges are capped by Santa Cruz Mudstone and Purisima Formation, which limits recharge to the Santa Margarita aquifer below. Private domestic pumpers and small water systems provide the majority of water to the residents in the subarea. The only municipal pumping occurs in the western portion of the subarea where SLVWD has its Olympia wellfield.

The highest groundwater elevations are in upland areas in the northern portion of the subarea (Figure 2-41 and Figure 2-42) where recharge to the exposed portions of the aquifer occurs by direct percolation of precipitation and streambed percolation in the upper reaches of creeks. Groundwater flows from the upland areas to lower elevations discharging at: 1) Zayante Creek, west of the Olympia wellfield, 2) near the confluence of Lockhart Gulch and Ruins Creek with Bean Creek, and 3) in springs that occur at the contact of the Santa Margarita aquifer and Monterey Formation along the sides of Zayante and Bean Creeks. A localized pumping depression is associated with the Olympia wellfield.

The Olympia/Mission Springs subarea is separated from the Pasatiempo/Camp Evers/Scotts Valley subarea by Bean Creek, which is a groundwater discharge location in the Santa Margarita aquifer, as shown on the groundwater elevation contour maps (Figure 2-41 and Figure 2-42). Groundwater level declines north of Bean Creek are unlikely to influence groundwater elevations south of Bean Creek, and vice versa.

North Scotts Valley and Mount Hermon/South Scotts Valley Subareas

The Santa Margarita aquifer south of Bean Creek is divided into 2 subareas: North Scotts Valley and Mount Hermon/South Scotts Valley (Figure 2-37). Most of the Santa Margarita aquifer in the North Scotts Valley subarea is overlain by the Santa Cruz Mudstone. There has not been municipal pumping in the subarea, and there is limited private domestic pumping.

The Mount Hermon/South Scotts Valley subarea lies south of the lower to mid-reach of Bean Creek (Figure 2-37), both where it is exposed at the surface and locally overlain by the Santa Cruz Mudstone. It includes most of the City of Scotts Valley, the communities of Camp Evers and Mount Hermon, and the Hanson Quarry (Figure 2-37). It is considered separately from the Northern Scotts Valley subarea because it contains the dewatered portion of the aquifer.

Most of the groundwater pumping in the Mount Hermon/South Scotts Valley subarea is by municipal suppliers, SVWD, SLVWD, and Mount Hermon Association, who pump from the deeper Lompico aquifer and not from the Santa Margarita aquifer. Historically, municipal, environmental remedial, and sand quarry pumping from the Santa Margarita aquifer took place in the subarea, but that use no longer occurs, as described in Section 2.2.5.1.1. There is limited pumping by private domestic pumpers in the subarea.

The highest groundwater elevations are in the upland areas in the North Scotts Valley subarea (Figure 2-41 and Figure 2-42). Groundwater recharge is mostly from precipitation and streambed percolation where the Santa Margarita aquifer is exposed at the surface. Santa Cruz Mudstone overlying much of the Santa Margarita Aquifer limits the amount of precipitation and return flows reaching the aquifer. Groundwater recharge also occurs along Carbonera Creek where it flows in the Santa Margarita aquifer or the alluvium directly overlying the Santa Margarita aquifer (Kennedy/Jenks Consultants, 2015b).

Groundwater flows south from the northern upland area and north from Mount Hermon to the central part of the subarea. Groundwater flow converges toward Bean Creek where the lowest groundwater elevations are found along the subarea's boundary with the Olympia/Mission Springs subarea. Bean Creek is the primary groundwater discharge area for groundwater in the subareas south of Bean Creek. In the western portion of the Mount Hermon/South Scotts Valley subarea, groundwater discharges at numerous springs along the Santa Margarita Sandstone outcrop areas bordering Bean, Eagle, and Camp Evers Creeks. Figure 2-41 and Figure 2-42 indicate areas where groundwater elevations simulated in the groundwater model lie above the land surface. These areas correlate with known springs, which are indicated on the contour maps.

Historically, some of Mount Hermon Association's water supply was from the Ferndell and Redwood springs. Water discharged by these springs is now sourced from the upland areas of the Santa Margarita aquifer adjacent to the springs.

In the past, when there was environmental remediation, quarry, and municipal pumping in the Santa Margarita aquifer, there were localized pumping depressions in the aquifer, but those have dissipated since that pumping ceased. Figure 2-41 and Figure 2-42 show the location where the Santa Margarita aquifer is unsaturated or dewatered for its entire thickness. Even with portions of the aquifer dewatered, groundwater flow in this area is still toward Bean Creek.

2.2.5.1.3 Monterey Formation Groundwater Elevations

As described in Section 2.2.4.5.3, the Monterey Formation is not a high yielding aquifer and is not considered a principal aquifer, but its groundwater is pumped by some Basin residents because there is no alternative water source. Groundwater elevation data for wells screened in the Monterey Formation in the Basin are very limited. The only long-term record is from SVWD Well #9 previously thought to be screened in the Santa Margarita aquifer (Kennedy/Jenks Consultants, 2015b). The lack of monitoring data in the Monterey Formation indicates a data gap that should be addressed by adding some private wells to the County's private well monitoring network described in Section 2.1.2.4.1 or by installing dedicated monitoring wells.

The single hydrograph for the Monterey Formation on Figure 2-43 shows that groundwater elevations have a much more pronounced response to drought and increased water usage than the Santa Margarita aquifer, presumably because recharge to sandy layers tapped in the Monterey Formation is impeded by the low conductance of the surrounding mudstone and shale layers. A decline in groundwater elevations of about 150 feet corresponds with an extended dry period that started in the mid-1980s (Figure 2-43) and population growth in the Basin. It is notable that the SVWD Well #9 was pumped more between 1983 and 1988 than in the years before and after. Groundwater elevations stabilized in 1994 during a period of 4 consecutive wet years. Since 1998, a more typical rainfall pattern and a 50% reduction in extraction from SVWD Well #9 allowed groundwater elevations to recover by about 30 feet (Figure 2-43).

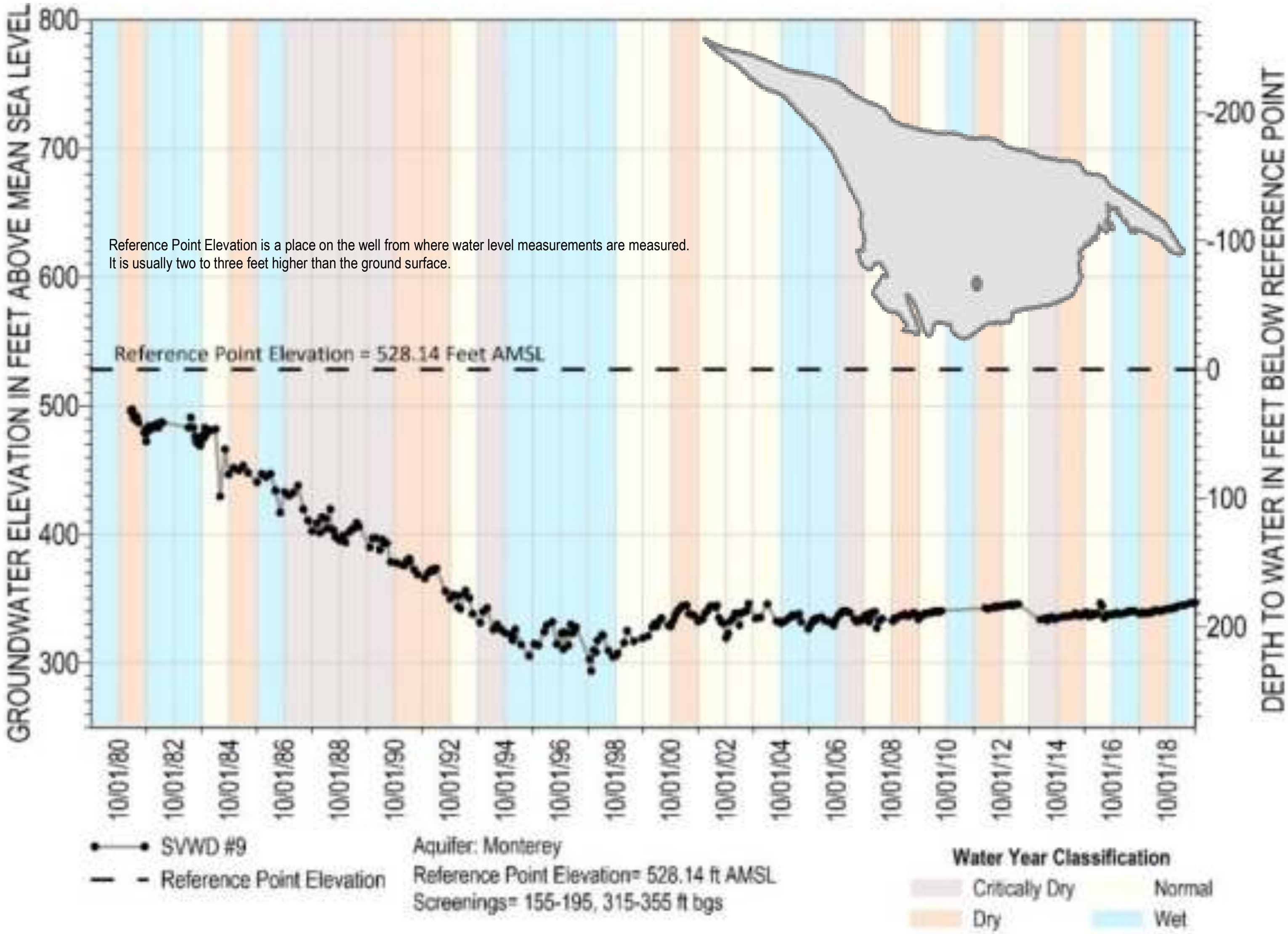


Figure 2-43. Monterey Formation Hydrograph

2.2.5.1.4 Lompico Aquifer Groundwater Elevations

2.2.5.1.4.1 Lompico Aquifer Groundwater Elevations over Time

Most of the groundwater pumped from the Lompico aquifer in the Basin is extracted in the Scotts Valley area, because this area has the sole potable source available to SVWD. The Lompico aquifer is also pumped by the SLVWD Pasatiempo and Mount Hermon Association wellfields to the south of Scotts Valley. There is little to no Lompico aquifer pumping north of Bean Creek and therefore there has been no historical groundwater level monitoring conducted in the North of Bean Creek subarea (Figure 2-39).

In the Mount Hermon/South Scotts Valley subarea of the Basin, which includes central Scotts Valley south of Bean Creek, Camp Evers, and Pasatiempo, groundwater elevations in the Lompico aquifer declined as much as 200 feet in well SVWD #10 during the drought period between 1985 and 1994 (Figure 2-44). Other nearby wells have a shorter measurement record but display similar trends. The groundwater elevation declined more in this subarea than in other parts of the Basin during the drought due to population growth, remediation pumping at 2 cleanup sites, and pumping at the Hanson Quarry that led to overextraction of groundwater. Subsequent groundwater management efforts and reduced pumping due to conservation slowed the decline in groundwater levels, stabilizing them in the early 2000s. Since 2017 there has been a small but sustained increase in groundwater elevations of about 10 feet per year (Figure 2-44). The SVWD TW-19 monitoring well installed in the North Scotts Valley subarea demonstrates similar overall trends, though the record only starts in 1996 and has a short-term groundwater level increase between 1996 and 2000 not observed in the other hydrographs (Figure 2-44).

For the purposes of groundwater management in the Basin, it is important to highlight that elevation data for wells in the Lompico aquifer indicate that sometime around 2012, pumping volumes ceased to be unsustainable. Most wells exhibited more or less constant seasonal lows in groundwater elevation during the recent drought of 2012-2015. Moreover, it appears that groundwater elevations have been recovering since 2017. These facts suggest that over-pumping is no longer occurring in the Lompico aquifer.

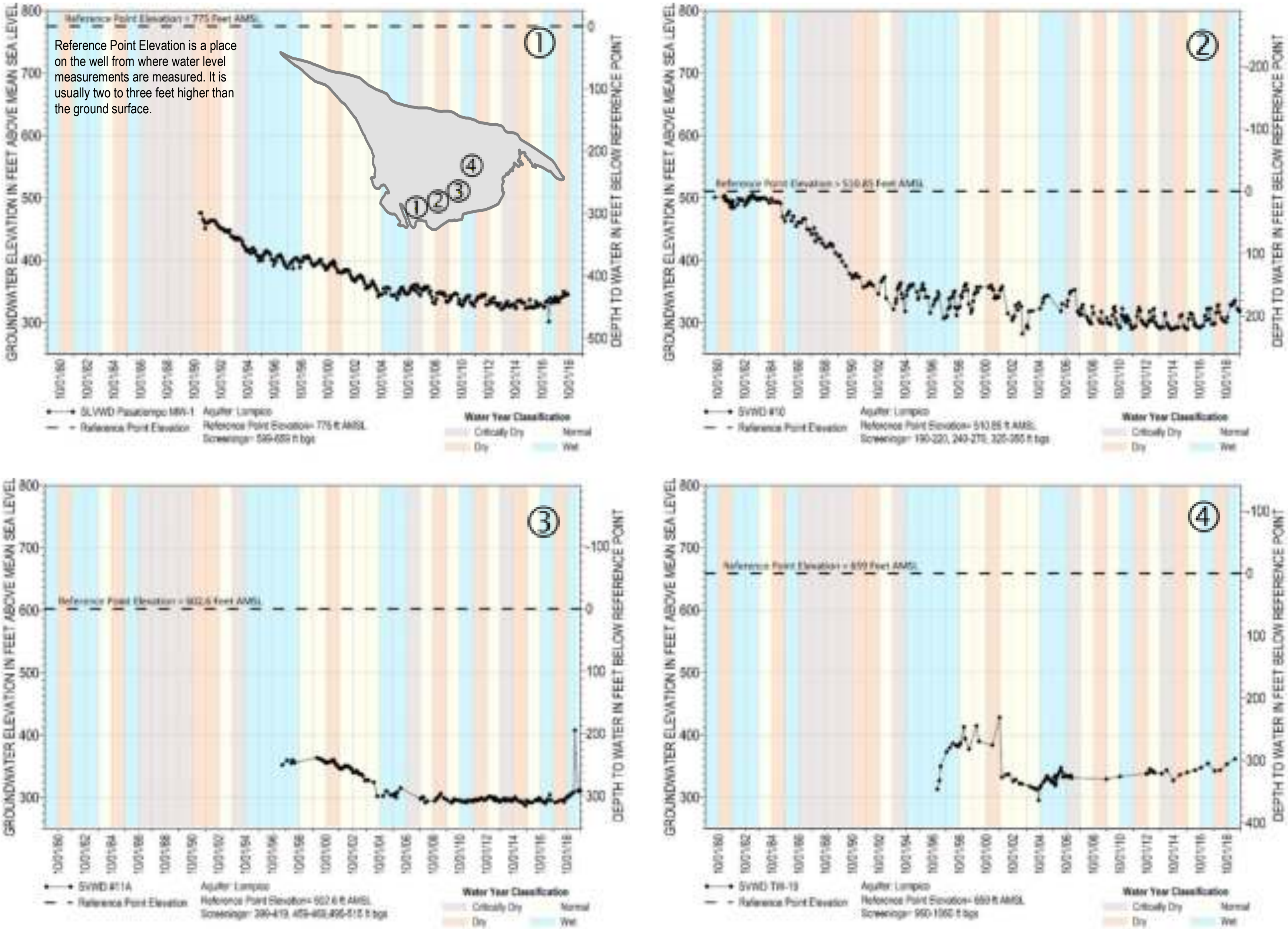


Figure 2-44. Lompico Aquifer Hydrographs

2.2.5.1.4.2 Lompico Aquifer Groundwater Elevation Contours and Flow Directions

The highest groundwater elevations in the Lompico aquifer occur at the northern boundary of the Basin, where the Lompico Sandstone is exposed at the surface in a narrow strip parallel to the Zayante-Vergeles fault. This is the only area the Lompico aquifer can be recharged directly by percolation of precipitation or streamflow; elsewhere it is covered by younger geologic units that either prevent direct recharge. Groundwater flow in the southern portion of the Lompico aquifer is primarily controlled by municipal pumping in the Scotts Valley area by SVWD and in the Pasatiempo area by SLVWD and Mount Hermon Association. Extraction of water causes depression of groundwater levels around the wells, such that groundwater flows down-gradient from the north and south toward the pumping wells. Groundwater elevation contours for Spring and Fall of WY2018 are shown on Figure 2-45 and Figure 2-46, respectively.

Measured groundwater elevation data are only available in the Pasatiempo, Camp Evers, and Scotts Valley areas. Consequently, the contour maps (Figure 2-45 and Figure 2-46) include large areas that display model-simulated contours. The simulated contours reveal 3 primary discharge points along the San Lorenzo River where there is outcrop of Lompico Sandstone. These include outcrops on the west side of the Ben Lomond fault near Felton and further upstream near the communities of Ben Lomond and Boulder Creek. These locations are where the Lompico aquifer contributes to San Lorenzo River baseflow.

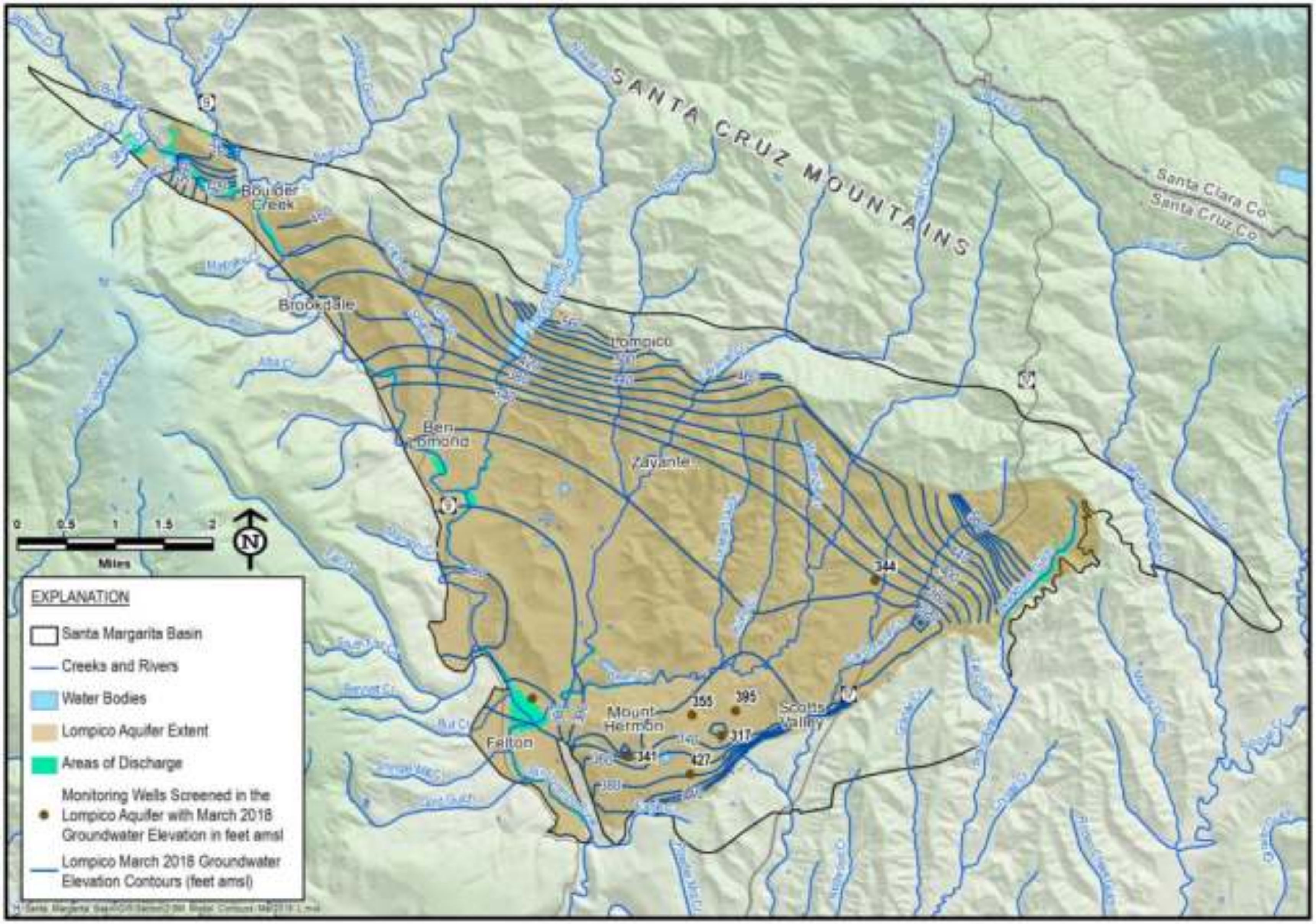


Figure 2-45. Spring (March) Water Year 2018 Groundwater Elevations in the Lompico Aquifer

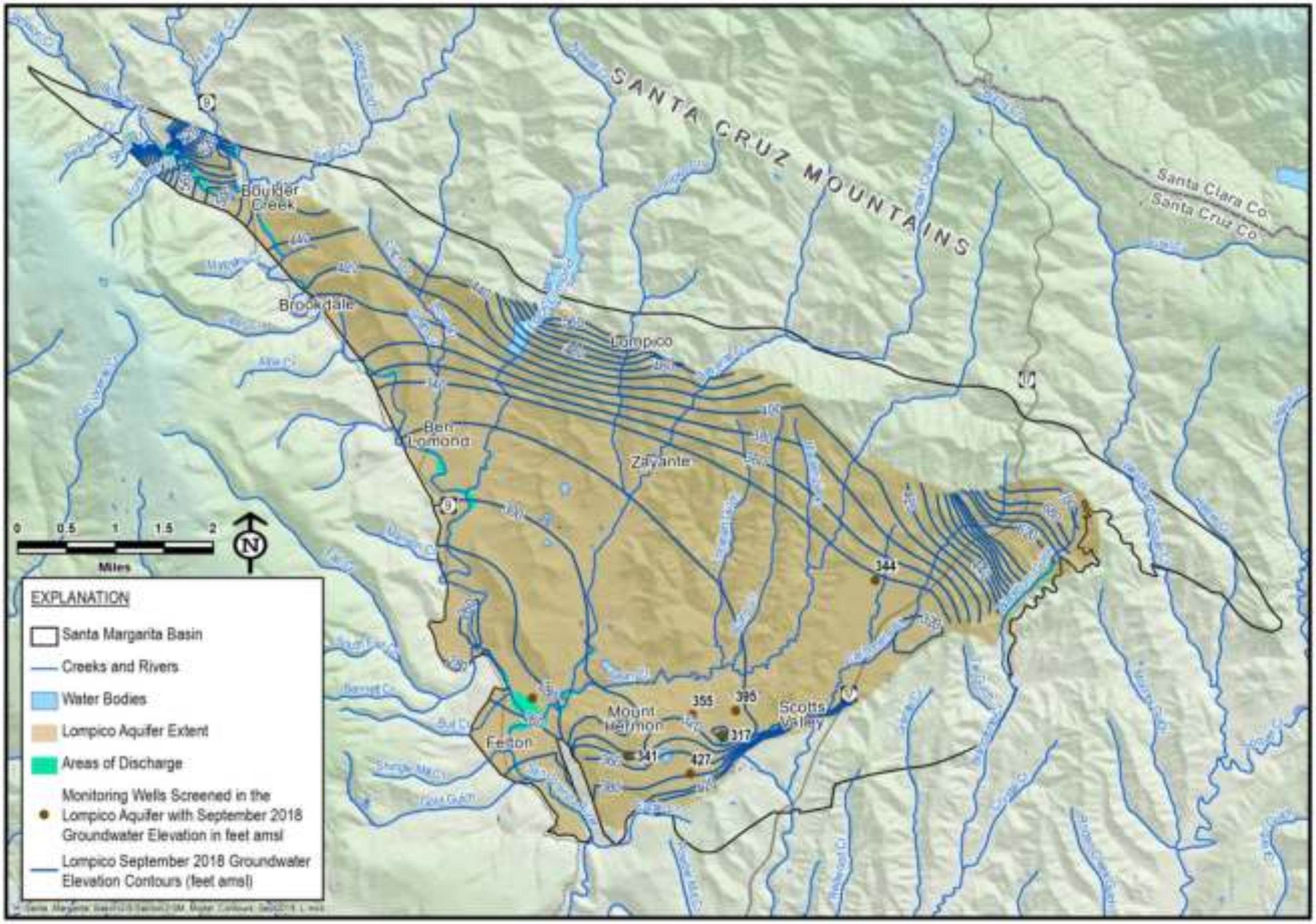


Figure 2-46. Fall (September) Water Year 2018 Groundwater Elevations in the Lompico Aquifer

2.2.5.1.5 Butano Aquifer Groundwater Elevations

2.2.5.1.5.1 Butano Aquifer Groundwater Elevations over Time

The Butano aquifer is the deepest of the productive aquifers in the Basin. Due to its great depth, there are few wells completed in it, and limited groundwater elevation data available for analysis. SVWD's water supply wells in the aquifer are SVWD #3B and #7A/Orchard Well (#7A was replaced in WY2018 by the similarly screened Orchard Well). The SVWD supply wells are screened in both the Butano Formation, at depths greater than 1,000 feet, and the overlying Lompico Formation; hence groundwater elevations measured in these supply wells are a composite elevation from both aquifers. As such, the groundwater elevations are not specific to the Butano aquifer making them difficult to interpret. The SVWD Canham and Stonewood monitoring wells are installed entirely within the Butano aquifer though not close to the SVWD supply wells (Figure 2-39).

Hydrographs shown on Figure 2-47 reflect long-term stable groundwater elevation trends since 1994, especially in the Butano-specific monitoring wells. The monitoring wells do not have seasonal groundwater elevation fluctuations. The supply wells show seasonal groundwater elevation fluctuations of greater than 50 feet, due to pumping during high-demand summer months, and the influence of flow to the supply wells from multiple aquifers.

For the long-term management of the Butano aquifer, a dedicated monitoring well in the Butano aquifer closer to these water supply wells will be drilled in 2022.

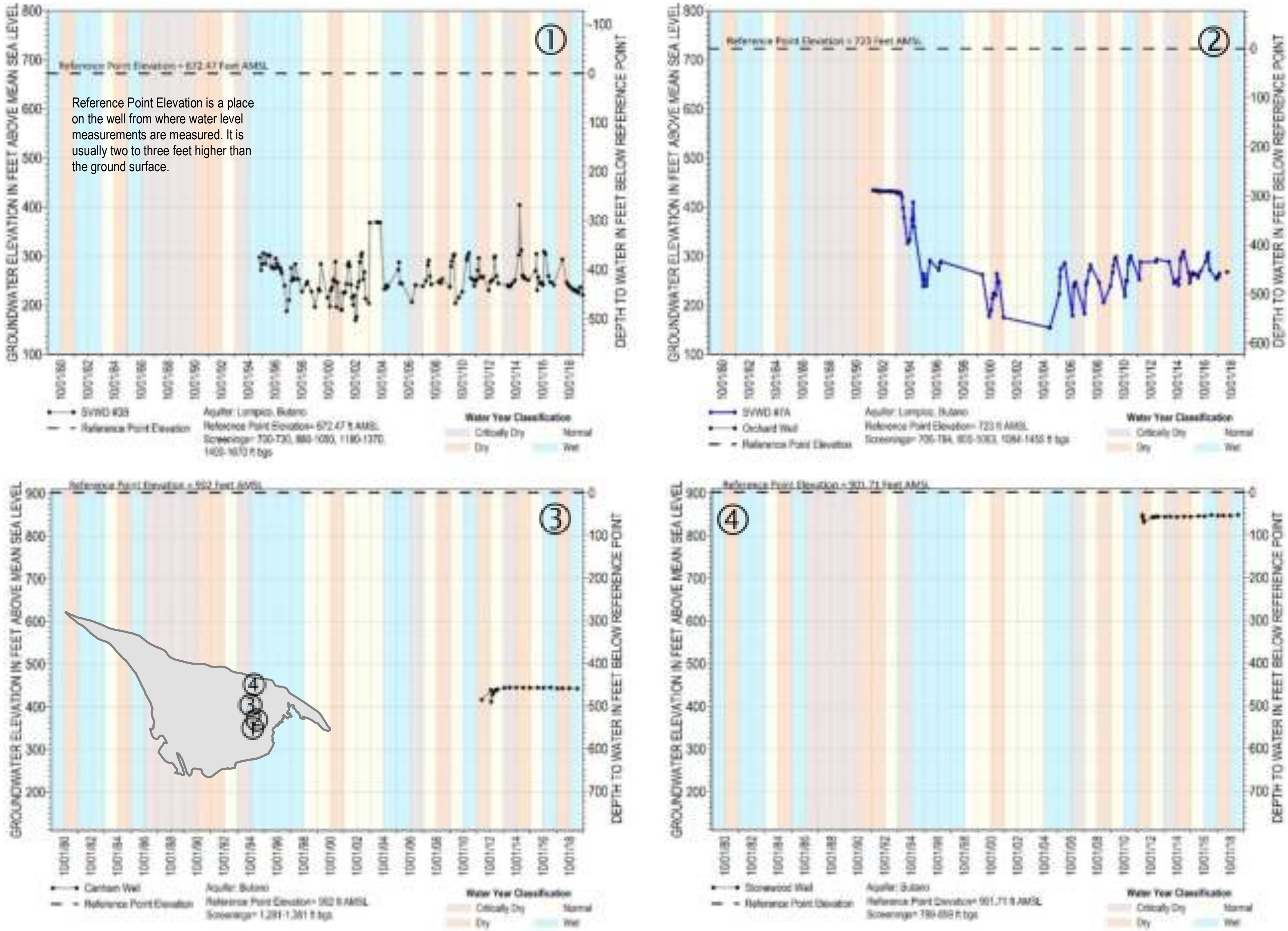


Figure 2-47. Butano Aquifer Hydrographs

2.2.5.1.5.2 Butano Aquifer Groundwater Elevation Contours and Flow Directions

The limited wells available to contour groundwater elevations in the Butano aquifer are:

- SVWD's Canham and Stonewood monitoring wells screened solely in the Butano aquifer (Figure 2-39),
- Monitoring well SVWD #15 screened roughly in equal lengths in the Lompico and Butano aquifers (Figure 2-39), and
- SVWD's 2 active supply wells, #3B and Orchard Well, screened in the Lompico and Butano aquifers are not suitable for control points for contouring because 1) they do not consistently have static levels unless they are offline for an extended period of time, and 2) although in the past it has been assumed their groundwater levels are more representative of the Butano aquifer than the Lompico aquifer because a greater percentage of their screened interval is within the Butano aquifer (Kennedy/Jenks Consultants, 2015b), this has not been confirmed with downhole flow surveys. Monitoring well SVWD #15 located very close to these 2 pumping wells is therefore a better control point for contouring.

Groundwater elevation contour maps for spring and fall of WY2018, respectively, are shown on Figure 2-48 and Figure 2-49. The extent of the Butano aquifer contours is limited to just the area of available control points. Since these are the same points used for model calibration there is greater uncertainty in the simulated contours with distance from the control points. Also, complicating the simulated elevations is that each of the 3 Butano Sandstone members (upper, middle, and lower) are assigned their own model layers and thus each has its own simulated groundwater elevations which makes it difficult to produce a realistic combined contour map.

Like groundwater elevations in the Lompico aquifer, the Butano aquifer's highest groundwater elevations are where it is exposed at the surface along the Basin's northern boundary parallel to the Zayante-Vergeles fault. This is an important recharge area for the aquifer as it can only be recharged directly by percolation of precipitation and streamflow where it is exposed at the surface. The drawdown caused by pumping the SVWD's Well #3B and Orchard Well forms a pumping depression around them. The Canham and Stonewood monitoring wells have higher groundwater elevations than the water supply wells, which indicates that groundwater flow is mostly north to south towards the pumping center caused by the Lompico/Butano aquifer water supply wells. Model-simulated groundwater elevations indicate that south of the pumping depression there is south to north flow towards the depression.

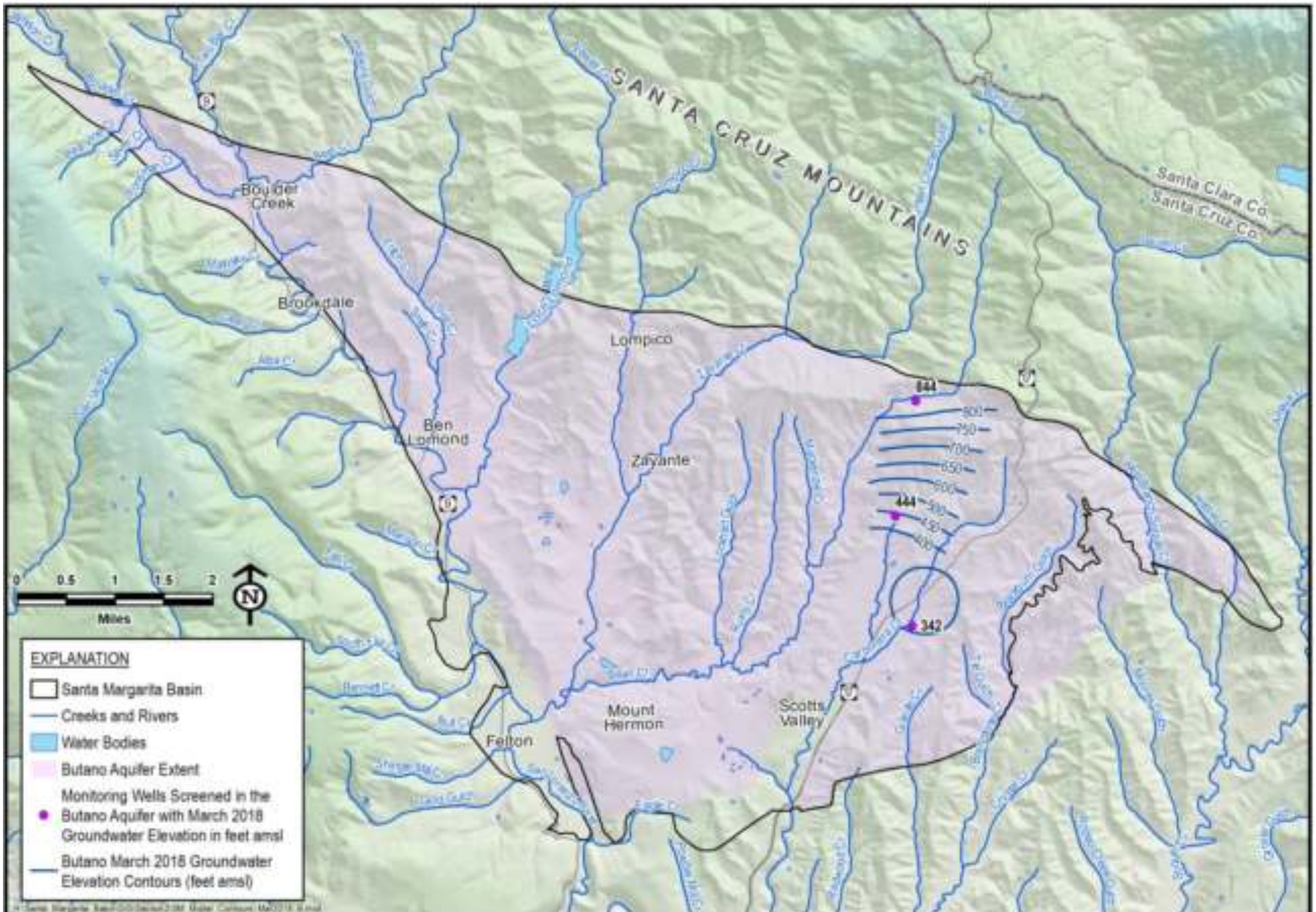


Figure 2-48. Spring (March) Water Year 2018 Groundwater Elevations in the Butano Aquifer

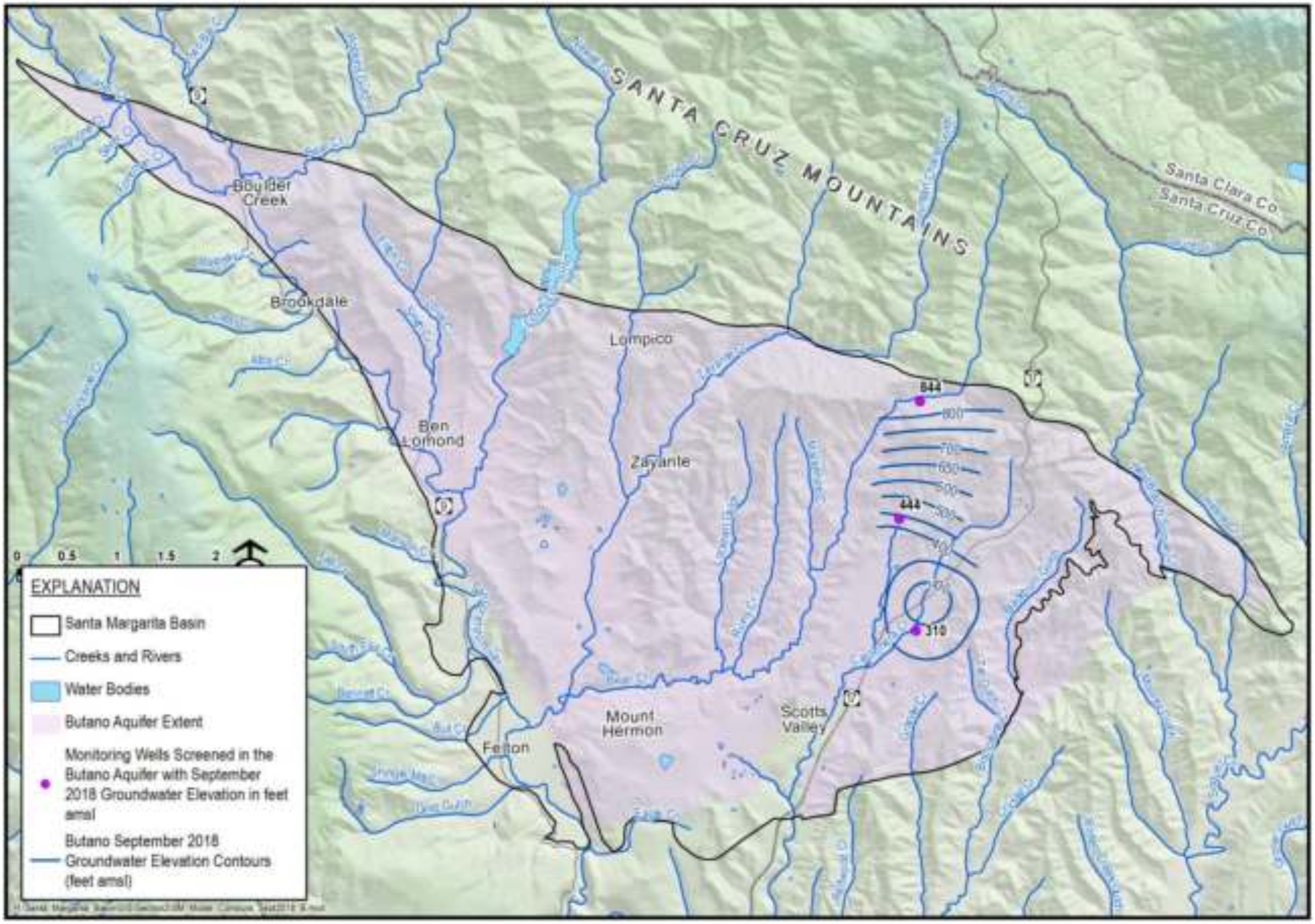


Figure 2-49. Fall (September) Water Year 2018 Groundwater Elevations in the Butano Aquifer

2.2.5.2 Vertical Hydraulic Gradients

Differences in groundwater elevations between the Basin's aquifers and within some of the thicker aquifer units create vertical hydraulic gradients. Vertical gradients produce upward or downward flow within aquifers, or flow between overlying or underlying aquifers. Previous studies have identified substantial vertical gradients in the Pasatiempo, Camp Evers, and Scotts Valley areas, where overpumping in the Lompico aquifer has created local pumping depressions that cause groundwater to flow downward (Johnson, 2009; Kennedy/Jenks Consultants 2015b).

In the relatively small area of the Basin where the Santa Margarita and Lompico aquifers are in direct contact with each other (Figure 2-18), the vertical hydraulic gradient induces recharge from the unconfined Santa Margarita aquifer into the deeper Lompico aquifer (Kennedy/Jenks Consultants 2015b). For most of the Basin where the fine-grained Monterey Formation separates the Santa Margarita and Lompico aquifers, downward vertical flow is significantly reduced (Kennedy/Jenks Consultants 2015b).

Figure 2-50 and Figure 2-51 show groundwater elevation hydrographs for 2 sets of multi-level monitoring wells located in the Pasatiempo / Camp Evers area. Groundwater elevations in the Santa Margarita aquifer at these locations are currently at least 50 feet to 150 feet higher than in the confined Lompico aquifer that is separated from the Santa Margarita aquifer by the Monterey Formation. The hydrographs on Figure 2-54 for the Pasatiempo monitoring wells illustrate how continually lowered groundwater elevations in the Lompico aquifer progressively increased the downward vertical gradient over time. At the start of the hydrograph record, groundwater elevation differences are around 10 feet, and increase to roughly 150 feet. It is possible that prior to 1990, the vertical hydraulic gradient may have been upward, with the Lompico aquifer elevations being higher than those in the Santa Margarita aquifer.

Vertical hydraulic gradient information is only available in the Pasatiempo/Camp Evers/southern Scotts Valley area because this is the only area where groundwater elevation data from nested or multi-level monitoring wells are available. There is not enough information to assess vertical gradient between the Lompico and Butano aquifers.

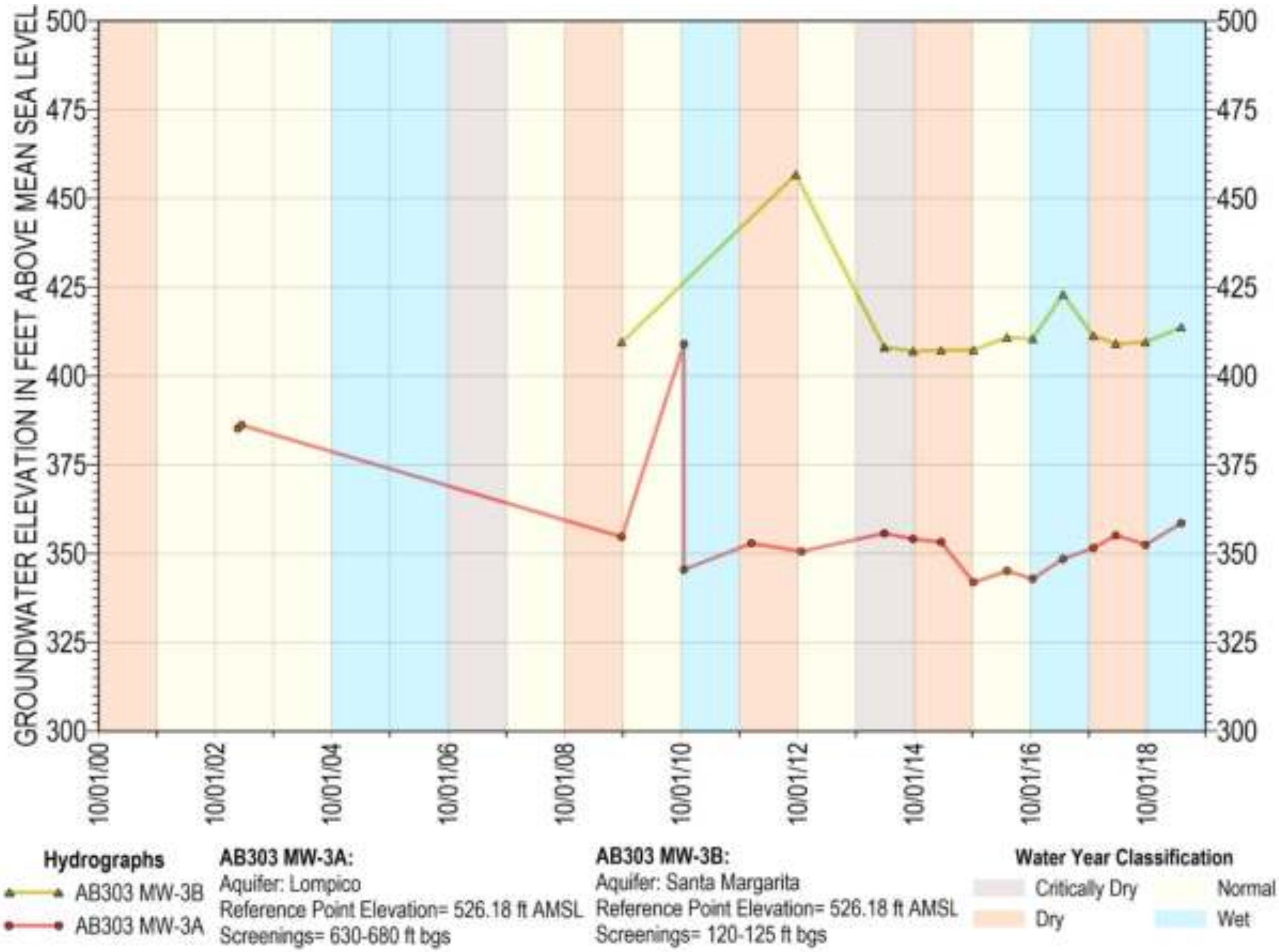


Figure 2-50. Monitoring Well AB303 MW-A and AB303 MW-B Hydrographs Illustrating Vertical Gradients Over Time

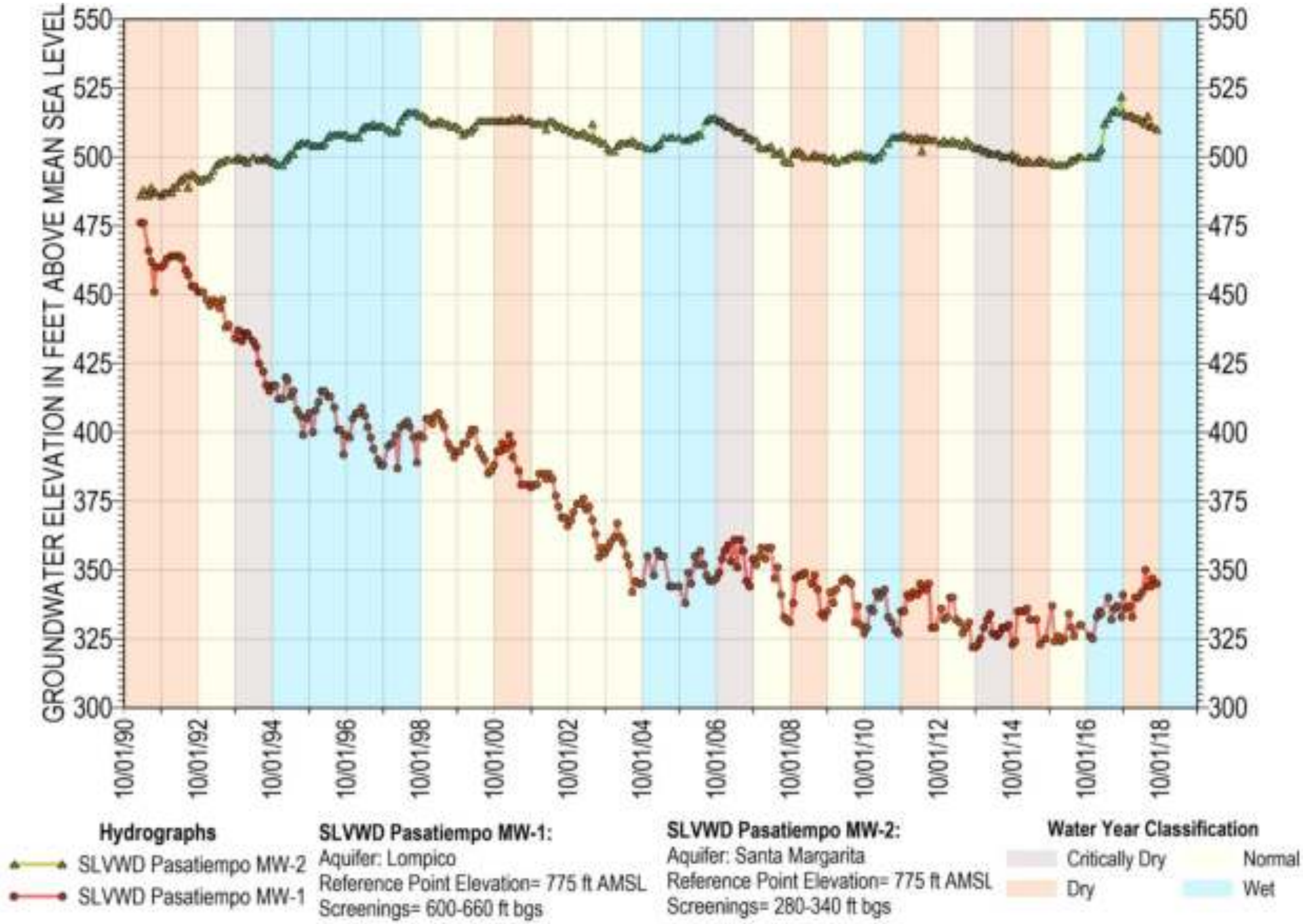


Figure 2-51. Monitoring Well SLVWD Pasatiempo MW-1 and SLVWD Pasatiempo MW-2 Hydrographs Illustrating Vertical Gradients Over Time

2.2.5.3 Change of Groundwater in Storage

Since the 1980s, and even possibly starting in the 1960s, there has been a consistent loss of groundwater stored in the Basin due primarily to over-pumping of the Lompico aquifer in the south Scotts Valley area. Figure 2-52 shows groundwater model simulated annual change in storage with the color of the bars correlating with the water year type, and the solid line reflecting the cumulative change in storage.

Individual annual increases of groundwater stored in the Basin correlate with wet years and normal years if they precede a dry year. Historically, normal or drier water year types generally result in groundwater lost from storage. This is reflected on Figure 2-52 where cumulative storage change shows a consistent decline. After WY2014, cumulative change in storage appears to be leveling out but it is anticipated that the overall below average rainfall from 2018 to present will continue the trend of declining groundwater in storage.

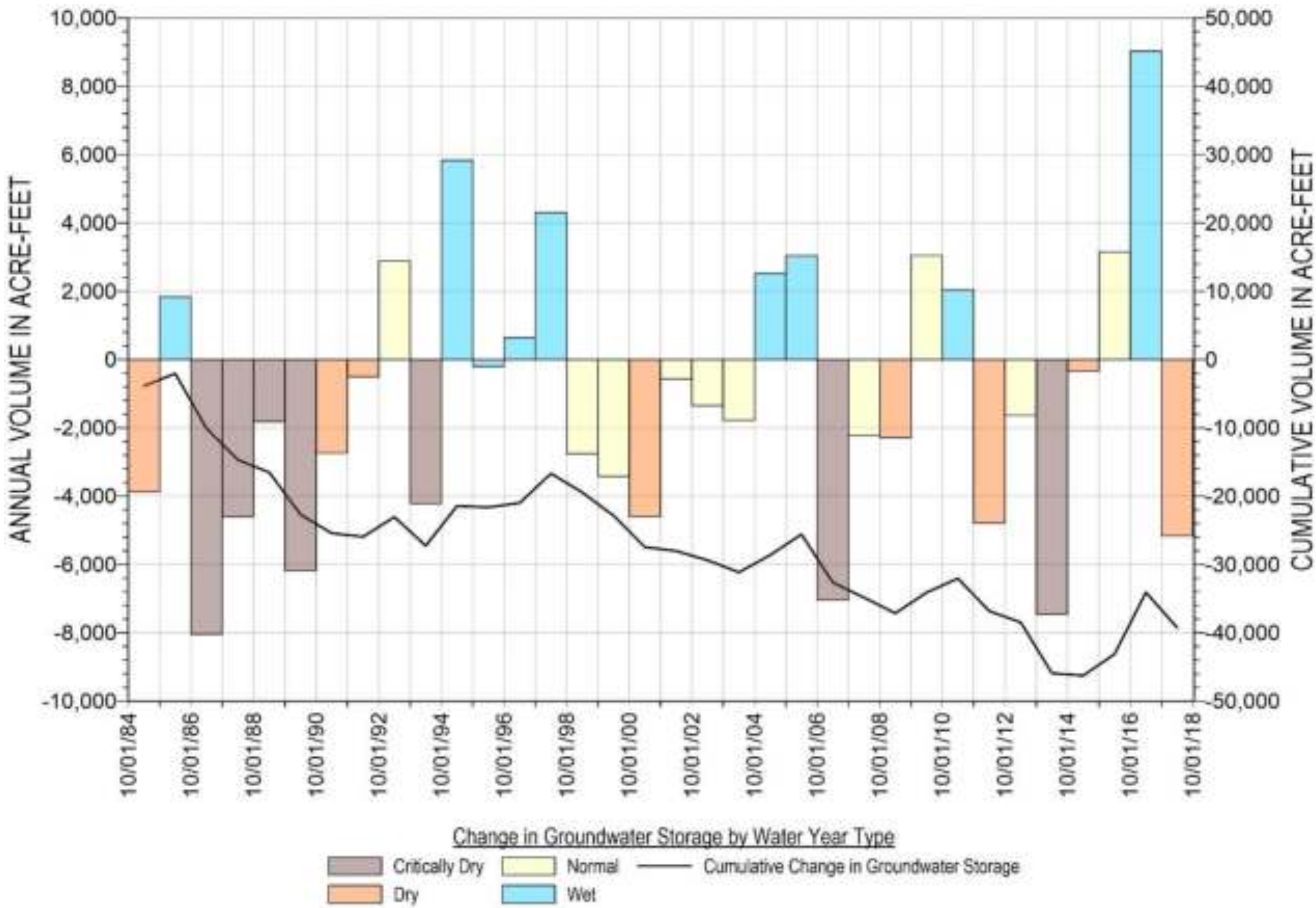


Figure 2-52. Santa Margarita Basin Annual Change of Groundwater in Storage

2.2.5.4 Groundwater Quality

Groundwater in the Basin is generally of good quality and does not regularly exceed primary drinking water standards. However, both naturally occurring and anthropogenic groundwater quality concerns are present in some aquifers and areas. The following subsections discuss general groundwater quality with a focus on chemical constituents that have concentrations above state drinking water standards. The chemical constituents included in this section are used as the basis for COC for which SMC are developed in Section 3. Appendix 2C contains chemographs for wells with current groundwater quality data in the Basin.

2.2.5.4.1 Groundwater Quality Standards

As a relative measure of groundwater quality, this section compares groundwater quality in the Basin's different aquifers to primary and secondary drinking water standards. These standards are established by the US Environmental Protection Agency (USEPA) and the California State Water Resources Control Board's Division of Drinking Water (DDW). Standards for contaminants in drinking water established by the USEPA represent the legal maximum allowable concentration for a constituent in public water systems. The maximum limits, referred to as maximum contaminant levels (MCLs), have been developed under the Safe Drinking Water Act. Some states, including California, have state laws or regulations which set MCL values consistent with or lower than federal MCLs, or for chemicals for which no federal MCL has been established. For example, the federal MCL for benzene is 0.005 milligrams per liter (mg/L) but the state MCL is 0.001 mg/L. Methyl-tert-butyl ether (MTBE), on the other hand, does not have a federal MCL but California established an MCL of 0.013 mg/L.

California MCLs are in accordance with Title 22 of the California Code of Regulations and are categorized as either primary or secondary. Primary MCLs are those which address health concerns, whereas secondary MCLs address aesthetics such as taste and odor. Not all constituents with an established primary MCL have a secondary MCL, and not all constituents with a secondary MCL have a primary MCL. Using the example of MTBE above, the primary MCL is 0.013 mg/L whereas the secondary MCL is 0.005 mg/L. Manganese, on the other hand, has no primary MCL yet has a secondary MCL of 0.05 mg/L. The California Office of Environmental Health Hazard Assessment establishes public health goals based on lifetime exposure risk for constituents with an established MCL or those for which an MCL will be established in the future, and MCL values may be revised based on the public health goal.

In addition to regulated constituents, California DDW has established notification levels and response levels for some constituents which do not have an established MCL. Recommended actions for constituents exceeding these levels are established by DDW.

2.2.5.4.2 Groundwater Quality Testing

Municipal water suppliers regularly sample and test both raw and treated water sources per state requirements contained in the California Code of Regulations, Title 22. Groundwater quality parameters typically tested for include general minerals, general physical parameters, and organic/inorganic compounds. All municipal water sources are treated to state drinking water standards.

The Code of Regulations requires that public water systems annually provide their customers with an annual water quality report called a Consumer Confidence Report (CCR). This includes information on source water, levels of any detected contaminants, and compliance with drinking water regulations (including monitoring requirements), along with some educational information. CCRs for SLVWD and SVWD are available at the following websites: https://www.slvwd.com/water-quality/pages/consumer-confidence-reports-ccrs and https://www.svwd.org/resources-information/reports, respectively.

Groundwater quality is not regularly tested at SLVWD and SVWD monitoring wells. There have been some one-off samples collected and tested over the years, but there is no long-term groundwater quality record in any municipal monitoring well. There are longer groundwater quality records in monitoring wells associated with contamination cleanup sites. These only provide data for the period during active site assessment and remediation. Many of these monitoring wells are destroyed once clean up goals have been achieved.

Private domestic use wells are not subject to DDW drinking water regulations. However, the County requires one-time testing of nitrate, TDS, chloride, iron, and manganese for any new private well. Small water systems that supply groundwater to 15 – 199 service connections also report water quality to the County. These water quality constituents include inorganics, nitrates, arsenic, perchlorate, chromium, radiation, synthetic organic compounds, VOCs, and fuel oxygenates, which include MTBE. The frequency of monitoring ranges between 1 year and 9 years depending on the constituents. Smaller water systems with between 5 and 14 service connections have limited one-time testing requirements for inorganics and report quarterly bacteriologic water quality to the County.

2.2.5.4.3 Naturally Occurring Groundwater Quality

2.2.5.4.3.1 Salinity

Elevated salinity in groundwater can occur from both natural geologic sources and as a result of anthropogenic groundwater contamination. Salinity in groundwater is often measured using TDS and chloride concentrations. There are no primary drinking water standards for TDS and chloride, but rather secondary drinking water standards that are set at 1,000 and 250 mg/L, respectively.

Natural waters contain some dissolved solids (salinity) from contact with soils, rocks, and other natural materials. Geologic formations can influence groundwater quality, and formations often have their own unique groundwater salinity signature. Surface activities by humans can artificially introduce salts into groundwater through the natural recharge process where infiltrating rainfall dissolves anthropogenic salts on the land surface allowing salts to enter the underlying aquifers. Slight differences in salinity occur across the Basin due to its geology. Improperly constructed wells can also allow salts to migrate from 1 aquifer to another.

Total Dissolved Solids

The regulatory drinking water limit for TDS is a SWRCB secondary MCL, that differs from a primary MCL because it is based on aesthetics rather than health risk. Santa Cruz County enforces the 1,000 mg/L upper limit of the secondary MCL. TDS concentrations in portions of the Santa Margarita aquifer are generally low as a result of its high permeability, exposure at the surface, and associated high rate of aquifer "flushing" (Johnson, 2006; Johnson, 2009). In areas where wells pump from the Santa Margarita aquifer and data on TDS concentrations are available, the following observations on Santa Margarita aquifer TDS are made:

- Quail Hollow has relatively low TDS concentrations typically below 150 mg/L (Figure 2-53)
- The Olympia area has higher TDS concentrations typically ranging between 200 and 600 mg/L (Figure 2-53)
- Historical TDS concentrations in Santa Margarita aquifer wells in the Pasatiempo/Camp Evers/southern Scotts Valley area were lower and more stable than TDS concentrations in the Olympia wells (Johnson, 2009). Since the Santa Margarita aquifer is no longer pumped by municipal suppliers in the Pasatiempo/Camp Evers/southern Scotts Valley area there is no current testing of groundwater quality to determine if this is still the case.

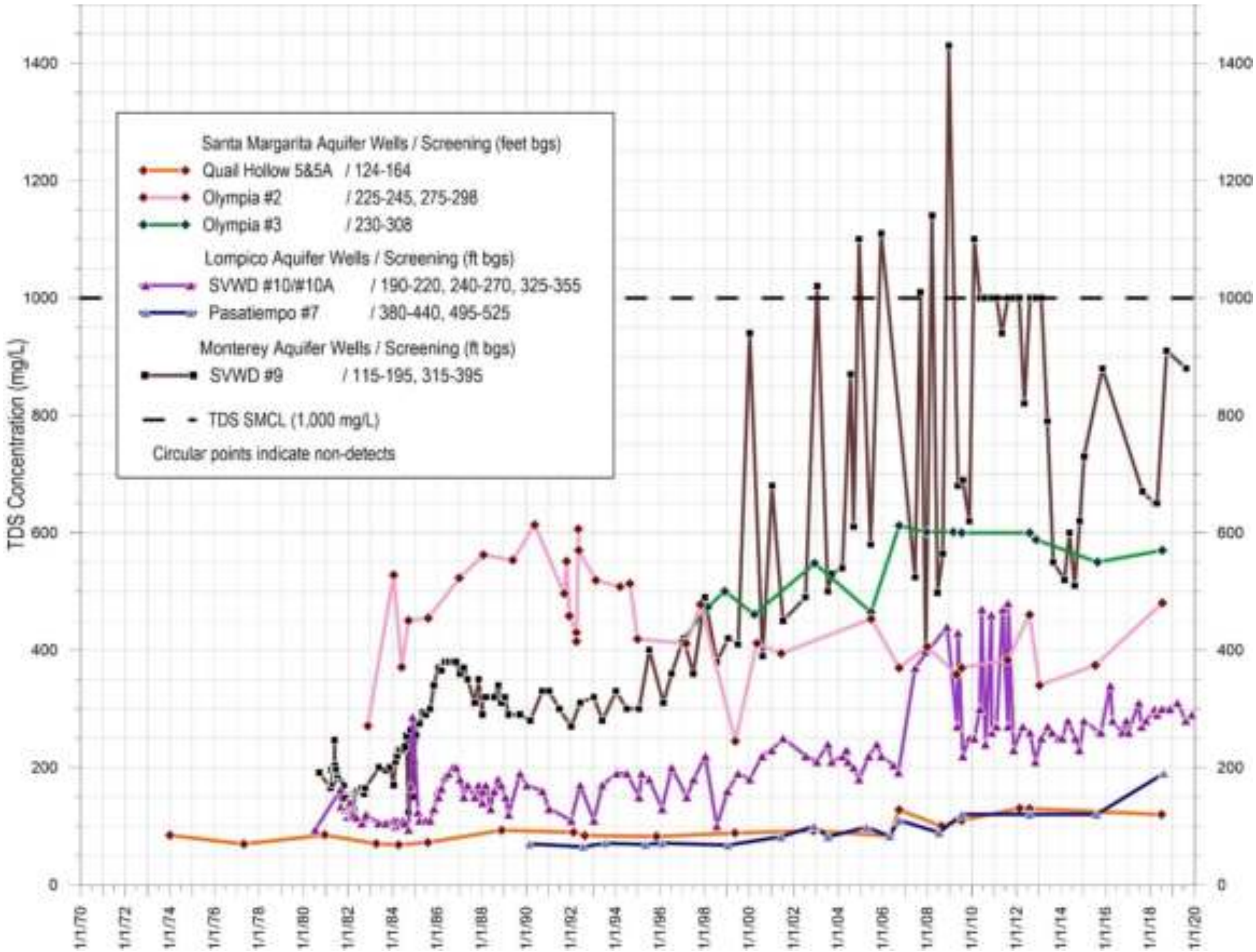


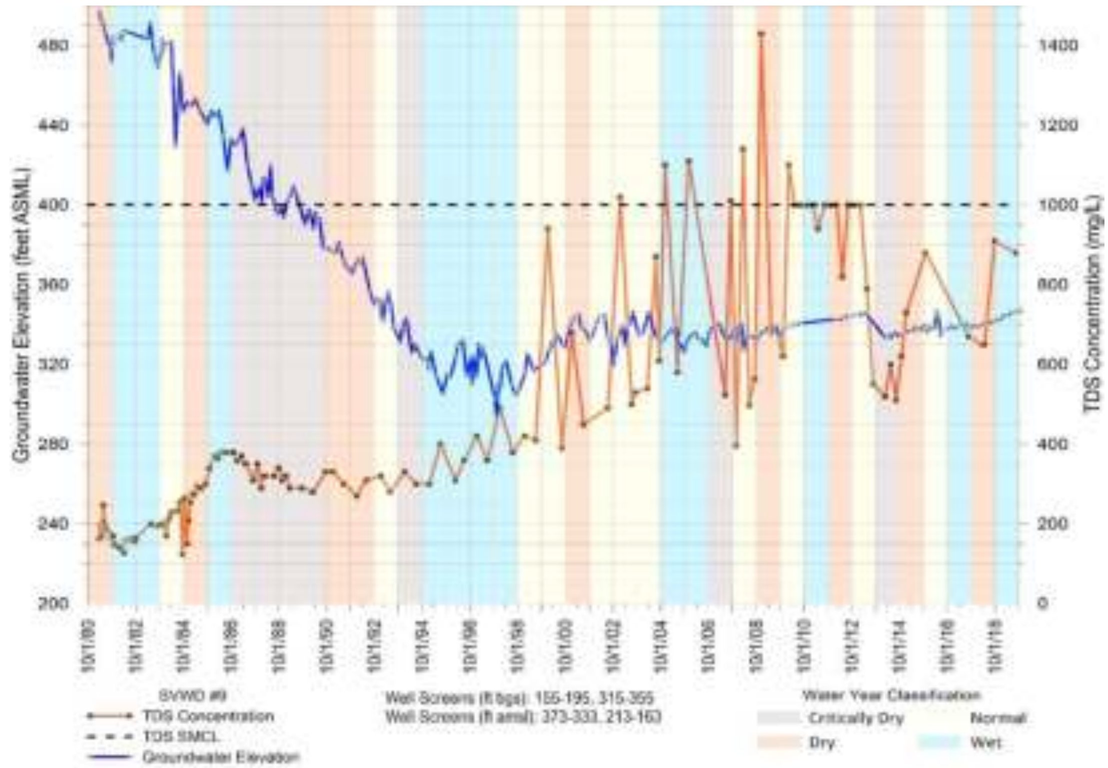
Figure 2-53. Total Dissolved Solids Concentrations in Select Wells from 1970-2019

There are very few wells screened in the Monterey Formation that have groundwater quality data. SVWD's Well #9, the only Monterey Formation well in the Basin with long-term and recent groundwater quality data, has TDS concentrations ranging from 300 to 1,430 mg/L (Figure 2-54). Together with 2 Lompico aquifer wells (SVWD #10A and SLVWD Pasatiempo #7), SVWD's Well #9 has an increasing TDS trend. It is thought its increased TDS concentration is linked to the dewatered Santa Margarita aquifer in the area that has caused reduced leakage of good quality water to the underlying aquifers (Johnson, 2009). High TDS concentrations appear to correspond to periods when the well was being pumped more and thereby extracting a greater proportion of its groundwater from deeper in the Monterey Formation which is known to have elevated TDS because of its marine origin and more limited flushing. This well is no longer used by SVWD for water supply because of its low yield and poor water quality. Further supporting the occurrence of saline water in the Monterey Formation are reports of saline water received by Santa Cruz County from well drillers working in the lower Newell Creek and lower Zayante Creek areas.

Wells screened in the Lompico and Butano aquifers do not exceed TDS secondary drinking water standards and concentrations typically range from 200 to 700 mg/L (Figure 2-53). Municipal extraction wells with increasing TDS trends as described above are SVWD #10A and SLVWD Pasatiempo #7. Similar to increased TDS concentrations in SVWD #9 in the Monterey Formation, increased TDS appears to correspond to declining groundwater elevations (Figure 2-54). However, a corresponding TDS increase and groundwater elevation decrease in the Lompico aquifer does not always occur, as shown on Figure 2-55 where TDS does not increase despite groundwater elevation declines in the SVWD's El Pueblo wellfield (SVWD #11A and 11B). This indicates that the increasing TDS trend associated with declining groundwater elevations in the Lompico aquifer may just be confined to the Pasatiempo/Camp Evers/southern Scotts Valley area.

Of interest, there is a known area of elevated salinity north of the Basin between Kings and Bear Creeks that is likely associated with connate water. Connate water is saltwater water trapped in the pore spaces of marine sediments when it was deposited and subsequently buried by younger sediments. A USGS water resource investigation in 1977 indicated that this area has some saline groundwater and surface water that may be degraded by connate water leaking upward from depth through improperly sealed, abandoned oil test wells (USGS, 1977). Although the source of saline water is outside of the Basin, higher salinity water does impact streams upgradient of the Basin which then flow into the Basin thereby slightly impacting surface water quality in the Basin.

Figure 2-56 summarizes the spatial distribution of TDS and chloride across the Basin by aquifer.



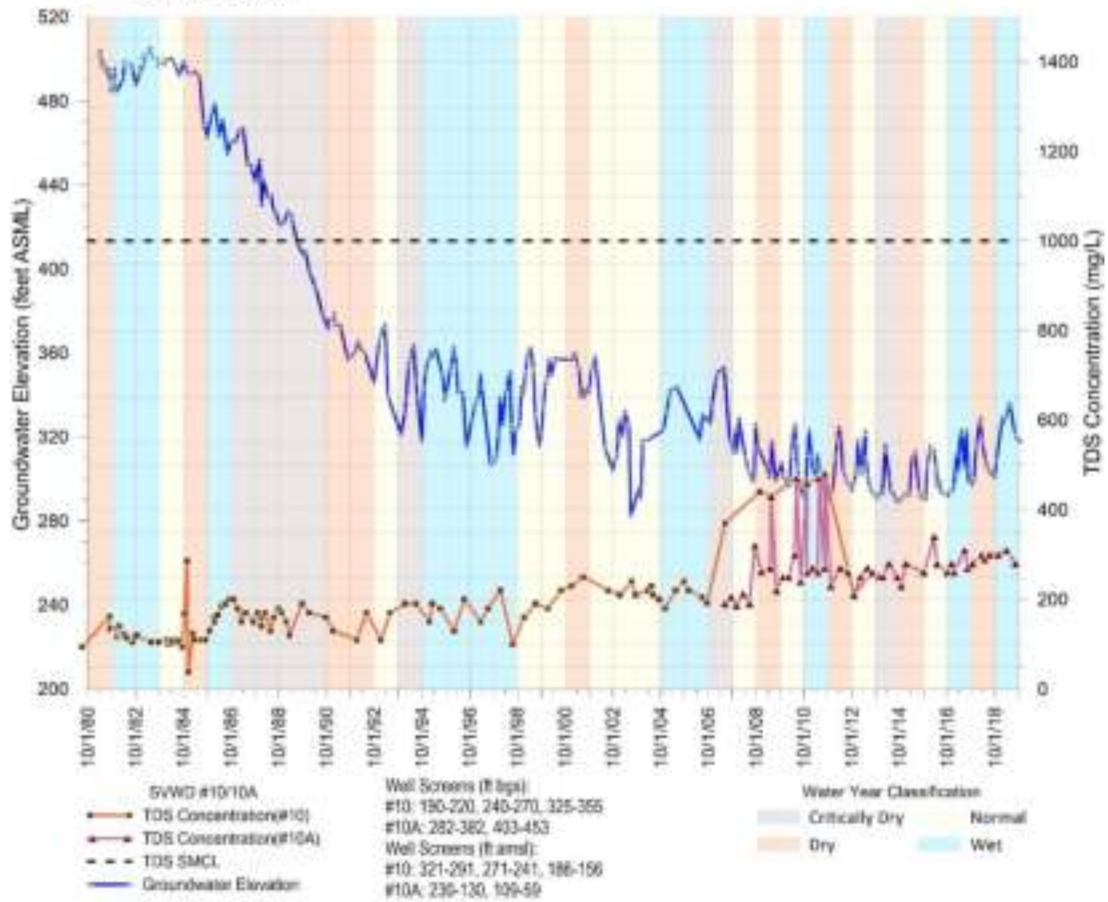


Figure 2-54. Total Dissolved Solids Concentrations and Groundwater Elevations in SVWD Well #9 (Monterey Formation) and SVWD #10/10A (Lompico Aquifer)

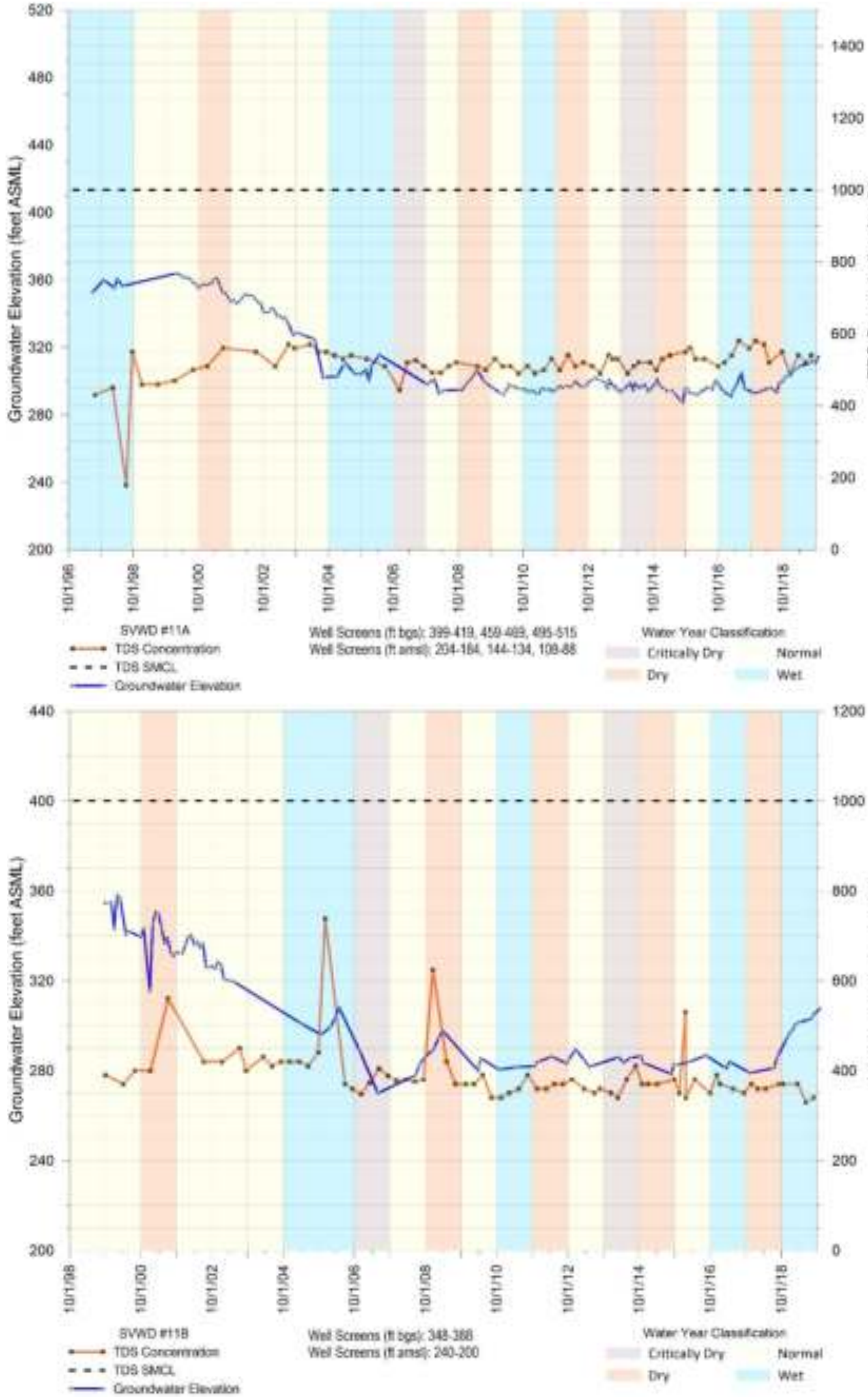


Figure 2-55. Total Dissolved Solids Concentrations and Groundwater Elevations in SVWD Well #11A and SVWD #11B (Lompico Aquifer)

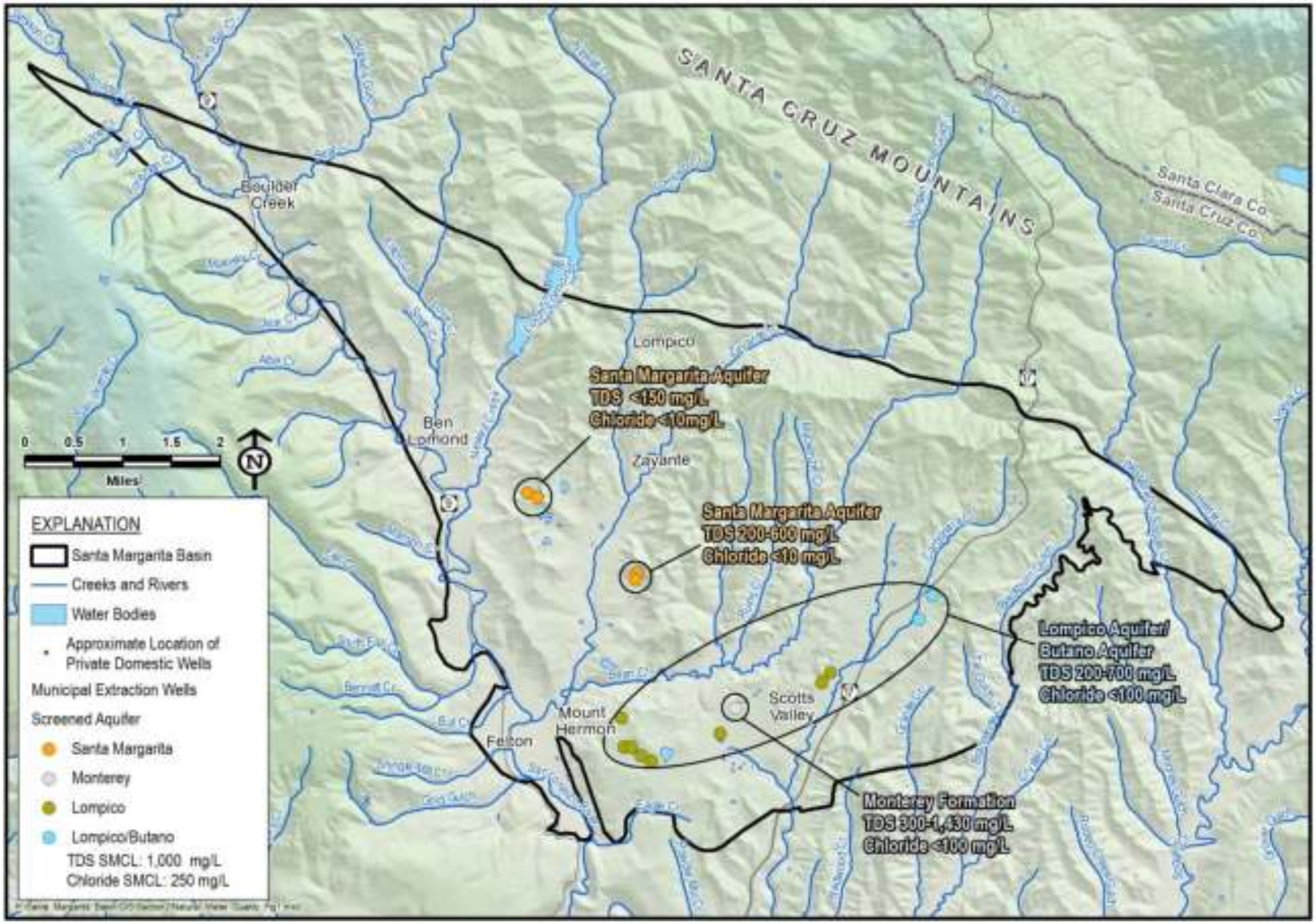


Figure 2-56. Distribution of Total Dissolved Solids and Chloride Across the Santa Margarita Basin

Chloride

Chloride can be a major component of TDS and is also used to determine salinity in groundwater. Chloride concentrations in the Basin are well below chloride's secondary MCL of 250 mg/L and are typically below 100 mg/L. Apart from increasing chloride in the Monterey Formation and Lompico aquifer in the Pasatiempo/Camp Evers/southern Scotts Valley area that mirror TDS trends, chloride concentrations do not have increasing (or decreasing) trends over time. Appendix 2C contains plots of chloride over time for wells with recent groundwater quality data.

2.2.5.4.3.2 Iron and Manganese

Although iron and manganese are required nutrients in the human diet, concentrations above secondary drinking water standards can create aesthetic problems including metallic taste, staining, accumulation of oxides in pipes, and eventually toxicity. Iron and manganese occur naturally in much of the world's groundwater and surface water but can also originate from anthropogenic sources including automobile exhaust and manufacturing (WHO, 2011). The state secondary MCLs for iron and manganese are 0.3 and 0.05 mg/L, respectively.

Iron and manganese concentrations are detected above state secondary MCL in all Basin aquifers, but not in all wells. The widespread occurrence of iron and manganese detections have a naturally occurring origin, associated with the dissolution of metals present in the Basin's geologic formations. There have been no trends in iron or manganese concentrations associated with contaminating activities. All groundwater extracted for municipal purposes with elevated iron and manganese is treated to reduce concentrations below secondary MCLs prior to distribution. Small water systems report iron and manganese concentrations to the County to ensure public health.

As with TDS, previous analysis has noted generally lower iron and manganese in some areas of the Santa Margarita aquifer as a result of high rates of aquifer "flushing" (Johnson, 2009; Johnson, 2016). Concentrations in these areas are consistently below state secondary MCLs including frequent non-detects (Figure 2-57 and Figure 2-58). However, iron and manganese concentrations above respective secondary MCLs do occur in other areas of the Santa Margarita aquifer, such as in the Olympia area, where concentrations of iron and manganese can be as high as 1.5 mg/L and 0.33 mg/L, respectively. Figure 2-59 shows iron and manganese concentrations for extraction well SLVWD Olympia #2 versus its groundwater elevations. Over the period of record, there have been both decreases and increases in manganese concentrations, none of which appear related to changing groundwater elevations. Iron concentrations do not follow the same trend as manganese and generally remain below the secondary MCL, but they do periodically and temporarily increase above the secondary MCL. For the most part, changes in iron concentrations do not appear to be influenced by changing groundwater elevations, although the historically low groundwater elevation for this well in WY2016 did correspond to 2 samples above the secondary MCL during that year (Figure 2-59).

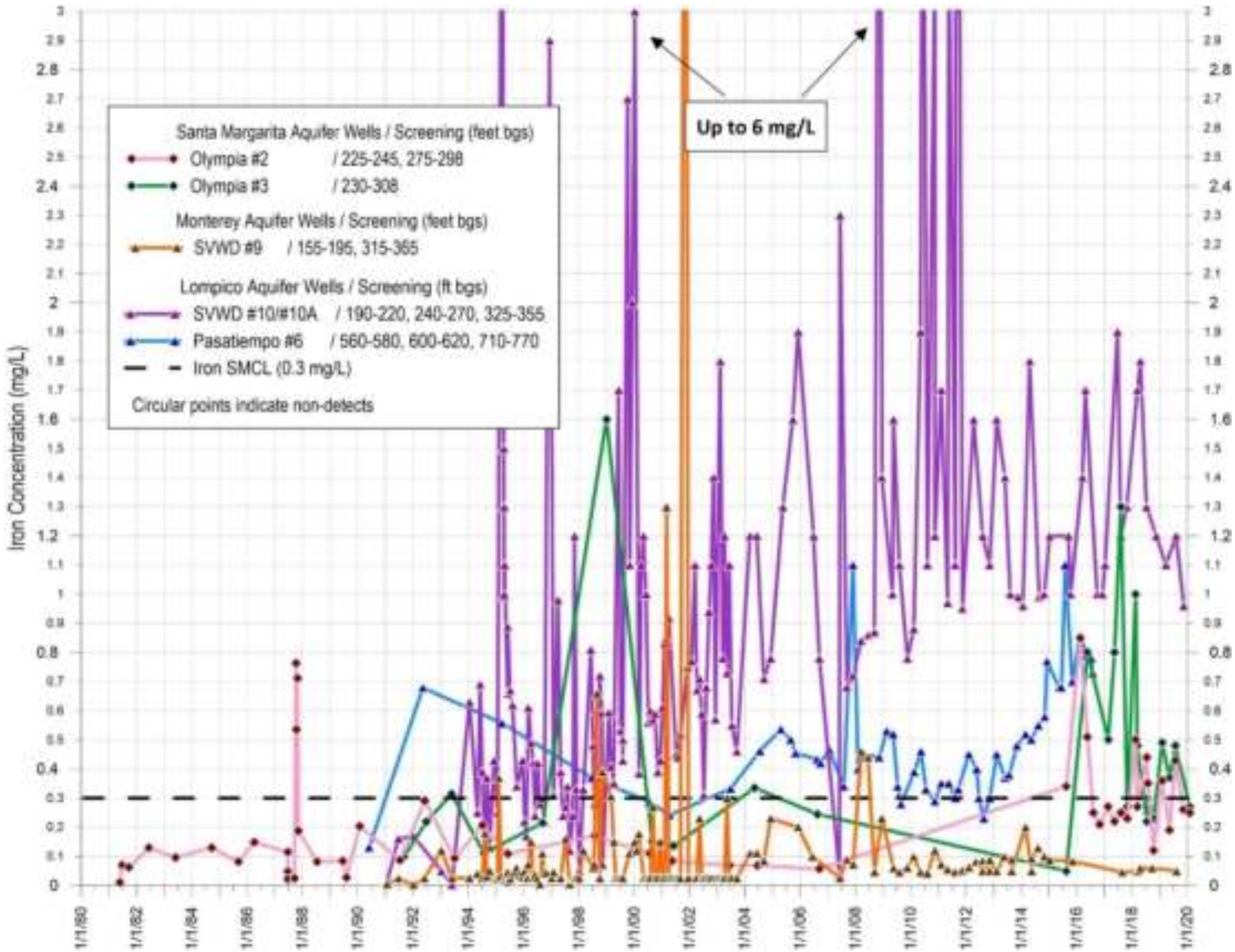


Figure 2-57. Iron Concentrations in Select Wells from 1980-2019

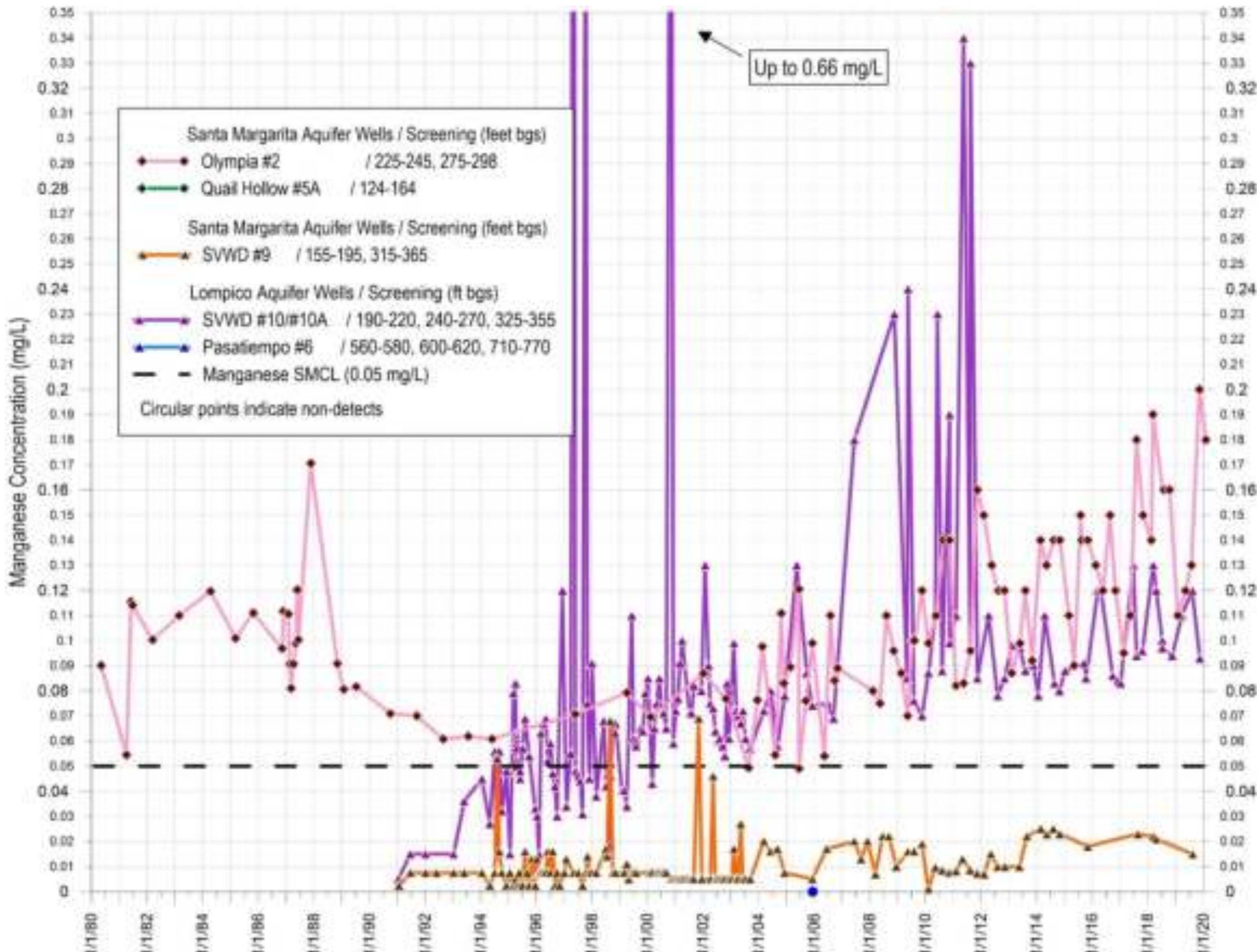


Figure 2-58. Manganese Concentrations in Select Wells from 1980-2019

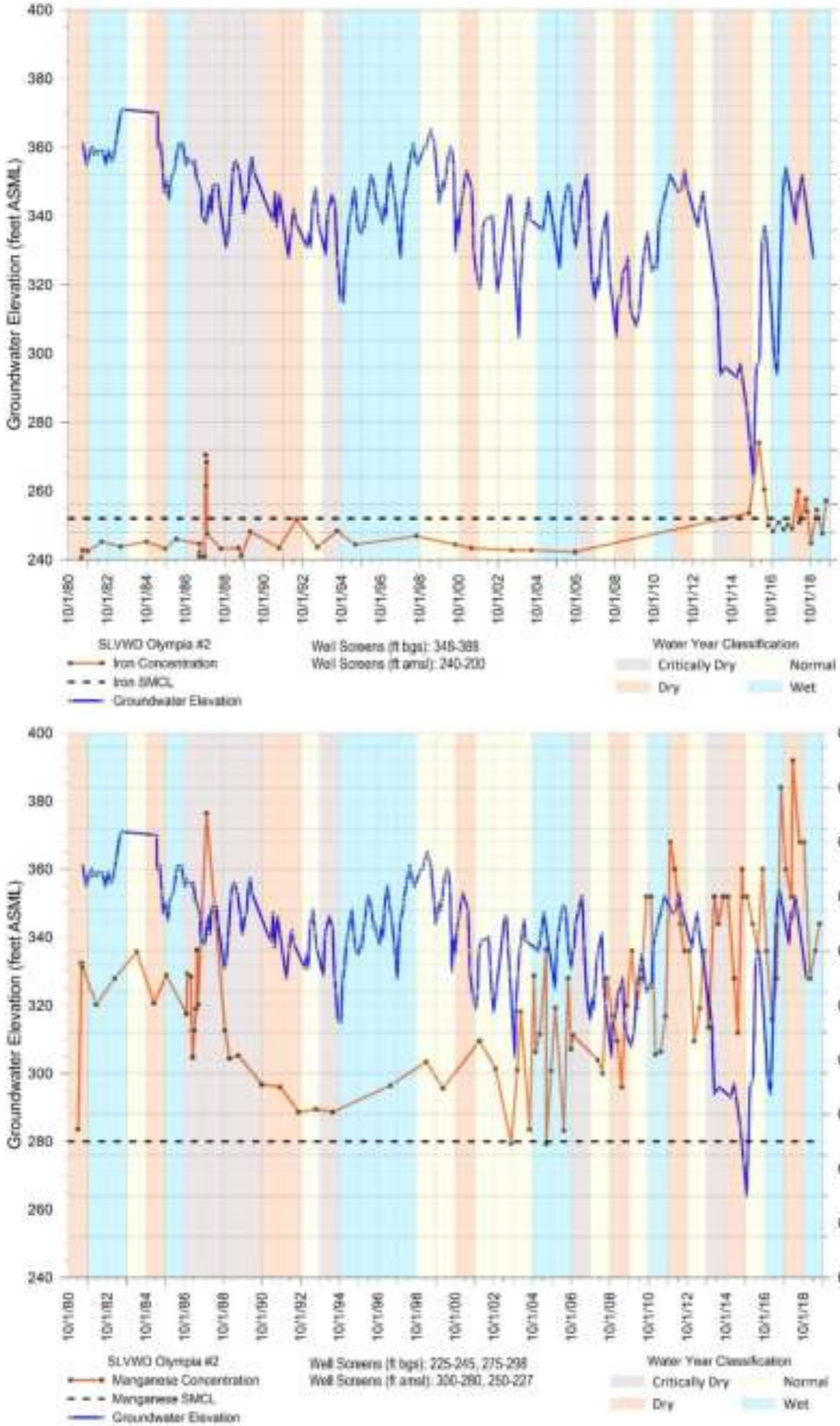


Figure 2-59. Historical Iron and Manganese Concentrations and Groundwater Elevations in SLVWD Olympia #2 (Santa Margarita Aquifer)

Iron and manganese concentrations in the Santa Margarita aquifer are found to be directly correlated with groundwater residence time, and therefore inversely correlated with the rate of aquifer flushing driven by rainfall (Johnson, 2009). Furthermore, where Santa Margarita Sandstone contacts overlying Santa Cruz Mudstone and underlying Monterey Formation, increased iron and manganese concentrations in the Santa Margarita aquifer can occur (Johnson, 2009).

Groundwater in SVWD #9, which is screened in the Monterey Formation, generally has iron and manganese concentrations below secondary MCLs that occasionally spike higher (Figure 2-57 and Figure 2-58). There are no groundwater quality data for other Monterey Formation screened wells.

Iron and manganese concentrations in the Lompico aquifer are typically above state secondary MCLs and can reach concentrations of 6 mg/L and 0.66 mg/L (Figure 2-57 and Figure 2-58), respectively. An increasing trend in iron and manganese has been observed in SVWD Well #10/10A since samples were first analyzed in 1990. There is a possibility the increase corresponds with its declining groundwater elevation (Figure 2-60). However, this is not conclusive as there are no iron and manganese data prior to 1990 for the period when most of the groundwater elevation decline occurred. Lompico aquifer screened extraction well SVWD #11B has different trends in iron and manganese even though it is only 1-mile northeast of SVWD Well #10/10A. This well has no trend in iron and declining manganese concentrations with declining groundwater elevations (Figure 2-61). In contrast, extraction well SVWD #11A near SVWD #11B has a decreasing iron trend and no manganese trend (Figure 2-62). These differences within the same aquifer suggest that differences in how each well is operated and from where in the Lompico aquifer it pumps has an influence on its iron and manganese concentrations.

SVWD wells screened within both the Lompico and Butano aquifers, such as extraction well SVWD Well #3B, generally have iron and manganese concentrations below secondary MCLs with occasional temporary spikes above their secondary MCLs (Figure 2-63). There does not appear to be any iron or manganese concentration correlation with water year type or groundwater elevation.

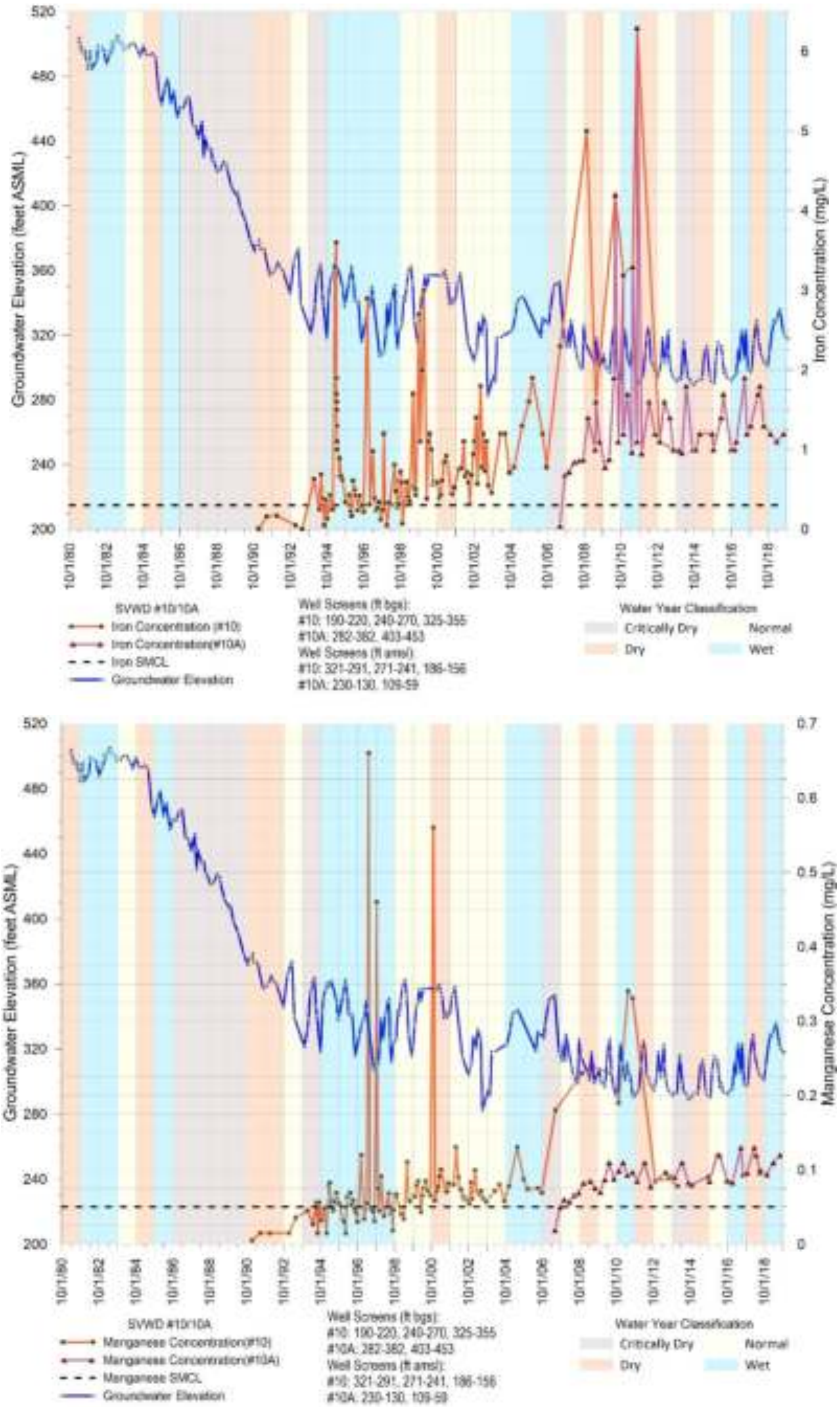


Figure 2-60. Historical Iron and Mangenese Concentrations and Groundwater Elevations in SVWD Well #10/10A (Lompico Aquifer)

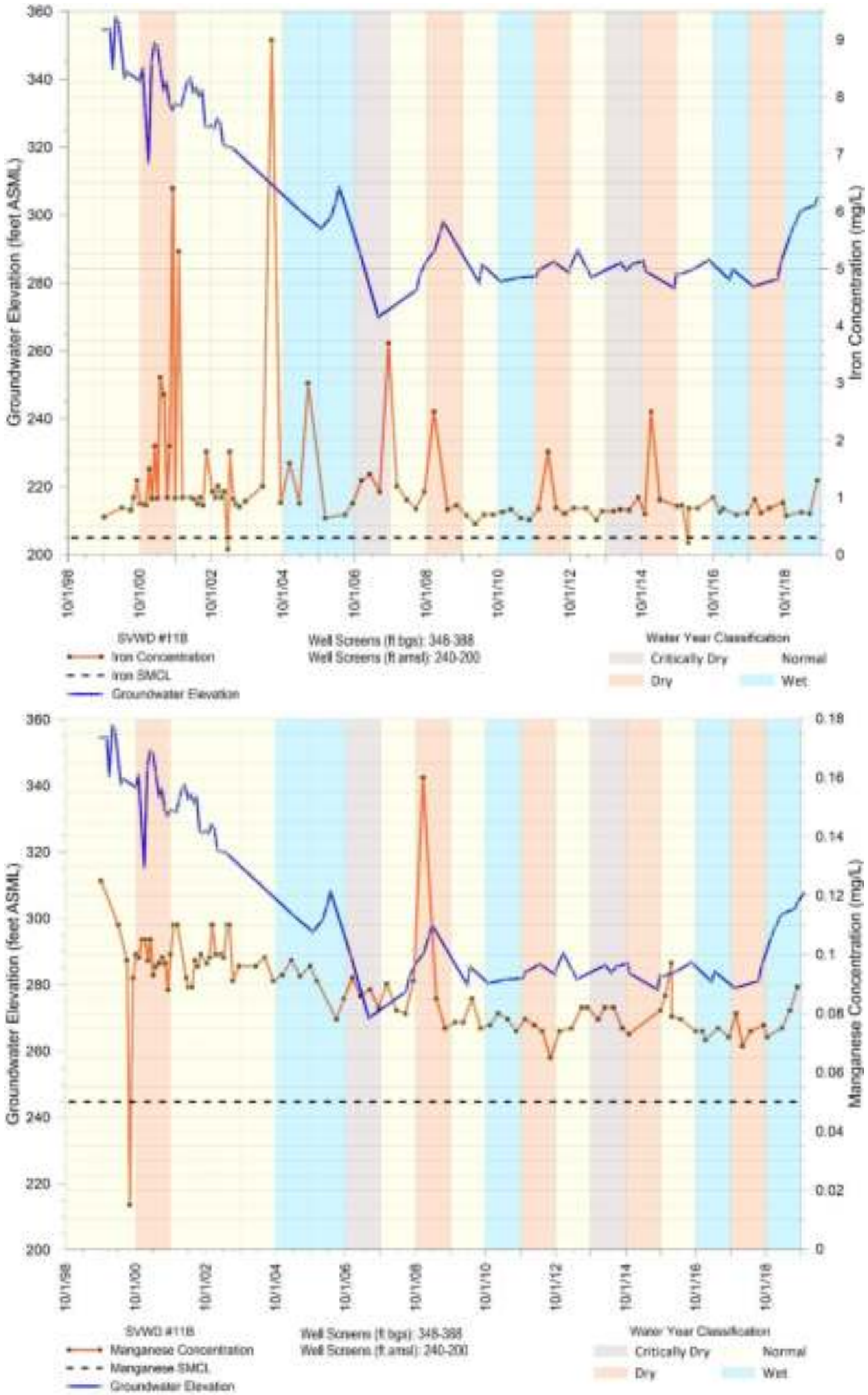


Figure 2-61. Historical Iron and Mangenese Concentrations and Groundwater Elevations in SVWD Well #11B (Lompico Aquifer)

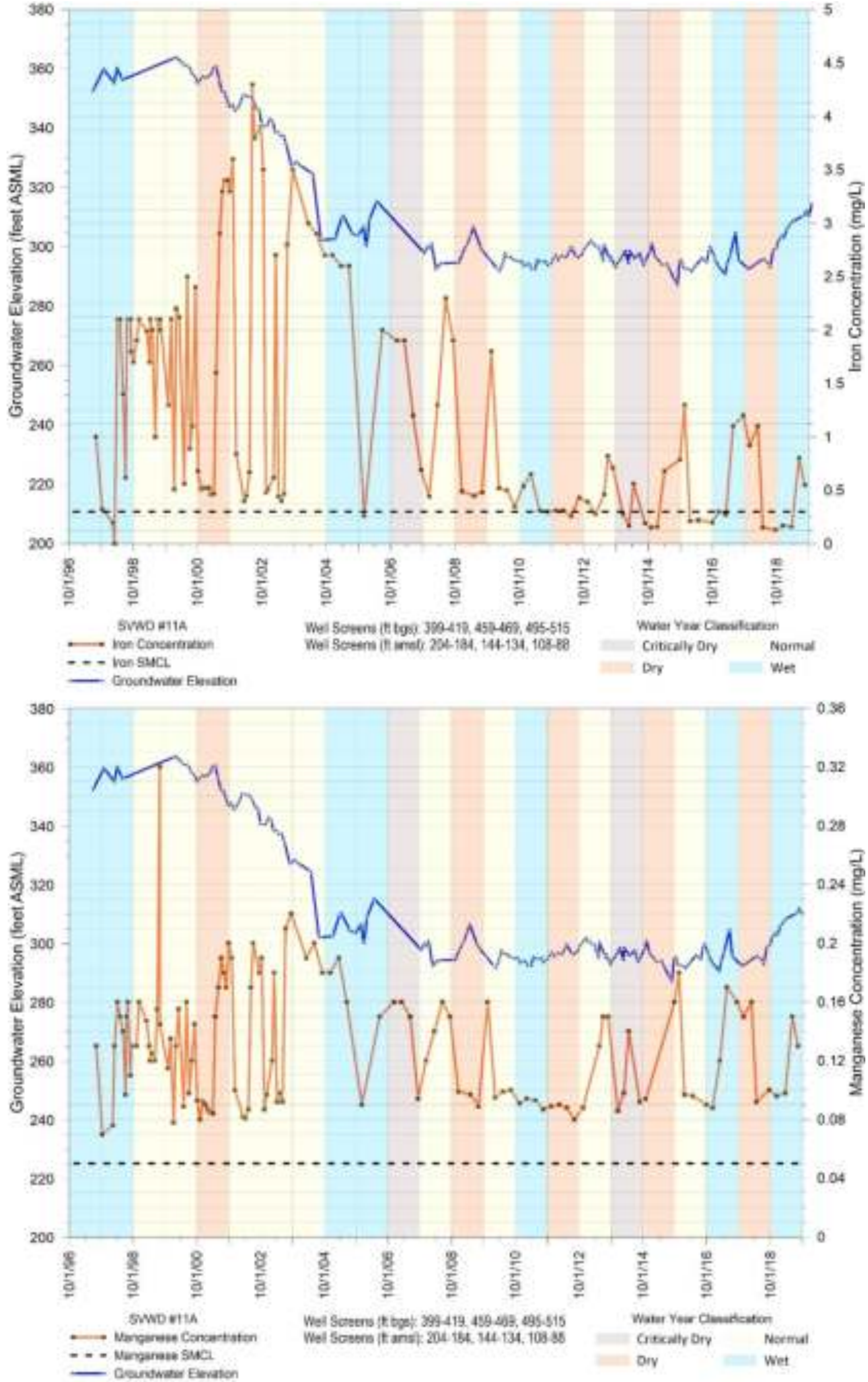
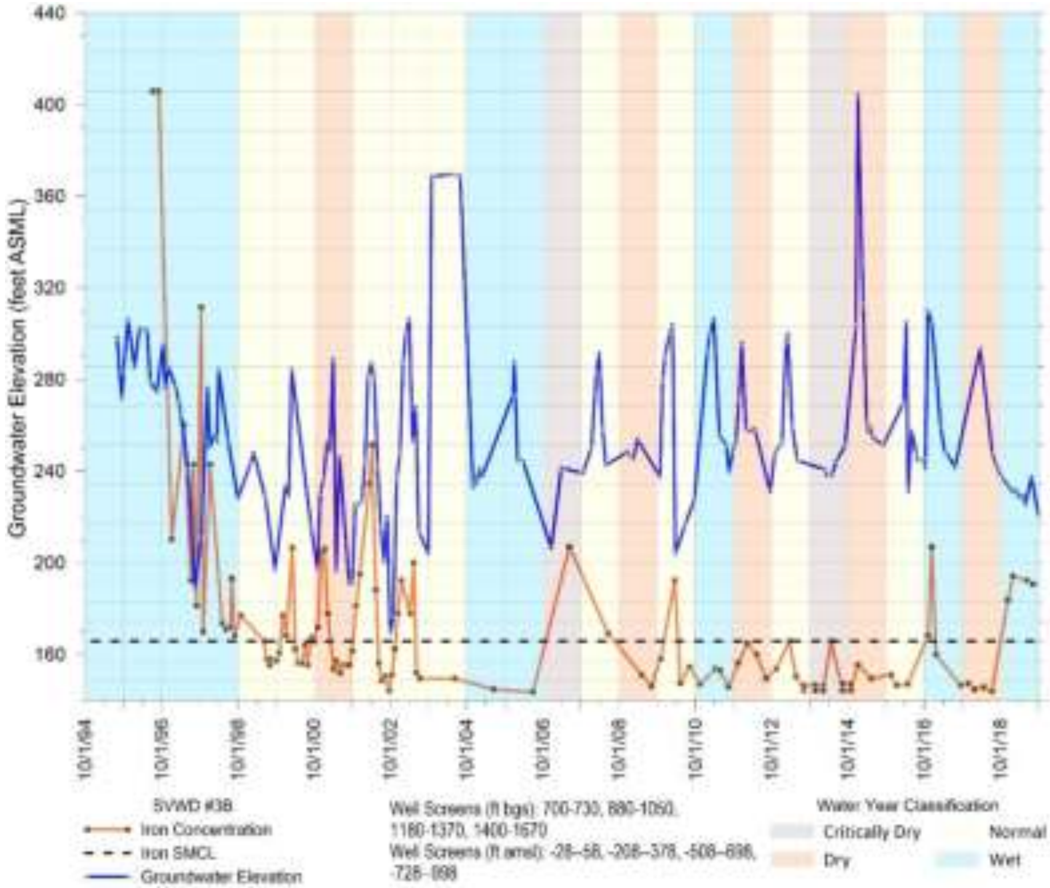


Figure 2-62. . Historical Iron and Mangenese Concentrations and Groundwater Elevations in SVWD Well #11A (Lompico Aquifer)



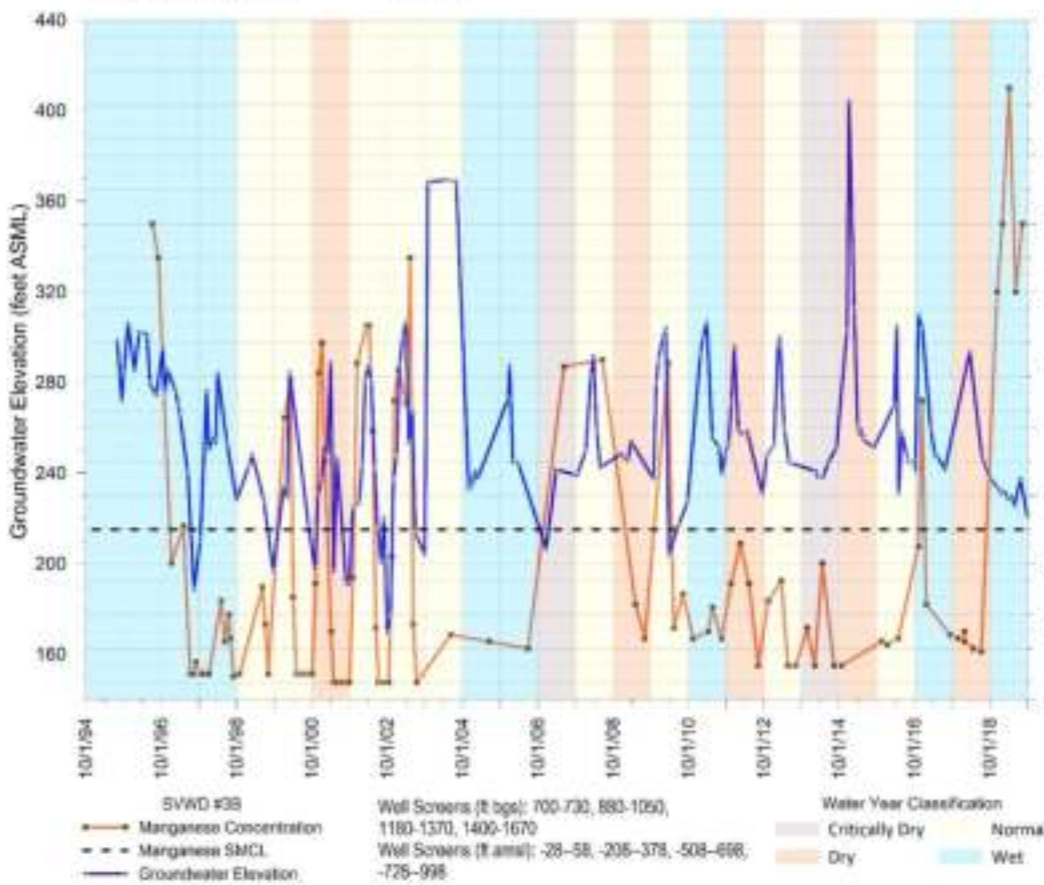


Figure 2-63. Historical Iron and Mangenese Concentrations and Groundwater Elevations in SVWD Well #3B (Lompico/Butano Aquifer)

2.2.5.4.3.3 Arsenic

Arsenic is a trace element often naturally present in groundwater that can negatively impact human health when consumed. Arsenic occurs naturally and is ubiquitous in the environment. It is found in many drinking water sources in California and is commonly associated with deeper portions of sedimentary fill-basins throughout the western United States. (Anning et al, 2012). The primary MCL for arsenic is 0.010 mg/L.

Arsenic concentrations above the MCL (up to 0.025 mg/L) are found periodically in wells pumping from the Lompico aquifer (Figure 2-64). Due to wells with groundwater quality data in the Lompico aquifer being limited to wells in the Pasatiempo and Scotts Valley portions of the Basin (Figure 2-66), there are no arsenic data for the Lompico aquifer in other portions of the Basin. Non-detect or low detections of arsenic in the Basin's other aquifers (all wells with data are included in Appendix 2C), including the Butano aquifer support the observation that elevated arsenic is limited to the Lompico aquifer.

Arsenic is occasionally detected above its MCL in surface waters in the northern and western portions of the Basin, such as near Boulder Creek and south Felton where the Lompico aquifer is exposed at the surface in this area. The iron and manganese treatment process used for groundwater extracted for municipal purposes coincidentally treats arsenic to below MCLs prior to distribution.

Except for the Lompico aquifer extraction well SVWD #11B, there are no increasing arsenic concentration trends in wells with arsenic detections. Increasing arsenic concentrations in SVWD #11B appear to be correlated with groundwater elevation declines and may reflect the well drawing groundwater from a different portion of the aquifer than SVWD #11A (Figure 2-65). SVWD #11A is only 725 feet from SVWD #11B but is screened deeper thereby extracting groundwater from deeper in the Lompico aquifer.

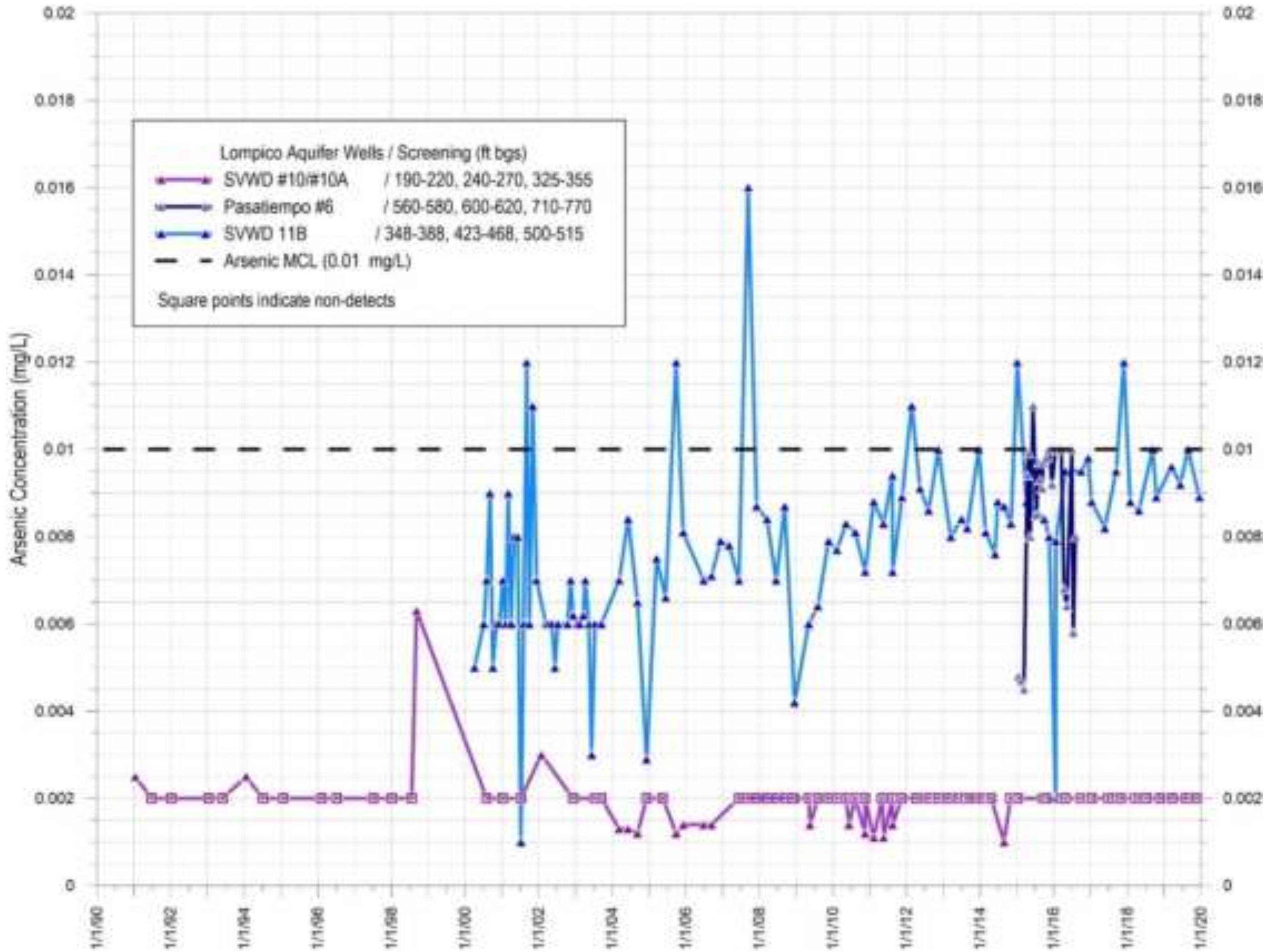
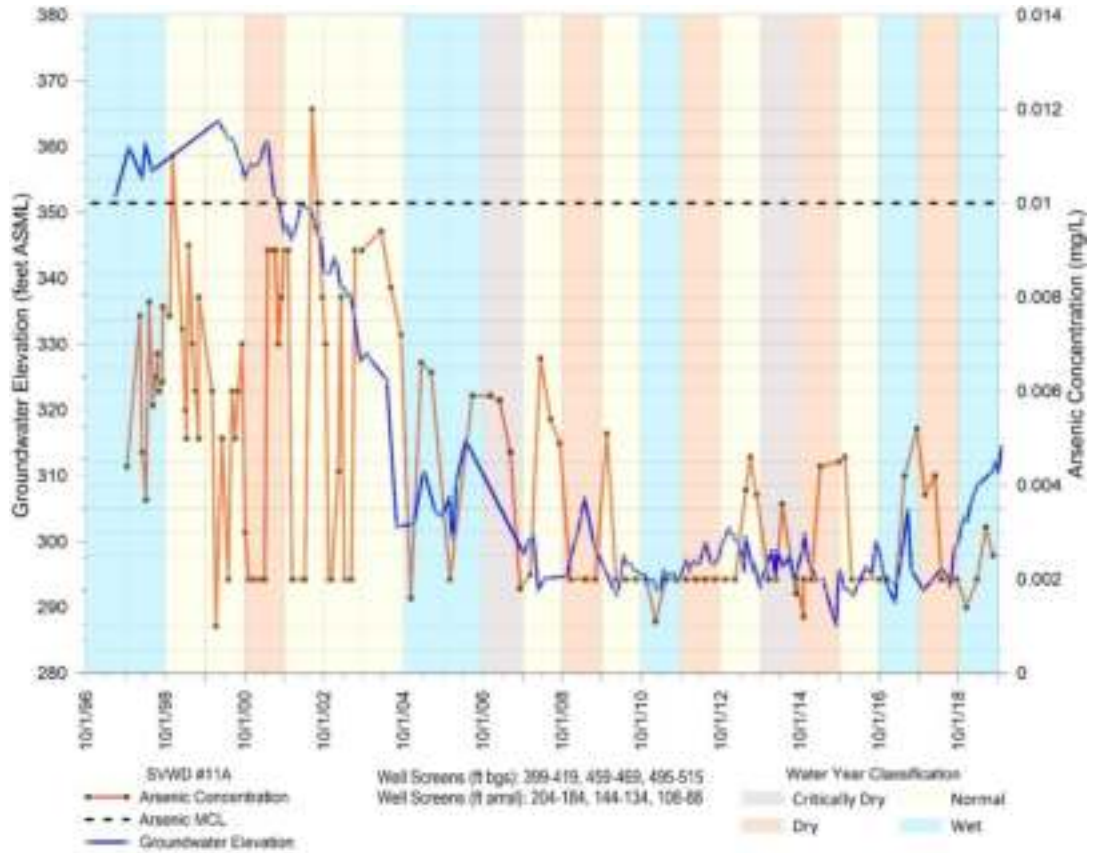


Figure 2-64. Arsenic Concentrations in Select Lompico Aquifer Wells from 1990-2019



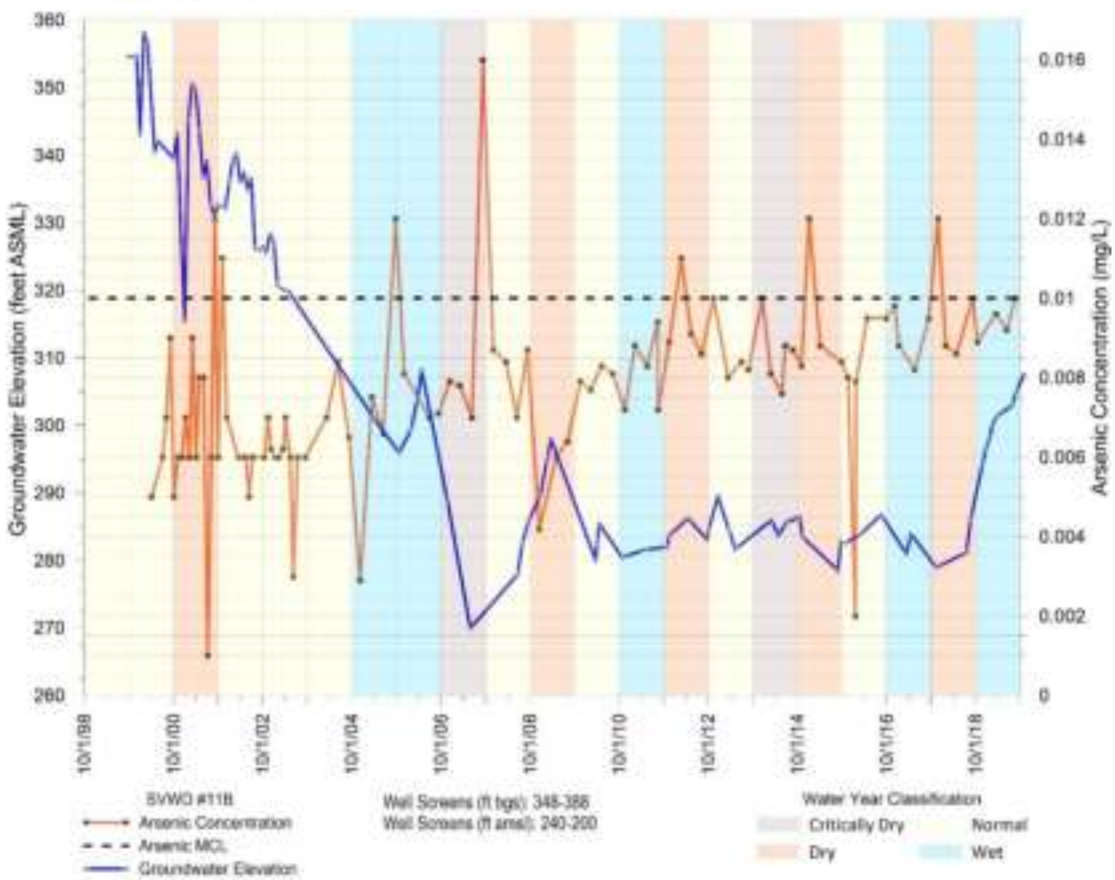


Figure 2-65. Historical Arsenic Concentrations and Groundwater Elevations in SVWD #11A and SVWD #11B

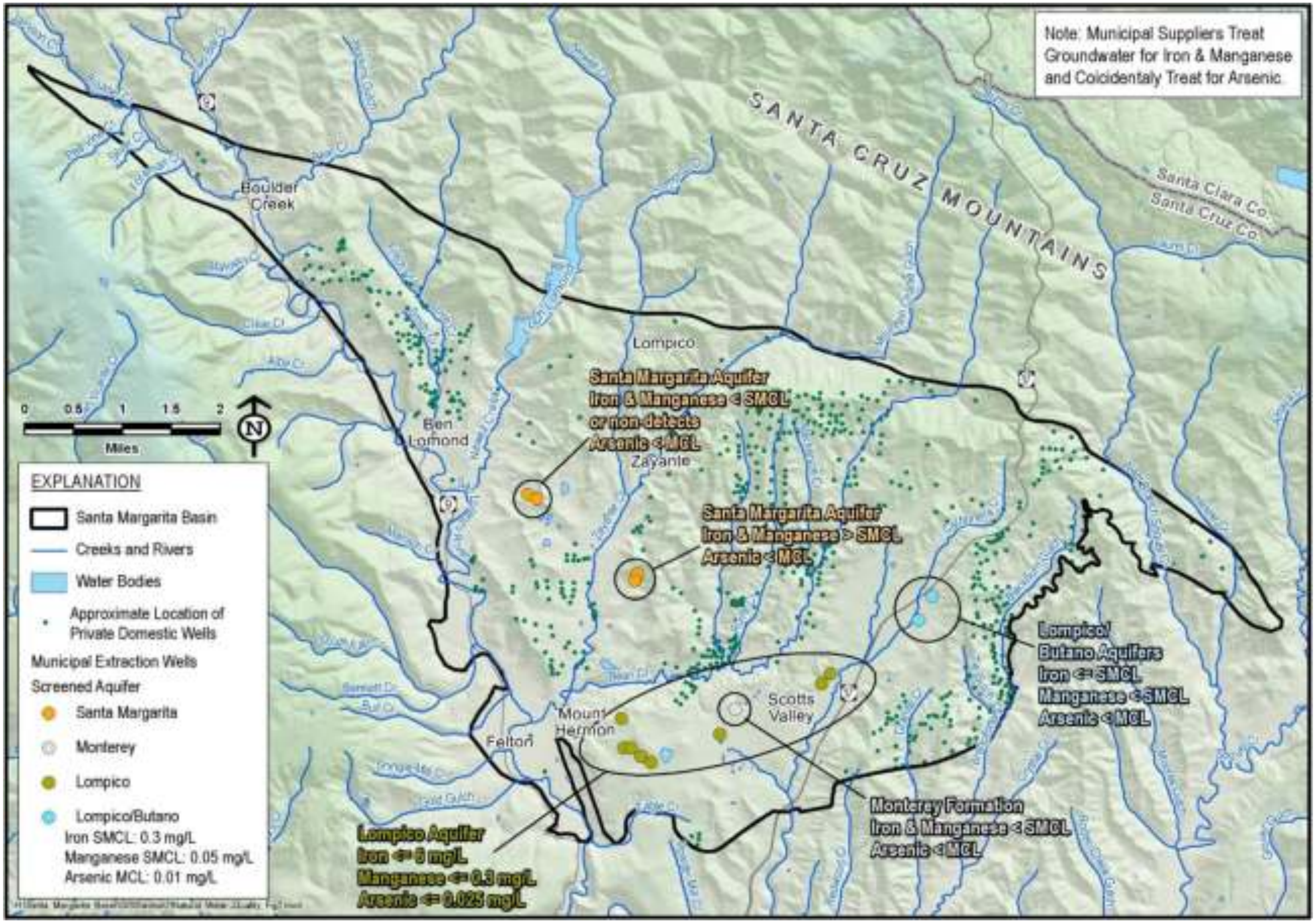


Figure 2-66. Areas of Elevated Naturally Occuring Groundwater Quality

2.2.5.4.4 Anthropogenic Constituents of Concern in Groundwater

2.2.5.4.4.1 Nitrate

Nitrate Sources

Elevated nitrate in groundwater is typically derived from anthropogenic sources such as fertilizer applied to crops and turf, animal operations, such as livestock/stables, and human sources such as wastewater treatment plant effluent and septic tanks. In response to observed increased nitrate concentrations in the San Lorenzo River in the 1980s and 1990s, the County prepared a San Lorenzo Nitrate Management Plan to evaluate the impacts of nitrogen release from septic systems and other sources, and to develop recommendations for reduction of nitrate levels in groundwater and surface water (County of Santa Cruz, 1995). The 1995 Nitrate Management Plan found that 76% of the nitrate load in the San Lorenzo River originated from human waste including septic systems and sewer discharges. The remaining 24% was associated with natural (animal and plant) sources (16%), livestock and stables (6%), and fertilizer use (2%). The Nitrate Management Plan also found that the nitrate concentrations occurring in the San Lorenzo River at that time did not appear to have any adverse impacts on fishery resources, and that impacts on recreation were low.

Historically, the Hansen (also known as Kaiser) quarry in the Pasatiempo area was used to dispose of several thousand gallons per day of primary effluent from the Scotts Valley Water Reclamation Facility constructed in 1964 (USGS, 1977). The City of Scotts Valley is the only area of the Basin that is sewered although there are still approximately 445 operating septic systems (6% of systems in the Basin) within City limits (Figure 2-67). The vast majority of the Basin's residents, as shown on Figure 2-67, use septic systems to treat and dispose of sanitary waste. Using land use data and County septic system inspection records, it is estimated that there are approximately 7,789 septic systems in the Basin. Table 2-18 summarizes the estimated distribution of septic systems, with a major proportion of the Basin's septic systems in areas supplied water by SLVWD.

Table 2-18. Santa Margarita Basin Septic System Distribution

Water Supplier	Estimated Number of Septic Systems (2018)	Percent
SLVWD	5,275	68%
Private domestic wells	784	10%
SVWD	747	10%
Mount Hermon Association	586	7%
Small Water Systems	397	5%
Total	7,789	

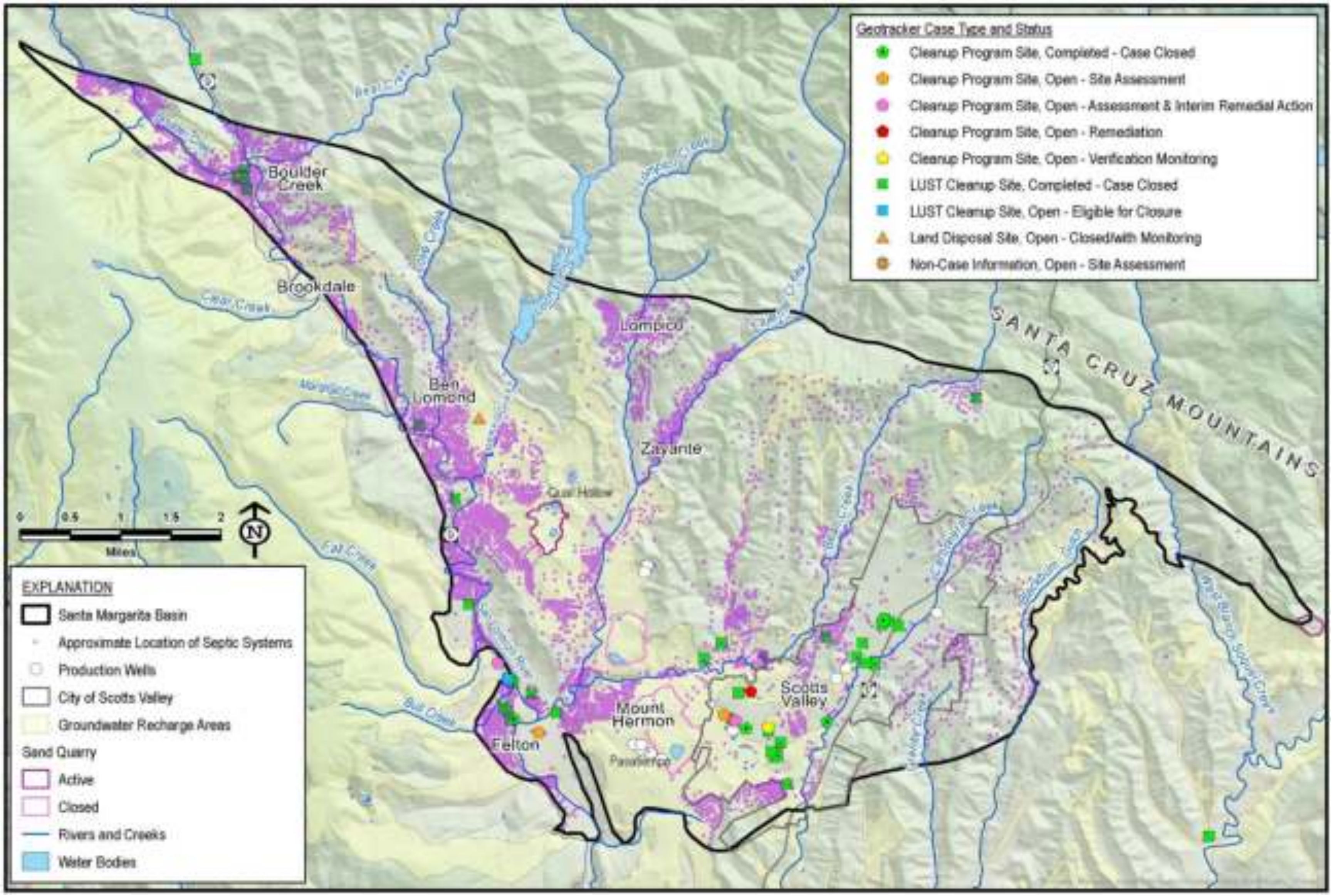


Figure 2-67. Potential Groundwater Contamination Sources

If sited or operated incorrectly, septic systems can be a significant source of groundwater contamination. The USEPA (2001) describes a typical household septic system as:

> A septic tank, a distribution box, and a leachfield. Wastewater flows into the septic tank, where it is held for a period of time to allow suspended solids to separate out. The heavier solids collect in the bottom of the tank and are partially decomposed by microbial activity. Grease, oil, and fat, along with some digested solids, float to the surface to form a scum layer. The partially clarified wastewater that remains between the layers of scum and sludge flows to the distribution box, which distributes it evenly through the leachfield. The leachfield is a network of perforated pipes laid in gravel-filled trenches. Wastewater flows out of the pipes, through the gravel, and into the surrounding soil. As the wastewater effluent percolates down through the soil, chemical and biological processes remove some of the contaminants before they reach groundwater.

Nitrogen, primarily from urine, feces, food waste, and cleaning compounds, is present in sanitary wastewater. Consumption of nitrates can cause methemoglobinemia (blue baby syndrome) in infants, which reduces the ability of the blood to carry oxygen. If left untreated, methemoglobinemia can be fatal for affected infants. Due to this health risk, a drinking water standard of 10 mg/L is set for nitrate measured as nitrogen (N) or 45 mg/L for nitrate as nitrate (NO_3). Even properly functioning conventional septic systems may contribute nitrogen to groundwater exceeding this standard (USEPA, 2001).

The CCRWQCB has historically delegated authority to oversee and regulate the installation of septic systems to SCEH through a memorandum of understanding. The County must comply with the minimum standards contained in the Basin Plan in order to keep the authority to permit septic systems. The County Board of Supervisors has adopted Section 7.38 of the County Code (the Sewage Disposal Ordinance) which specifies the standards for septic system installation in Santa Cruz County. The County is currently in negotiations with the Regional Board for establishment of a Local Area Management Plan (LAMP), which will be in compliance with the California Water Board's 2012 Water Quality Control Policy for Siting, Design, Operation and Maintenance of Onsite Wastewater Treatment Systems.

Nitrate Concentrations in Groundwater

Maximum nitrate (as N) detections in municipal wells from 2010 to 2020 were 3.6 mg/L in the Santa Margarita aquifer, and 0.7 mg/L in the Lompico aquifer which are below the nitrate (as N) MCL of 10 mg/L. Nitrate concentrations are generally higher in the permeable Santa Margarita aquifer due to its widespread exposure at the surface and proximity to potential nitrate contamination sources such as septic tanks and livestock/stables. The description of nitrate concentrations below is limited to areas where groundwater quality data are available.

Figure 2-68 plots nitrate (as N) concentrations in SLVWD Quail Hollow extraction wells from 1970-2020. These wells are screened in the Santa Margarita aquifer at different depths as noted on the chart. Near-surface sources of nitrate have a greater impact on shallower wells (Quail Hollow #5 and #5A) compared to the deeper screened Quail Hollow #4 and #4A wells. There are also more septic systems potentially impacting Quail Hollow #5/5A than Quail Hollow #4/4A. Figure 2-68 shows that from the 1970s to the 1990s, during the County's greatest population growth (Figure 2-35), nitrate concentrations increased in the Santa Margarita aquifer in the Quail Hollow area. Nitrate concentrations peaked in WY1987 which was during the 6-year statewide drought that extended from WY1986 through WY1991. Johnson (1988) demonstrated with a groundwater model that the nitrate peak at Quail Hollow was associated with late-season, drought-year pumping and the number of septic systems within the wells' capture zones. Johnson forewarned that nitrate concentrations had the potential to increase again in the future. Thus far, only a temporary spike that remained below drinking water standards occurred during the WY2012 through WY2015 statewide drought in the Quail Hollow #5A well (Figure 2-69). From Figure 2-69, it does not appear that there is any correlation between nitrate concentrations, water year type, and groundwater elevation. It should be noted, however, that the nitrate data plotted on Figure 2-69 is from groundwater quality samples collected every 3 years per DDW requirements. Comparing nitrate concentrations with water year type and groundwater elevations does not tell a complete story because the 3-year sampling frequency does not allow for comparisons at a seasonal level.

Apart from the temporary increase in WY2015, concentrations in the Quail Hollow wells have been stable or slowly decreasing (Figure 2-68), possibly in response to the County's efforts starting in 1986 to work with property owners to reduce the occurrence of failing septic systems as well as instituting new requirements for the construction and performance of new and existing septic systems, including the requirement for enhanced treatment for effluent nitrogen reduction for new and replacement systems in sandy soils.

Historically, the Santa Margarita aquifer in the Pasatiempo/southern Scotts Valley area was impacted by nitrate (as N) up to 6 mg/L due to septic and sewer waste disposal described above in the section on nitrate sources (Johnson, 2009). Recent nitrate concentration data are not available since the Santa Margarita aquifer is no longer pumped for municipal use.

Included on Figure 2-68 are public water supply wells screened in the Lompico aquifer. Groundwater in the Lompico aquifer generally has lower nitrate concentrations than the Santa Margarita aquifer because of greater travel time nitrate has to reach the deeper aquifer from the surface. The extraction well, SVWD #10/10A, is screened in the Lompico aquifer below the Monterey Formation, which forms a barrier to downward recharge, and has mostly non-detects of nitrate. The SLVWD's Pasatiempo wells, on the other hand, are in an area where the Monterey Formation is absent or very thin. With the barrier between the Santa Margarita aquifer and Lompico aquifer missing, nitrate concentrations are slightly higher than in areas overlain by the Monterey Formation but are lower than in the Santa Margarita aquifer (Figure 2-68). The few public water supply wells screened in the Butano aquifer mostly have no detectable nitrate due to the very deep occurrence of the aquifer.

County well permitting code requires well owners of new private domestic wells to submit a single groundwater quality test result following well installation. Private domestic wells are more vulnerable to nitrate contamination than municipal wells because private wells are typically shallower and are closer to septic systems. The period from 2010 to 2019, only had 1 well with an elevated nitrate (as N) concentration of 4.9 mg/L and the remainder of the nitrate concentrations were less than 1 mg/L.

Figure 2-70 summarizes the Basin's spatial distribution of nitrate concentrations for different aquifers described above.

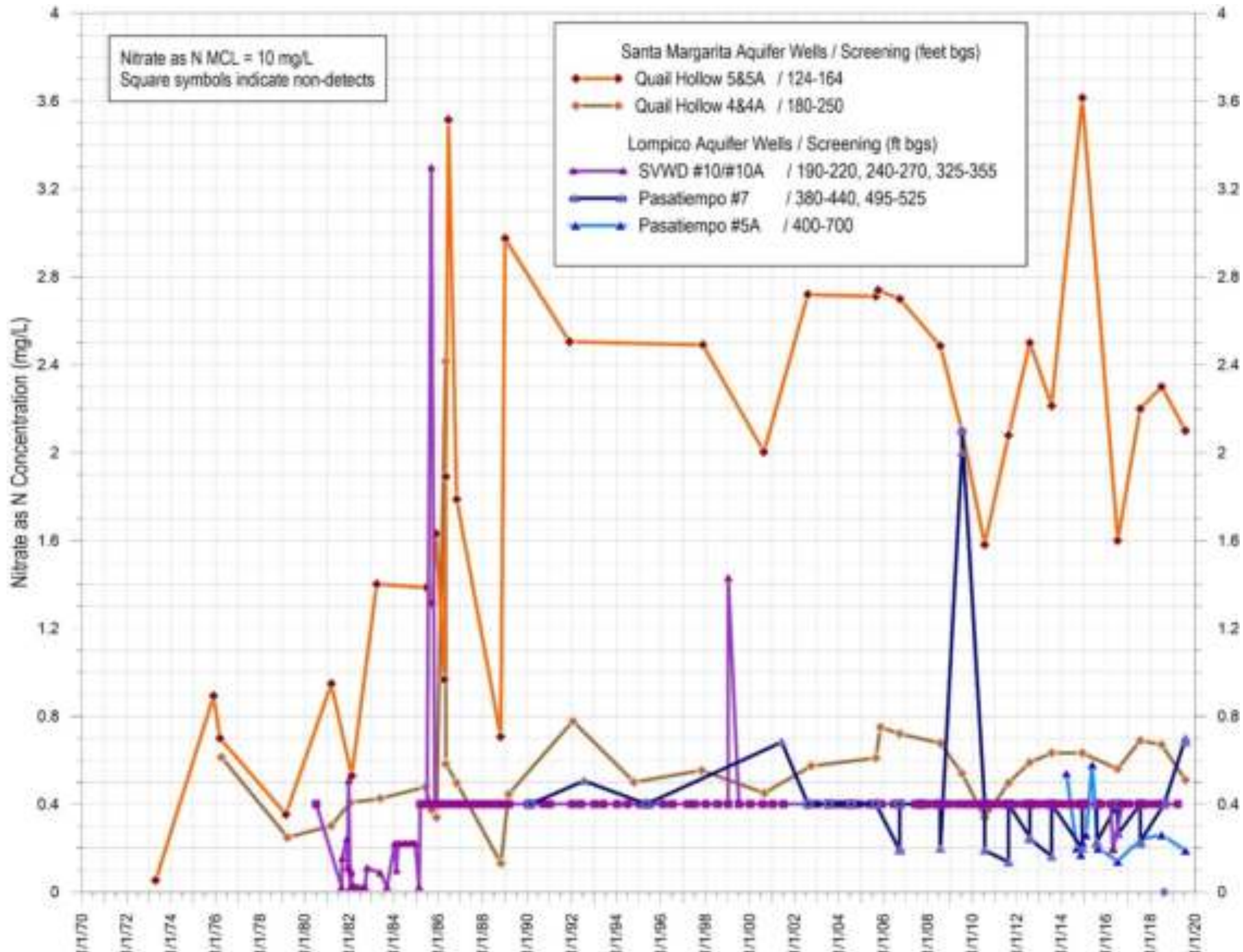


Figure 2-68. Historical Nitrate (as N) Concentrations, 1970-2020

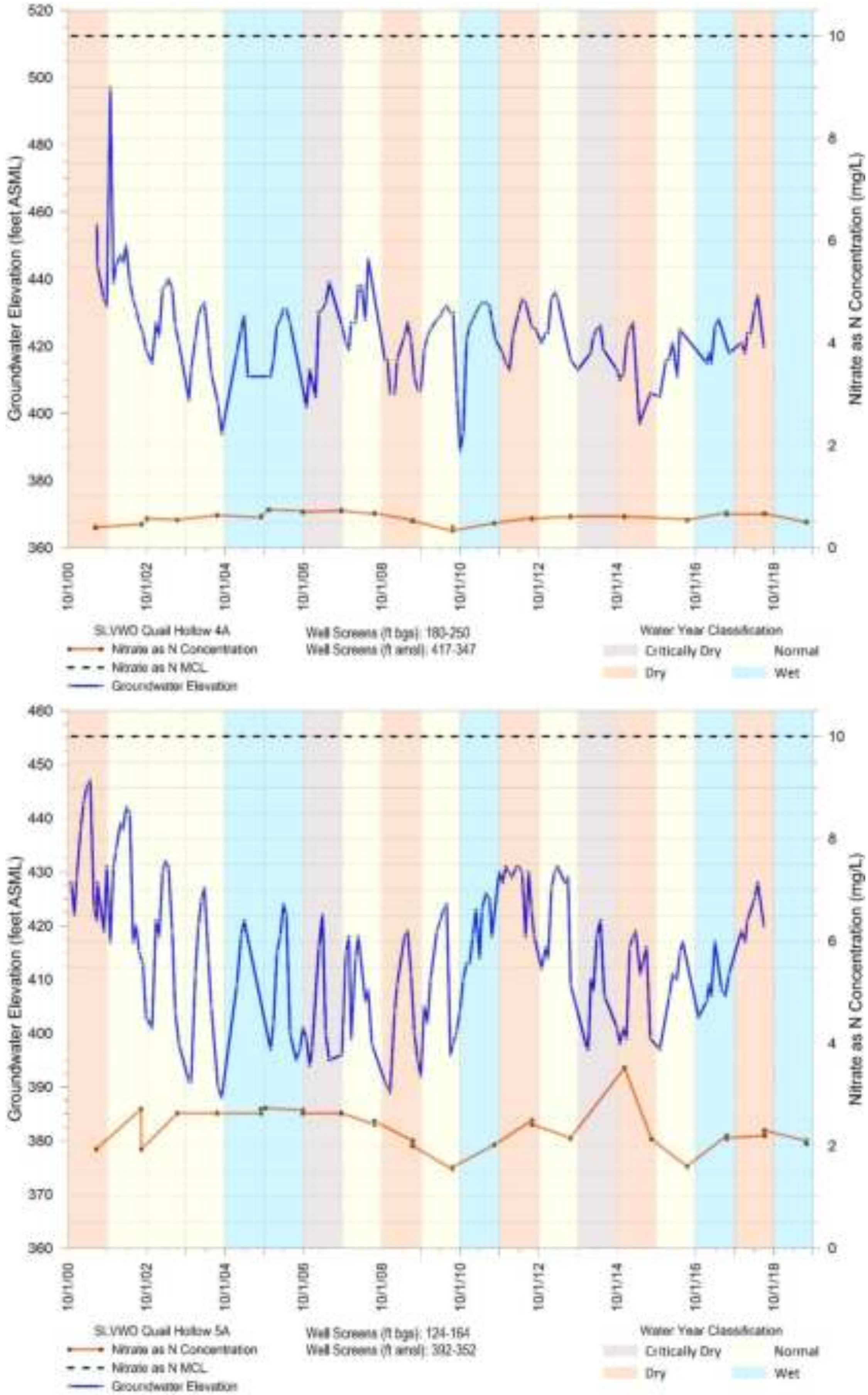


Figure 2-69. Historical Nitrate Concentrations and Groundwater Elevations in SLVWD Quail Hollow #4A and #5A (Santa Margarita Aquifer)

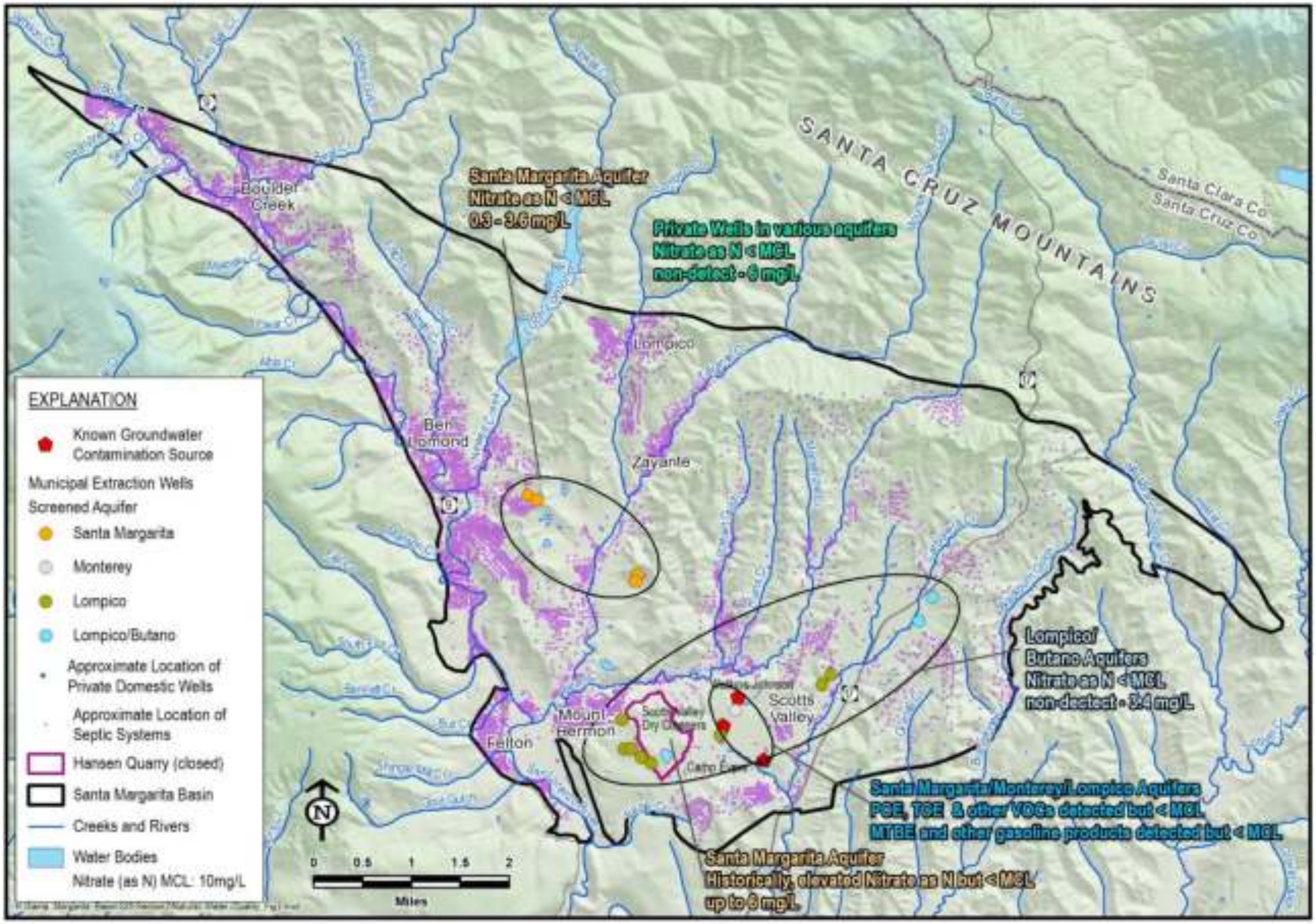


Figure 2-70. Areas of Known Anthropogenic Groundwater Quality Impacts

Nitrate Concentrations in the San Lorenzo River

Water quality in the Basin has a strong influence on water quality in the San Lorenzo River. Nitrate released from septic systems, livestock, fertilizer use, and other sources passes readily through the sandy soil, into the basin groundwater and eventually into tributary streams and the San Lorenzo River. Summer average nitrate (as N) concentrations at the San Lorenzo River at Felton from 1976 to 1993 was 0.42 mg/L (County of Santa Cruz, 1995). More recently, nitrate (as N) concentrations at this same location averaged 0.47 mg/L between September 2011 and September 2018 (converted from nitrate (as NO_3) of 2.1 mg/L; Trussell Technologies Inc., 2019). This indicates that nitrate concentrations in the San Lorenzo River at Felton have increased approximately 11% over the past 30 years.

The San Lorenzo River has been designated as impaired by the State and the USEPA due to elevated levels of nitrate, which stimulates increased algal growth and release of compounds that degrade the quality of drinking water and require increased cost for treatment. Increased nitrate and algal growth also cause impacts in the San Lorenzo lagoon, degrading salmonid habitat and potentially creating harmful algal blooms. Sixty five percent of the nitrate load in the River originates from the Basin, the majority of which is from septic systems.

In order to reduce nitrate levels in the San Lorenzo River, the County developed the San Lorenzo Nitrate Management Plan in 1995, and the CCRWQCB adopted a Nitrate Total Maximum Daily Load (TMDL) of 0.33 mg/L (as N). These plans call for various measures to prevent any increased nitrate discharge and to reduce existing sources, particularly requiring individual enhanced treatment systems as existing septic systems in sandy soils are replaced or upgraded. Additionally, the use of recycled water in the basin requires additional treatment for denitrification before the water can be used.

2.2.5.4.4.2 Contaminants of Emerging Concern

Contaminants of emerging concern (CECs), including pharmaceuticals and personal care products, are detected at low levels in the Basin’s surface water and groundwater. CEC pathways to surface and groundwater resources are similar to nitrate since these constituents are typically found in wastewater. New and emerging contaminants are currently unregulated but may be subject to future regulation. Examples of new and emerging contaminants are N-Nitrosodimethylamine, and 1,4-dioxane, disinfection byproducts, and perfluorinated substances.

The Unregulated Contaminant Monitoring Rule (UCMR) is part of the federal Safe Drinking Water Act Amendments of 1996 and administered by the U.S. Environmental Protection Agency (USEPA). SVWD and SLVWD have had CECs tested in their source waters and treated water in three separate UCMR testing cycles: 2009/2010 (UCMR 2), 2014/2015 (UCMR 3), and 2018/2019 (UCMR 4). Apart from very low levels of brominated haloacetic acid disinfection byproducts in treated water, there have been no CECs detected in groundwater or surface water that are the 2 water districts' sources of water. UCMR data can be accessed from the USEPA (https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule).

The San Lorenzo River which is a primary source of water for the City of Santa Cruz has detections of CECs at both the Tait and Felton diversions. The Tait diversion is south of the Basin and the Felton diversion is within the Basin. The City's CEC testing was initially undertaken to inform planning for upcoming improvements to the Graham Hill Water Treatment Plant (City of Santa Cruz, 2016b); it is now conducted annually and includes CEC testing of influent and effluent from the treatment plant. The most common CECs detected in raw San Lorenzo River water samples are 2 types of artificial sweeteners, Sucralose (i.e. Splenda) and Acesulfame-K, (i.e. Sunett and Sweet One). Sampling conducted over time and during different seasons found that the most diverse set of CECs were found in the first flush sample that reflects the influence of the first significant rainfall of the season on river flows and is intended to capture the impacts on water quality of both surface runoff and rewetting of the streambed.

Table 2-19 summarizes 1 year of monthly samples tested for CECs, including frequency of detections in either the raw source water blend and/or the treated drinking water at the Graham Hill Water Treatment Plant. In this 1-year water treatment plant study, 59 total detections out of 2,304 CECs measured, which equals a 2.6% rate of CEC detection. Blending of the City's raw water sources prior to treatment was documented to decrease the higher CEC concentrations measured in the San Lorenzo River. Samples collected during the drier months of May through September measured lower concentrations of artificial sugars (universal indictors of wastewater) and a dissimilar variety of CEC compounds compared to those CECs detected during the wetter periods. This occurs because of CECs entering the San Lorenzo River as either surface water runoff or septic system effluent through saturated underground water flow, which are less prevalent during dry season conditions. During these warmest months of the year, weekday, and weekend recreational activities in and around the San Lorenzo River are a probable source of human contamination from swimming and wading, as increased pharmaceutical and personal care products detections.

While there are few regulations for CECs at this time, it is expected there may be more in the future. There is a high likelihood that additional treatment techniques will be used to remove or reduce CECs from the treated drinking water which will be more costly and likely require upgrades to existing water treatment plants.

Table 2-19. Summary of Constituents of Emerging Concern Detections in Raw Source Water Blend and/or Treated Drinking Water at the Graham Hill Water Treatment Plant (2016/2017)

CEC Type	Chemical Type or Use with Common Name if Applicable	Number of CECs detected in the raw source water blend and/or treated drinking water in 2016/2017	Number of Detections
Artificial sweeteners and caffeine	Artificial sweetener (Sunett and Sweet One)	Acesulfame- K (16)	23 detections ranging from 6-320 ng/L, average detection of 70 ng/L
	Artificial sweetener (Splenda)	Sucralose (5)	
	Stimulant (coffee, tea, some energy drinks)	Caffeine (2)	
Pharmaceuticals	Antibiotic	Erythomycin (6)	22 detections ranging from 6-130 ng/L, average detection of 34 ng/L
	Contrast media used for x-ray imaging	Iohexal (4)	
	Organic chemical used in the manufacture of a variety of other products such as dyes, some pharmaceuticals, and niacin (vitamin B3)	Quineline (3)	
	Pain relief medicine	Acetaminophen (2)	
	Veterinary drug for swine	Carbadox (2)	
	Antacid and antihistamine	Cimetidine (2)	
	Anti-inflammatory medicine	Meclofenamic acid (2)	
	High blood pressure medicine	Diltiazem (1)	
Herbicides and insecticides	Insect repellent	DEET (5)	8 detections ranging from 5-60 ng/L, average detection of 23 ng/L
	Herbicide	Chloridazon (2)	
	Herbicide	Chlorotoluron (1)	
Personal care products	Alkylphenols used in manufacturing of antioxidants, lubricating oil additives, and laundry and dish detergents	4-nonylphenol (4)	5 detections ranging from 8-240 ng/L, average detection of 150 ng/L
	Paraben family of preservatives in personal care products found in cosmetics, pharmaceuticals and foods	Propylparaben (1)	
Flame retardant	Flame retardant	Tris(1,3-dichloro-2-propyl) phosphate (1)	1 detection at 1,300 ng/L

2.2.5.4.4.3 Organic Compounds

Organic compounds are those that include VOCs and pesticides. VOCs are chemicals that are carbon-containing and evaporate or vaporize easily into air at normal air temperatures. VOCs are found in a variety of commercial, industrial, and residential products, including gasoline, solvents, cleaners and degreasers, paints, inks and dyes, and pesticides. VOCs in the environment are typically the result of human activity, such as a spill or inappropriate disposal where the chemical has been allowed to infiltrate into the ground. Once released into the environment, VOCs may infiltrate into the ground and migrate into the underlying production aquifers.

Figure 2-67 shows the locations of all historical and current cleanup sites in the Basin sourced from the SWRCB GeoTracker database. GeoTracker is a database and geographic information system (GIS) that provides online access to environmental data. It tracks regulatory data about leaking underground fuel tanks, Department of Defense, Spills-Leaks-Investigations-Cleanups, and landfill sites. Most the Basin's cleanup sites are in the Scotts Valley area and along the San Lorenzo Valley corridor and are impacted with VOCs. These areas correspond with the Basin's developed areas and to detections of anthropogenic contaminants in wells (Figure 2-66). While closed-case cleanup sites (green) are present across a wide range of this area, current open-site cleanup cases are clustered near Felton and the Scotts Valley/Camp Evers area. Section 2.1.3.4.6.1 summarizes the status of the Basin's groundwater cleanup cases based on information available from GeoTracker. The bullets below summarize cleanup sites not included in Section 2.1.3.4.6.1:

- To the southwest of the Watkin-Johnson site there are 2 open-case dry cleaner cleanup sites in the City of Scotts Valley: Scotts Valley Dry Cleaners (orange pentagon on Figure 2-67) and King's Cleaners (yellow pentagon on Figure 2-67). Both sites are located on Mt. Hermon Road between Scotts Valley Drive and Skypark Drive. The Scotts Valley Dry Cleaners site currently operates soil vapor extraction and air sparging systems to remediate PCE and TCE in the unsaturated soils above the groundwater table by extracting soil vapor. A groundwater remediation system was used from 1998-2015. The King's Dry Cleaners Site is operating soil vapor remediation to remove PCE and TCE contamination.
- The Ben Lomond Landfill (orange triangle on Figure 2-67) was closed in 2012 and is now operated as a transfer station. Groundwater monitoring has been ongoing at the now-closed landfill since 1980, as the site is associated with elevated levels of VOCs and heavy metals. Contamination associated with the site is not predicted to expand and is not thought to significantly impact 2 municipal wells operated by SLVWD east of Newell Creek (Johnson, 2009).

In addition to the open-case sites discussed above, there have been many cleanup sites in the Basin which are now closed, indicated in green on Figure 2-67. These include numerous LUST sites, such as the now closed (since November 21, 2017) Camp Evers Combined Site associated with four current and former gasoline stations located at the intersection of Scotts Valley Drive and Mount Hermon Road. Although the Camp Evers site cleanup is complete as described in Section 2.1.3.4.6.1, there are remaining gasoline related chemicals in groundwater below their relevant MCLs.

Several SVWD municipal water supply wells have been impacted by organic compounds originating from some of the sites described above (Montgomery & Associates, 2020). SLVWD's Quail Hollow wells have historically been impacted by organics thought to have originated from spills or septic system disposal of cleaning products by 1 or more of the local residences (Johnson, 2009). Table 2-20 identifies those wells with detections. SVWD and SLVWD use onsite treatment plants to remove certain constituents that are above or approaching primary or secondary drinking water standards.

Table 2-20. Summary of Municipal Water Supply Wells Historical Detections of Organic Compounds

Well	PCE MCL = 0.005 mg/L	TCE MCL = 0.005 mg/L	CISDCE MCL = 0.07 mg/L	Chloro-benzene MCL = 0.1 mg/L	MTBE MCL = 0.013 mg/L
Santa Margarita Aquifer					
SLVWD Quail Hollow #4A	ND	ND	ND	ND	ND
SLVWD Quail Hollow #5A	ND	Below MCL	ND	ND	Below MCL
SLVWD Olympia #2	ND	ND	ND	ND	ND
SLVWD Olympia #3	ND	ND	ND	ND	ND
Monterey Formation					
SVWD #9*	ND	Below MCL	Below MCL	ND	Below MCL
Lompico Aquifer					
SLVWD Pasatiempo #5A	ND	ND	ND	ND	ND
SLVWD Pasatiempo #7	ND	ND	ND	ND	ND
SLVWD Pasatiempo #8	ND	ND	ND	ND	ND
SLVWD Mañana Woods #2*	ND	ND	ND	ND	Above MCL
SVWD #10A	ND	ND	ND	ND	ND
SVWD #11A	ND	ND	ND	Below MCL	ND
SVWD #11B	ND	ND	ND	ND	ND
Lompico/Butano Aquifer					
SVWD #3B	ND	ND	ND	ND	ND
SVWD Orchard Well	ND	ND	ND	ND	ND

MCL = maximum contaminant level or primary drinking water standard
* Well no longer used for water supply

Similar to the fate of nitrate, organic constituents readily migrate through the Santa Margarita Sandstone to the water table. The Lompico aquifer is more protected from contaminants migrating downwards through the Santa Margarita aquifer by the Monterey Formation if it is present above the Lompico aquifer.

2.2.5.5 Land Subsidence

Land subsidence is the gradual or sudden lowering of the land surface. Subsidence can be inelastic or elastic. Elastic subsidence includes short-term land surface elevation changes that are reversible inelastic subsidence is irreversible. Only inelastic subsidence caused by groundwater pumping is subject to SGMA and GSP Regulations. Inelastic subsidence can be caused by the following processes, however only aquifer-compaction related to groundwater pumping is subject to SGMA and GSP Regulations:

- Drainage and decomposition of organic soils
- Underground mining, oil and gas extraction, hydrocompaction, natural compaction, sinkholes, thawing permafrost
- Aquifer-system compaction
- Tectonic forces such as fault uplift and landsliding

There is no known evidence of land subsidence in the Basin. Potential evidence of land subsidence related to lowered groundwater elevations might include damage to roads, bridges, and instances of protruding well casings. None of these conditions have been observed in the Basin.

The only potential cause of subsidence in the Basin that would be subject to SGMA is aquifer-compaction caused by lowered groundwater levels from groundwater pumping. The Monterey Formation and Lompico aquifer have experienced up to 200 feet in groundwater decline in the Scotts Valley area but no known subsidence impacts have been observed.

Pumping-induced subsidence is generally restricted to unconsolidated deposits of clay and fine silt, in which extraction of pore water results in the grains of sediment no longer being subjected to the buoyant support of fluid-saturated pore space. The collapse is inelastic in that, even if pumping were to cease, the deposit is now an aquitard with less pore space to hold water and very limited conductivity.

In contrast, the 3 principal aquifers in the Basin are sandstones that are, to varying degrees, consolidated and cemented. When groundwater is extracted from the pores, the pores do not collapse (as they would in unconsolidated deposits or clay-rich rocks) because the framework of sand and silt grains remains due to grain-on-grain contact and due to lithologic cement that holds the grains in place.

The Monterey Formation, though consisting mostly of siltstone and siliceous shale, has not undergone pumping-induced compaction because the formation is well consolidated and well-cemented. Moreover, the horizons tapped by the pumping are sandy interbeds that are coarser than the bulk of the formation.

As no reports or observations have been made regarding land subsidence due to lowered groundwater elevations in the basin, no local land subsidence monitoring has taken place. There is a continuous global positioning station (CGPS) near Felton about 2.4 miles west of the Basin that is part of the University NAVSTAR Consortium Plate Boundary Observatory network; however, it is located outside the sedimentary basin on granitic basement rock, making it useful for tracking movement of the land surface due to tectonic deformation but of no use for monitoring pumping-induced subsidence in the nearby sedimentary rocks of the Basin.

DWR has made vertical displacement spatial data available as part of its SGMA technical assistance for GSP development and implementation. Vertical displacement estimates are derived from Interferometric Synthetic Aperture Radar (InSAR) data that are collected by the European Space Agency Sentinel-1A and 1B satellites and processed by TRE ALTAMIRA Inc. The InSAR dataset has also been calibrated to best available independent data. The dataset starts in January 2015.

Figure 2-71, derived from the dataset, shows changes in total vertical ground surface displacement between June 2015 and June 2019. During this timeframe, the satellite data showed up to 1.2 inches (0.1 feet) of subsidence within the Basin. Most of areas with subsidence on Figure 2-71 are regional and not co-located with groundwater pumping. It is unlikely that these relatively minor changes in ground surface elevation reflect ongoing trends in inelastic subsidence. Rather, they may be attributed to expected measurement error inherent in the methodology, seasonal fluctuations in soil and vadose zone moisture that cause swelling and recession of the ground surface, or tectonic forces.

An area of approximately 1 square mile to the east of Loch Lomond Reservoir shows a slight increase in land surface elevation of up to 0.035 inches (Figure 2-71). Important to understand is that the DWR InSAR data is subject to potential errors of approximately 0.059 feet (0.7 inch) from error between InSAR data and CGPS data (Towill Inc., 2020) and 2) measurement accuracy when converting from the raw InSAR data to the maps provided by DWR of 0.048 feet (personal communication with Benjamin Breezing - DWR, 2019). A land surface change of less than 0.1 foot (1.2 inches) which is less than the combined error of the dataset is within the noise of the data and is not dispositive of subsidence in the Basin. Additionally, the InSAR data provided by DWR reflects both elastic and inelastic subsidence.

Land subsidence is not an applicable indicator of sustainability in the Basin and land surface elevations within the Basin have not been historically monitored nor are there plans to conduct such monitoring in the future. Consequently, land subsidence is not included in the discussion of applicable sustainability indicators and does not have SMC defined in Section 3. To confirm that subsidence is not occurring in the Basin in the future, the InSAR subsidence dataset (or other available datasets) will be reviewed by the SMGWA as part of its 5-year GSP updates. If future InSAR datasets indicate that subsidence is occurring in portions of the Basin that are being pumped, then additional analysis will be performed to confirm the measurement is not inelastic subsidence related to groundwater pumping. Additional analysis would focus on correlating subsidence observations to groundwater pumping volumes, groundwater elevations, and sources for false positives such as known land sliding and tectonic motion.

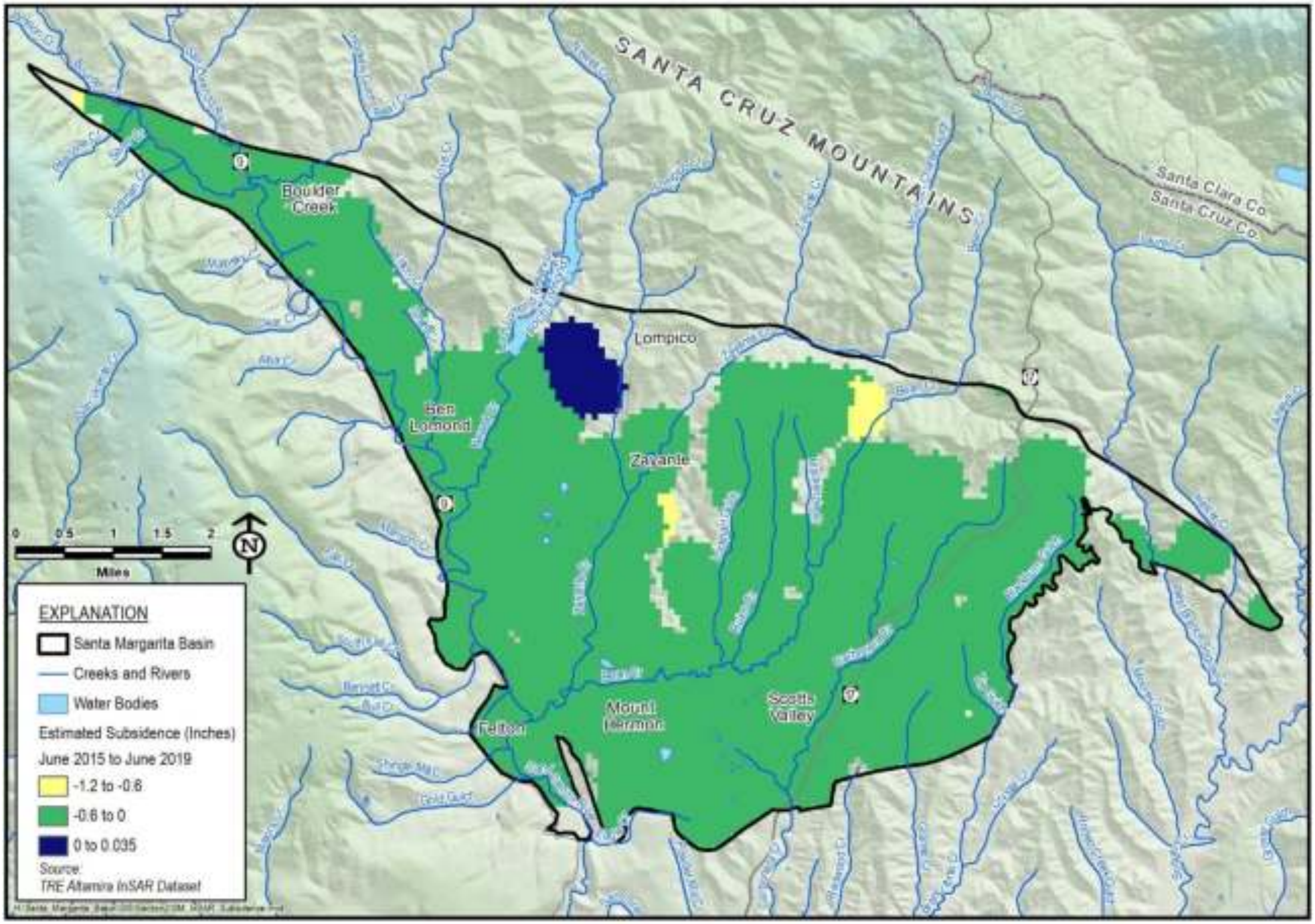


Figure 2-71. Total Vertical Land Surface Displacement in Santa Margarita Basin from June 2015 – June 2019 (based on TRE ALTAMIRA Inc. InSAR)

2.2.5.6 Interconnected Surface Water

Stream gauging, accretion studies, groundwater level monitoring, stream and GDE elevations, field reconnaissance and groundwater modeling have all be used to show that surface water is largely connected to groundwater throughout the Basin. As discussed in Section 2.2.4.8, essentially all of the water flowing in the Basin's streams and creeks is derived from groundwater during the dry season from late May through October (Johnson, 2009).

In 2017, Balance Hydrologics began evaluating interconnected surface water by conducting annual late-season stream observation walks ("accretion runs"), where flow and specific conductance were measured with high precision at select locations along the San Lorenzo River and its tributaries[2]. The accretion runs also include habitat-oriented measurements of localized changes in water temperature, whether stratification of temperature may be present in deep pools, and the presence and height of recent high-water marks, all of which also inform assessments of surface/groundwater exchange. Additionally, measurements of nitrate and sometimes other major ions or forms or organic carbon (Richardson et al., 2020) are also included in many of the 'runs.' Accretion studies tell where the aquifer is adding flow to the stream, and where the stream is replenishing the aquifer. Carefully conducted accretion studies are perhaps the best way of quantifying an understanding of aquifer dynamics and surface-groundwater exchange. Sites along the San Lorenzo River are measured from upstream of downtown Boulder Creek to below the USGS at Big Trees gauge. Much of the emphasis is on areas within the outcrop of the Santa Margarita Sandstone, which contributes water to the river and its tributaries, most notably from Love Creek to downstream of the USGS Big Trees gauge, beneath the Henry Cowell State Park entrance road.

The highly permeable nature of the Santa Margarita aquifer and its proximity to surface water features lends it to being a source of baseflows to the Basin's creeks and the San Lorenzo River. Groundwater in other aquifers is also connected to surface water but the Santa Margarita aquifer is the greatest overall contributor. The water budget in Section 2.2.6 estimates that net groundwater contributions to surface water (i.e., groundwater discharge to creeks less groundwater recharge from creeks) has historically averaged about 12,720 AFY. The Santa Margarita aquifer contributes 40%, the Butano aquifer contributes 32%, and the other formations connected to creeks contributing a combined 28% of net groundwater discharge to creeks. The Butano aquifer contributes a relatively larger amount than expected because it is intersected by numerous creeks along the Basin's northern boundary where these interactions occur. The other formations and aquifers that discharge groundwater to creeks in the Basin, include the small portion of alluvium near Felton, the Monterey Formation, and the Lompico aquifer.

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[2] This work grew out of detailed hydrologic studies conducted for the SLVWD during two very dry summers (2014 and 2015), coupled with the effects of a recovery year (2016), and the recommendations of the technical advisory committee reviewing that work.

As part of the on-going GSP processes, sites along Zayante, Lompico and Bean Creeks were added to the accretion runs in the summer of 2019 and 2020, with most of the additional sites along Bean Creek and its tributaries. During the summer and fall of 2019, 3 separate accretion runs (May, July, and September) were conducted on the San Lorenzo River, Lompico, Zayante, Bean, and Eagle Creeks, where measurements were collected at all sites over a period of 1 to 2 days for each run. During the summer and Fall of 2020, 2 separate accretion runs were conducted (July and September) at the same locations as in 2019.

The results of the accretion sampling have shown flow increases downstream along the San Lorenzo River, Bean, and Zayante Creeks, except for 1 dry reach along Bean Creek. The flow increases are independent of surface contributions from other small tributaries along the reaches. The finding suggests that the baseflow in these creeks is supported by groundwater discharge (Parke and Hecht, 2020a; Neill and Hecht, 2020; Neill at al., 2021). Previous studies have shown that streams flowing through the Santa Margarita Sandstone in the San Lorenzo Valley all share common characteristics of elevated baseflows, low solute loads (measured as specific conductance), very low chloride contributions and elevated nitrate loads (Ricker, 1979; Ricker et al., 1994; Sylvester and Covay, 1978; Hecht et al., 1991; Parke and Hecht, 2020a). These characteristics were observed in the accretion runs where streams pass through portions of the Basin influenced by the Santa Margarita aquifer.

Along Bean Creek, the findings of the accretion study are consistent with previous observations: the upper Bean Creek watershed and its tributaries are typically losing reaches that recharge the groundwater, whereas streamflow in the lower watershed is enhanced by groundwater discharge from the Santa Margarita (DWR, 1958 and 1966; Kennedy/Jenks Consultants, 2015b; Neill and Hecht, 2020). It has been noted that Bean Creek, beginning about a mile downstream of Mackenzie Creek, typically goes dry in the summer and has done so since the 1960s, although the extents vary between years (Kennedy/Jenks Consultants, 2015b; personal communication with John Ricker, March 2020). Balance Hydrologics conducted a stream walk along the dry reach to document the conditions and extent during October 2019 and July 2020 (Neill and Hecht, 2020, Neill et al., 2021). The greatest increases in flows were observed downstream of the confluence of Ruins Creek with Bean Creek. This reach, in particular, is the primary gaining reach within the Basin and is characterized by areas where the stream has cut through the Santa Margarita sandstone and into the top of underlying Monterey shale, such that springs in the streambed and along the sides of the stream are contributing groundwater discharge (Figure 2-72). Balance Hydrologics conducted a stream walk along the lower Bean Creek reach in September of 2020 to document the numerous seeps and springs contributing groundwater from the Santa Margarita aquifer (Neill et al., 2021). Similar observations of seeps and springs contributing groundwater along streams within the Basin have been documented along the San Lorenzo River, Zayante Creek, and Eagle Creek (Parke and Hecht, 2020a; Parke and Hecht, 2020b).

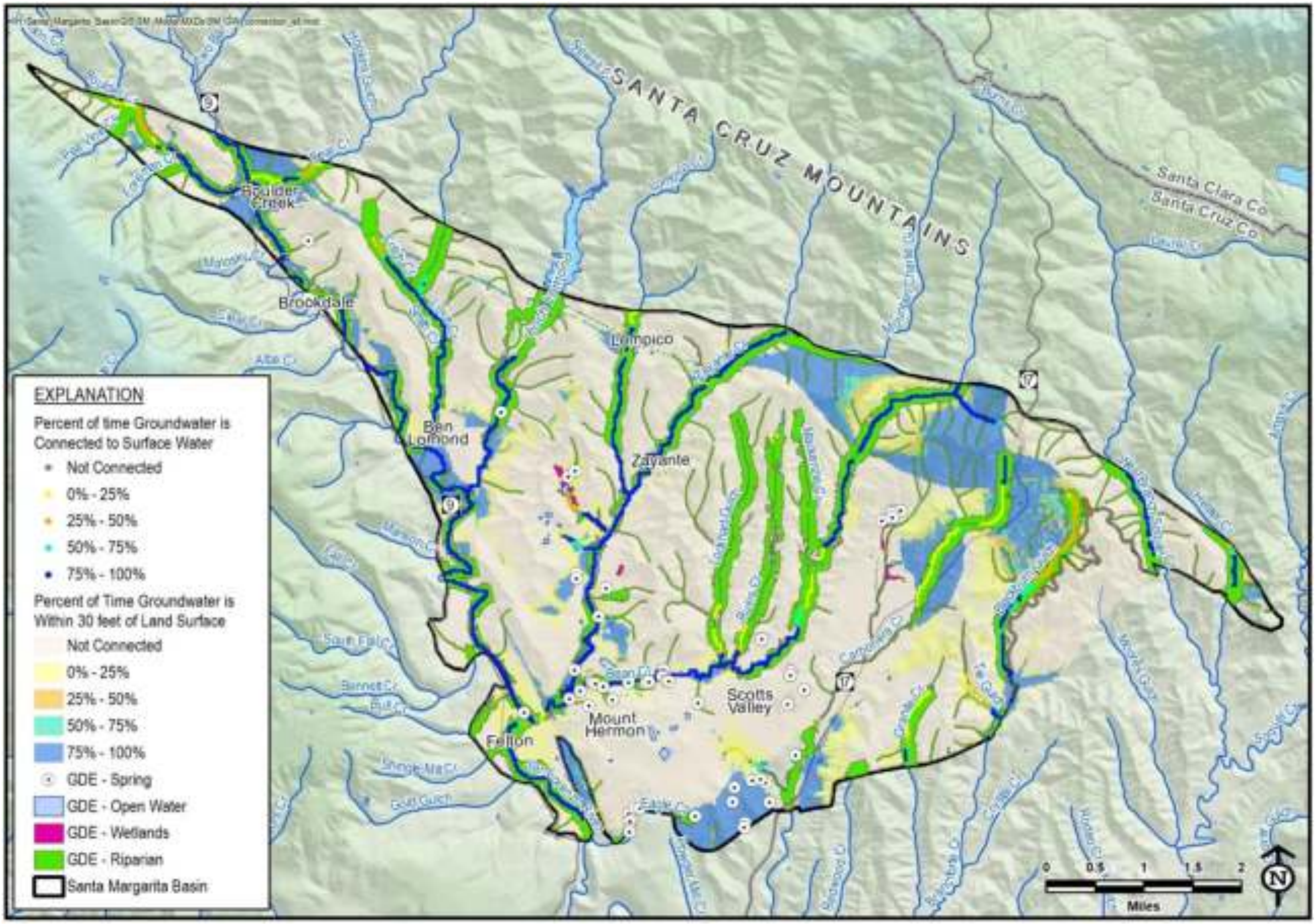

Figure 2-72. Interconnected Surface Water in the Santa Margarita Basin

In addition to accretion studies and field observations, a comparison of groundwater elevations in monitoring wells to nearby streambed elevations shows static groundwater levels consistently higher than the streambed, indicating that groundwater is contributing to streamflow in these locations year-round. For example, Figures 3-8 and 3-9 in Section 3.7.2 compare elevations in monitoring well SLVWD Quail MW-A with nearby streambed elevations in Zayante Creek and in monitoring well SV4-MW with nearby streambed elevations in Bean Creek, respectively.

Findings from these studies and observations are combined with model-simulated groundwater elevations in relation to creeks and land surface to produce a map of where surface water and groundwater are connected (Figure 2-72). The map includes creek connections together with non-riparian areas where depth to groundwater is on average less than 30 feet. A depth of 30 feet is selected because it is generally accepted as being the maximum rooting depth for most plants mapped in the Natural Communities Commonly Associated with Groundwater Dataset are supported by groundwater (TNC, 2019).

Up to 6 shallow monitoring wells will be constructed in 2022 to improve understanding of the interaction of groundwater and surface water in areas lacking groundwater level data. These additional monitoring wells are described in more detail in Section 3.3.4. The reach of Mackenzie Creek that seasonally dries up is 1 of the locations where a new monitoring well and subsurface flow gauge are to be installed.

2.2.6 Water Budget

A water budget is an accounting of the total annual volume of precipitation, surface water, and groundwater entering and leaving the Basin. This section provides an assessment of the historical, current, and projected Santa Margarita Basin water budgets in accordance with the GSP Regulations §354.18 and the Water Budget BMP (DWR, 2016a). Per the GSP Regulations, water budgets are presented in both graphical and tabular formats. Water budgets are developed using groundwater model inputs and outputs described in the Groundwater Model Appendix (Appendix 2D).

2.2.6.1 Water Budget Development

Water budgets are developed for the area and depth bounded by the lateral and vertical boundaries of the Basin. The lateral boundaries are the Basin boundaries described in Section 2.2.2. The water budgets were bounded vertically by the deepest principal aquifer, which in most places is the Butano aquifer. The lateral and vertical boundaries of the aquifers in the groundwater model are discussed in more detail in Appendix 2D: Section 5.2.1.

The water budgets are developed from an inventory of precipitation, surface water, and groundwater inflows (supplies) and outflows (demands) to and from the Basin. Some water budget components are measured, such as streamflow at a gauging station or municipal groundwater pumping from a metered well. Other components of the water budget are simulated by the model, such as recharge from precipitation and change in groundwater storage. The difference between groundwater inflows and outflows equals the change of groundwater in storage. The water budget inputs and outputs from the groundwater model are rounded to the nearest 100 for consistency across all summary tables and text. The larger values are not certain to this precision, but this approach helps summarize the data without introducing rounding errors into summation calculations such as total inflows, outflows, and change in storage.

The change over time in groundwater levels, groundwater and surface water interaction, and groundwater in storage derived from the water budgets will be used to assess Basin sustainability. Water movement in the Basin is driven by precipitation as surface runoff to creeks and groundwater recharge after accounting for evapotranspiration. Creeks flow into and out of the Basin, while interacting with groundwater. Water flows from creeks to groundwater and vice versa, depending on the gradient between creek stage and groundwater levels. Groundwater pumping removes groundwater from aquifers, though a small fraction of pumped water enters the groundwater system as return flows from septic systems, quarry usage, landscape irrigation, and sewer and water distribution system losses. Specific details on these components are described in the groundwater model report contained in in Appendix 2D: Section 5.1.4. Figure 2-73 presents a schematic hydrologic cycle that is included in the Water Budget BMP (DWR, 2016a). This is a generalized graphic and not all the components pictured apply to the Basin.

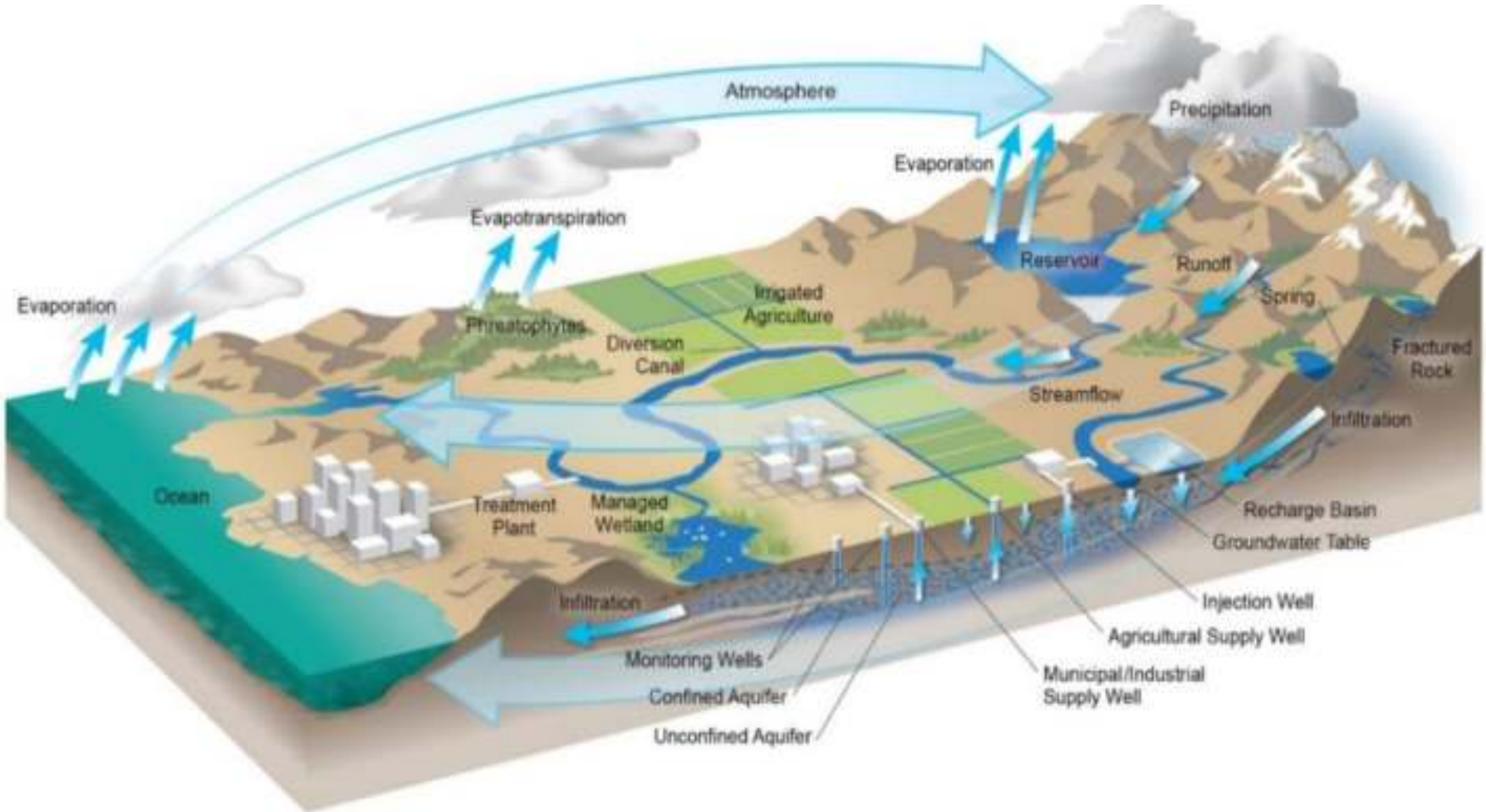

Figure 2-73. Generalized Hydrologic Cycle from Water Budget BMP (DWR, 2016a)

Although not required by GSP Regulations, the groundwater budgets of individual principal aquifers are analyzed to better understand and manage the various sources of groundwater in the Basin. The principal aquifers in the Basin are the Santa Margarita, Lompico, and Butano Sandstones. The Monterey Formation is not considered a principal aquifer but is included in the water budget because there are many private well owners that rely on it as their only source of water. The following describes the general characteristics of the aquifers relevant to water budgets:

- The Santa Margarita aquifer is the primary groundwater source for SLVWD and is also pumped by private well owners. It is the most significant aquifer in terms of groundwater's interactions with surface water.
- The Monterey Formation is primarily pumped to supply shallow private wells where more productive aquifers are not present at or near the surface. It is not currently pumped for municipal supply. Where it is present in the stratigraphic sequence, its low permeability retards recharge of the aquifers in the Lompico and Butano Sandstones below it. The Monterey Formation interacts with surface water where it outcrops in the streambed.
- The Lompico aquifer is pumped extensively for municipal supply in the Scotts Valley area where the formation is thickest. This aquifer has significantly less direct recharge from precipitation than the Santa Margarita aquifer as it outcrops over a much smaller area in the Basin. The area where the Monterey Formation is absent beneath the Santa Margarita aquifer is important for groundwater recharge of the Lompico aquifer in the south Scotts Valley area.
- The Butano aquifer is the deepest of the productive aquifers and is only pumped in northern Scotts Valley. It is recharged by surface water and precipitation where it outcrops along the northern margin of the Basin. In this area, private well owners also pump from it. SVWD pumps water from deep wells that are screened in both the Butano aquifer and the overlying Lompico aquifer.
- Other geologic formations having less of an impact on the water budget still contribute to overall inflows and outflows. The main formation not included in the water budget is the Quaternary alluvium, small deposits that occur widely throughout the Basin, but the most significant are deposits west of the Ben Lomond fault (Figure 2-18 and Figure 2-21).

Additional descriptions of hydrogeologic properties and extents of all aquifer units are provided in 2.2.4.4. The aquifer extents are shown in Appendix 2D: Figure 23 for the Santa Margarita aquifer, Monterey Formation, and Lompico aquifer and in Appendix 2D: Figure 24 for the Butano aquifer.

2.2.6.1.1 Precipitation Budget Components

The precipitation budget is an accounting of how much rain falls on the Basin, and where it is eventually allocated. A simplified schematic showing the precipitation budget components is provided on Figure 2-74. Precipitation budget components and associated data sources and uncertainties are described in the bullets below and in Table 2-21.

Precipitation Budget Inflow

- **Precipitation:** Rain that falls within the Basin.

Precipitation Budget Outflows

- **Evapotranspiration:** Water that evaporates from the land surface and soil or is transpired by plants.

- **Runoff:** Flow that traverses over the land surface into surface water bodies. Also referred to as overland flow.

- **Groundwater Recharge**: Water that percolates through the unsaturated zone and passes through the water table into the saturated zone, becoming groundwater.

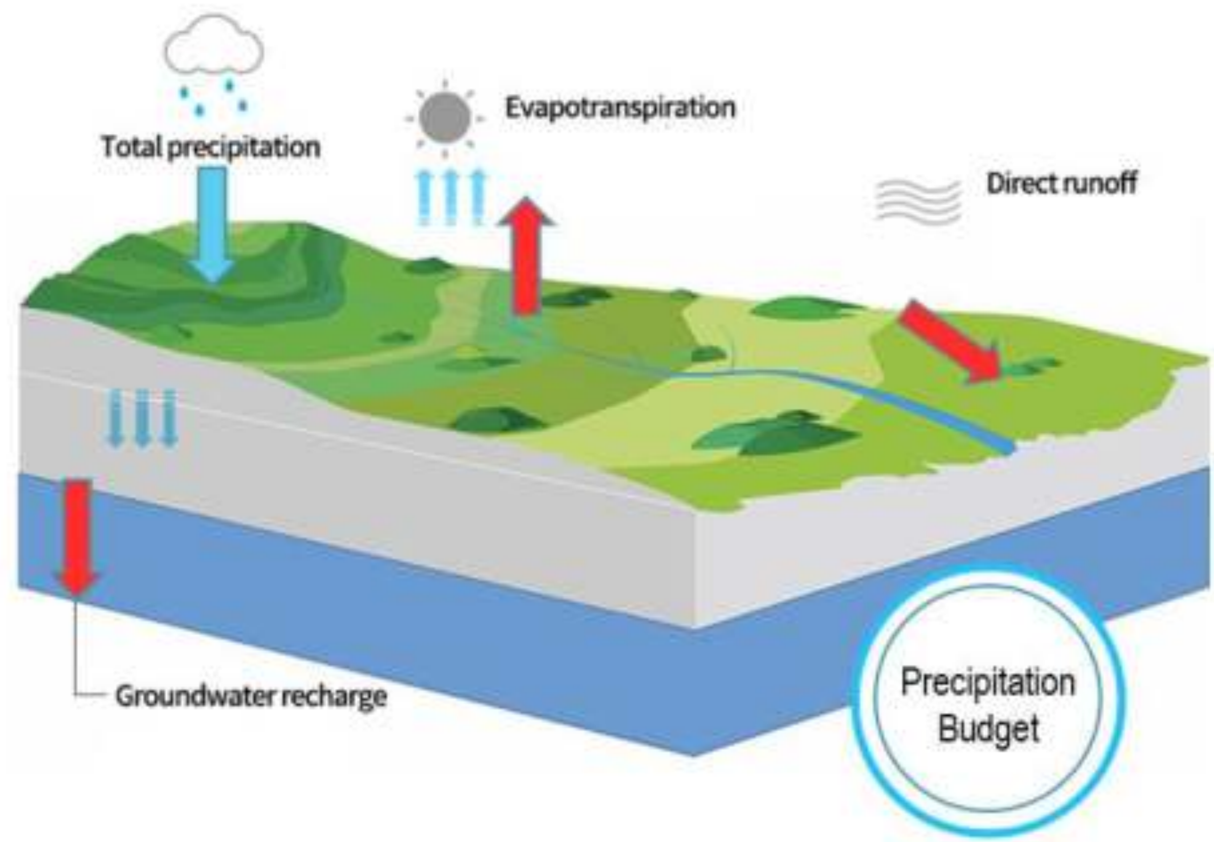

Figure 2-74. Precipitation Budget Components

Table 2-21. Precipitation Budget Components Data Sources and Uncertainty

Budget Component	Source of Model Input Data	Limitations
Inflows		
Precipitation	Monthly precipitation data from PRISM for historical model and Four-model Ensemble for future predictions (Figure 2-12).	Regional precipitation model used to develop model input may not account for local variability
Outflows		
Evapotranspiration	Calculated using the Blaney-Criddle (1962) method with adjusted factors from the Santa Cruz Water Balance Model. Temperature was sourced by PRISM for the historical and the Four-model Ensemble for future predictions. This is discussed in more detail in Appendix 2D: Section 5.1.3.	Regional temperature model used to calculate model input may not account for local variability in temperature
Direct Runoff	Calculated based on land use and geology which controls perviousness of land surface	Estimated, limited data for calibration.
Groundwater Recharge	Calculated from precipitation less evapotranspiration and runoff	Estimated, limited data for calibration.

2.2.6.1.2 Surface Water Budget Components

The surface water budget describes flows into and out of the Basin's surface water system. Evaluation of the surface water budget is important for understanding the groundwater-surface water connection, surface water use, and the responsiveness of the surface water system to historical climatic variation. A simplified schematic showing the surface water budget components is provided on Figure 2-75. Surface water budget components and associated data sources and uncertainties are described in the bullets below and in

Table 2-22.

Surface water diversions within the Basin are small relative to other components of the surface water budget. The only surface water diversion within the Basin is the rarely used City of Santa Cruz San Lorenzo River diversion at Felton that is used to divert to storage at Loch Lomond. SLVWD diversions are all outside of the Basin on upstream tributaries of the San Lorenzo River. The City of Santa Cruz primary surface water diversion occurs on the San Lorenzo River at Tait Street, which is in Santa Cruz and about 5 miles downstream of the Basin.

Despite not being included in the groundwater model simulations, surface water diversions outside of the Basin by SLVWD and the City of Santa Cruz are an important component of the regional water supply system. These diversions made outside of the Basin totaled about 2,300 AF in WY2018 (Table 2-17). In WY2018, SLVWD surface water diversions upstream of the Basin to the west totaled about 1,170 AF, which is about 2.2% of the surface water flow into the Basin that year. That same year, the City of Santa Cruz diverted about 1,230 AF at Tait Street and nothing at the Felton diversion, which is about 1.3% of the surface water budget flowing out of the Basin that year.

Surface Water Budget Inflows

- **Surface Water Inflow:** Streamflow that enters the Basin's surface water system from areas upstream of the Basin. Surface water inflow includes inflow on the San Lorenzo River, Newell Creek (downstream of Loch Lomond Reservoir situated on the northern Basin boundary), Bean Creek, and other smaller tributaries of the San Lorenzo River.
- **Direct Runoff**: Water that runs off the land surface into surface water bodies.
- **Groundwater Discharge to Creeks:** Groundwater that discharges into creeks, also known as gaining stream conditions. This is the component of groundwater-surface water interactions where surface water stage is lower than nearby groundwater levels, allowing groundwater to discharge to surface water.

Surface Water Budget Outflows

- **Surface Water Outflow:** Streamflow that leaves the Basin's surface water system to areas downstream of the Basin.
- **Streambed Recharge:** Water that percolates to groundwater from stream channels, also known as streambed seepage, or losing stream conditions. This is the component of groundwater-surface water interactions where surface water stage is higher than nearby groundwater levels, allowing surface water to recharge the groundwater system.

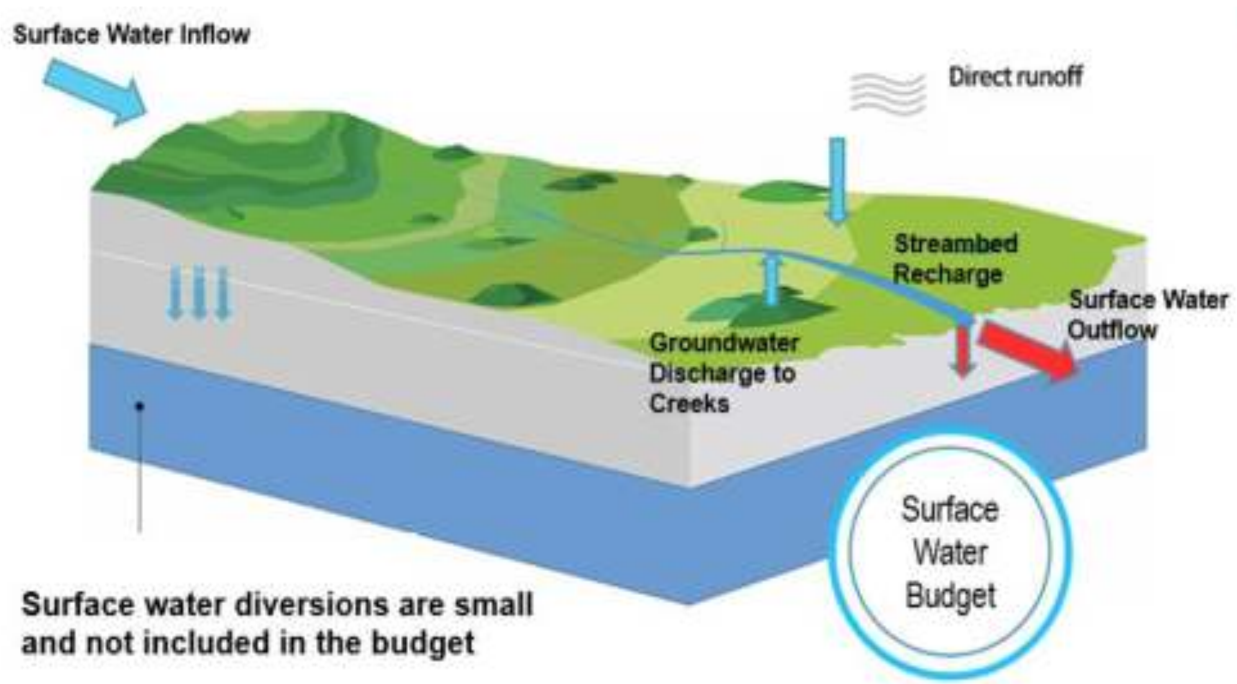

Figure 2-75. Surface Water Budget Components

Table 2-22. Surface Water Budget Components Data Sources and Uncertainty

Budget Component	Source of Model Input Data	Limitations
Inflows		
Surface Water Inflow	Calculated from runoff in areas upstream of the basin	Estimated, limited data for calibration
Direct Runoff	Calculated based on land use and geology which control perviousness of land surface	Estimated, limited data for calibration.
Groundwater Discharge to Creeks	Simulated by model using stream stage and groundwater head.	Calibrated parameter using limited historical stream accretion data; data are not available for every time period or every creek and tributary in the Basin
Outflows		
Surface Water Outflow	Simulated by model.	Calibrated parameter using available historical stream stage and discharge measurements; however, data are not available for every creek and tributary in the Basin.
Streambed Recharge	Simulated by model using stream stage and groundwater head.	Calibrated parameter using limited historical stream accretion data; data are not available for every time period or every creek and tributary in the Basin

2.2.6.1.3 Groundwater Budget Components

The groundwater budget describes flows into and out of the Basin's groundwater system. Evaluation of the groundwater budget is important for understanding trends in climate, groundwater use, and groundwater-surface water interaction. A simplified schematic showing the groundwater budget components is provided on

Figure 2-76. Groundwater budget components and associated data sources and uncertainty are described in the bullets below and in Table 2-23. Change in storage is calculated from model inputs and outputs for all surface water and groundwater budget components. However, change in storage is discussed in the groundwater budget subsections as the majority of storage changes in the Basin occur in groundwater.

Groundwater Budget Inflows

- **Groundwater Recharge:** Water that infiltrates the land surface, percolates through the unsaturated zone, passes through the water table into the saturated zone, thereby becoming groundwater. The term "precipitation recharge" is used interchangeably with groundwater recharge in the water budget section of this GSP.
- **Subsurface Inflow**: Subsurface flow that enters the Basin's aquifers from neighboring areas.

- **Streambed Recharge**: Water that percolates to groundwater from stream channels, also known as streambed seepage, or losing stream conditions. This is the component of groundwater-surface water interactions where surface water stage is higher than nearby groundwater levels, allowing surface water to recharge the groundwater system.
- **Septic Return Flows**: Water originating in domestic septic systems that percolates to groundwater.
- **System Losses:** Water originating from leakage in sewer and water distribution systems that percolates to groundwater.
- **Quarry Return Flows**: Water that originates from usage at quarry sites that percolates to groundwater.
- **Irrigation Return Flows**: Water originating from the inefficient portion of landscape irrigation that percolates to groundwater.

Groundwater Budget Outflows

- **Subsurface Outflow:** Subsurface groundwater that flows out of the Basin's aquifers into adjacent basins or areas.
- **Groundwater Pumping:** Groundwater extracted by wells for municipal, agricultural, domestic, and industrial uses.
- **Discharge to Creeks:** Flow that discharges from groundwater into stream channels, also known as gaining stream conditions. This is the component of groundwater-surface water interactions where surface water stage is lower than nearby groundwater levels, allowing groundwater to discharge to surface water.

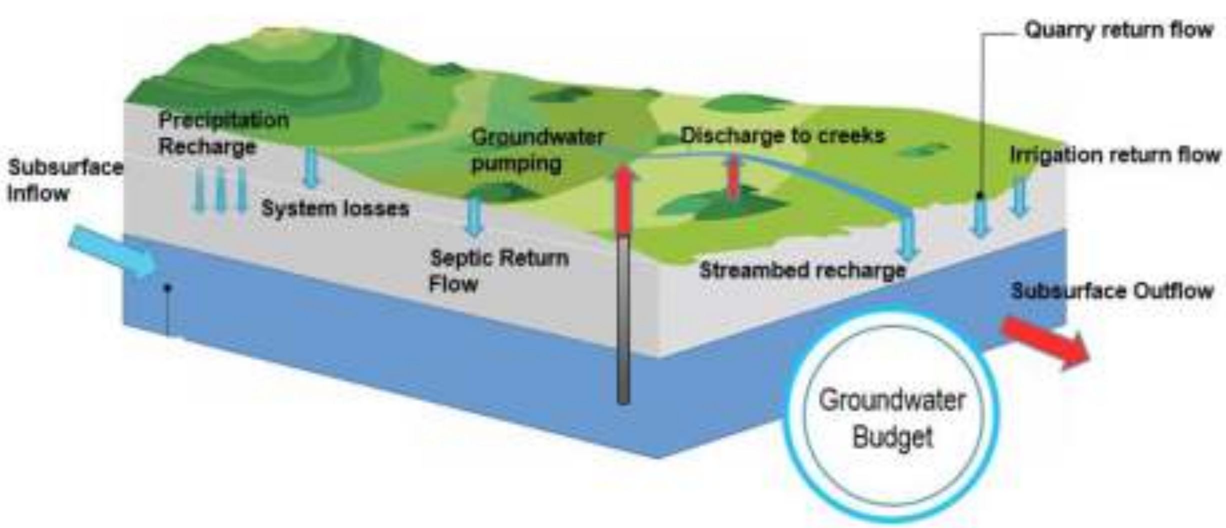

Figure 2-76. Groundwater Budget Components

Table 2-23. Groundwater Budget Components Data Sources and Uncertainty

Budget Component	Source of Model Input Data	Limitations
Inflows		
Precipitation (Groundwater) Recharge	Calculated from precipitation less evapotranspiration and runoff depending on land use and geology	Estimated, limited data for calibration.
Subsurface Inflow	Simulated by model.	Subject to uncertainty in simulated heads and aquifer hydraulic properties
Streambed Recharge	Simulated by model using stream stage and groundwater head.	Calibrated parameter using limited historical stream accretion data; data are not available for every time period or every creek and tributary in the Basin
System Losses	Estimated based on reported water demand or pumping and loss assumptions	Estimated, limited data for calibration.
Quarry Return Flows	Estimated based on reported pumping and loss assumptions	Estimated, limited data for calibration.
Irrigation Return Flows	Estimated based on assumed outdoor portion of reported water use for municipal users, and estimated for private domestic users and loss assumptions	Estimated, limited data for calibration.
Outflows		
Subsurface Outflow	Simulated by model.	Estimated, limited data for calibration.
Groundwater Pumping	Reported by providers for public supply use. Estimated for private well owner domestic use using number of domestic parcels and local estimate of water use coefficients. Estimated for industrial, pond-filling, and landscape uses.	Unmetered data subject to estimation errors.
Discharge to Creeks	Simulated by model using stream stage and groundwater head.	Calibrated parameter using limited historical stream accretion data; data are not available for every time period or every creek and tributary in the Basin

2.2.6.2 Historical Water Budget

Per GSP Regulations (§ 354.18), the historical water budget is developed to show past water supplies and demands. The historical water budget time frame for this GSP starts in WY1985 and ends in WY2018. This period encompasses multiple droughts and wet periods to represent historical variation in water budget components. The model period starts in 1985 because groundwater pumping and groundwater level data are only available for the majority of the Basin from 1985 on.

2.2.6.2.1 Historical Precipitation Budget

The historical precipitation budget provides an accounting of how much precipitation fell in the Basin and how much of it was lost to evapotranspiration, became surface water, or recharged groundwater. The historical precipitation budget is summarized in Table 2-24 and presented in a time series chart on Figure 2-77.

Table 2-24. Summary of Historical Precipitation Budget

Water Budget Components Average Total for Historical Water Budget (AF)		Historical Water Budget 1985-2018 Annual Average (AF)	Historical Water Budget 1985-2018 Percent of Total Inflow or Outflow	Annual Average by Water Year Type (AF) Critically Dry	Dry	Normal	Wet
Inflows (82,400)*	**Precipitation**	82,400	100%	49,400	65,600	83,400	122,000
Outflows (82,500)*	**Evapotranspiration**	38,000	46%	25,500	32,700	37,000	53,400
	Direct Runoff	30,800	37%	16,600	23,000	31,800	47,700
	Groundwater Recharge	13,700	17%	7,300	9,900	14,600	20,900

*Small discrepancies between total inflow and outflow may occur due to rounding.

On average, about 82,400 AFY of precipitation falls within the Basin boundaries, with critically dry years averaging about 49,400 AF and wet years averaging about 122,000 AF. On average, about 46% of precipitation is evaporated or transpired by plants, 37% runs off the land surface into creeks, and 17% percolates through the soil vadose zone and recharges groundwater.

Total outflow in the precipitation budget to evaporation, groundwater, and surface water is dependent on climate and land use/cover. As expected, evapotranspiration, runoff, and groundwater recharge are greater during dry years than wet years. In general, runoff and recharge are more responsive to climate variation than evapotranspiration because vegetation cover is relatively constant, dry soil in dry years absorbs soil moisture, and saturated soil moisture in wet years promotes runoff and infiltration. During critically dry years, a greater percentage of precipitation (about 52%) is lost from the system due to evapotranspiration than in wet years when only about 44% of precipitation is lost to evapotranspiration. As a result, a smaller percentage of precipitation enters the surface water and groundwater systems during critically dry years, and a greater percentage of precipitation enters the surface water and groundwater systems in wet years.

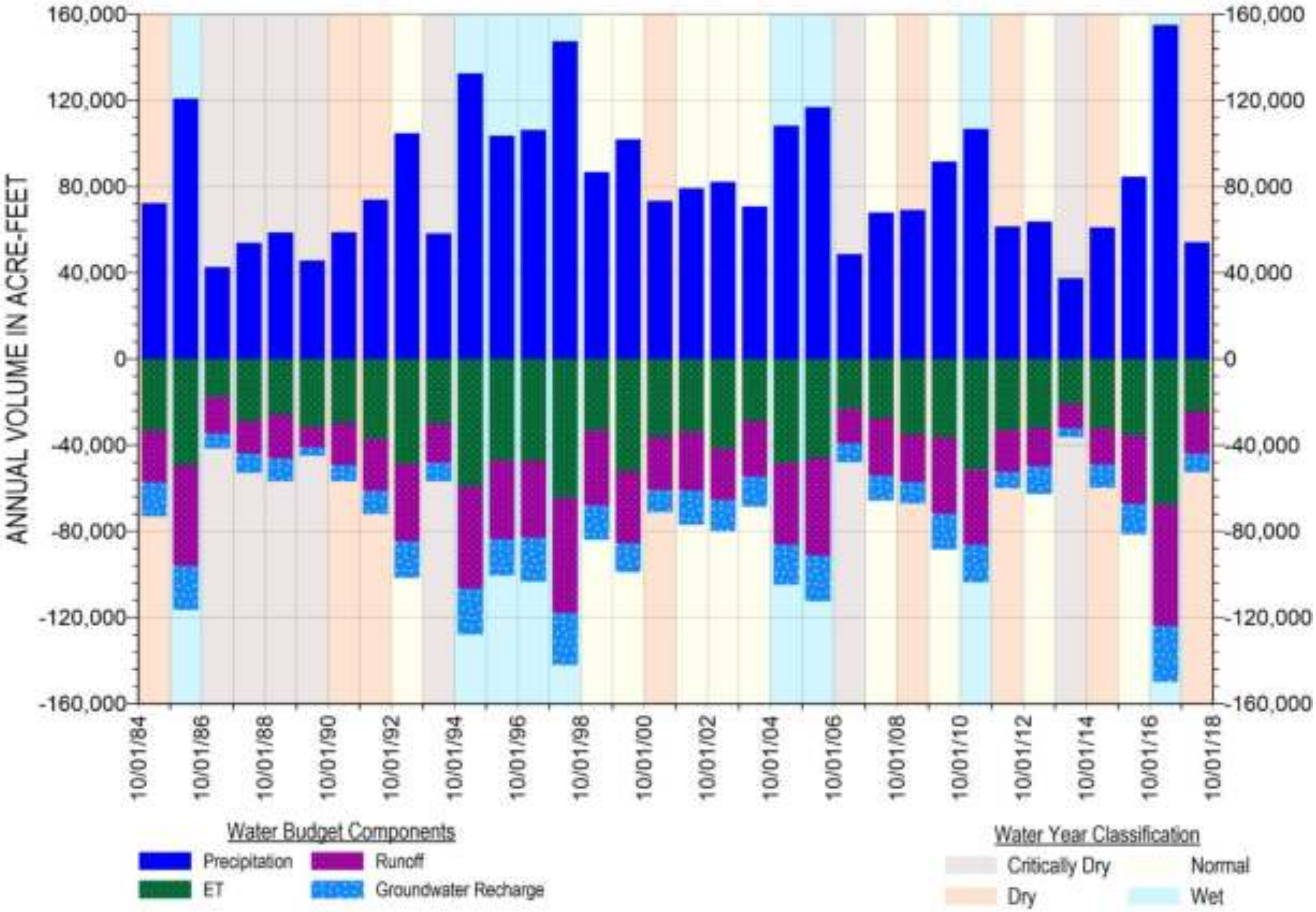

Figure 2-77. Historical Precipitation Budget

2.2.6.2.2 Historical Surface Water Budget

The historical surface water budget provides information on historical surface water and groundwater interactions, and how much surface water has flowed through the Basin. The historical surface water budget is summarized in Table 2-25, and is presented in a time series chart on Figure 2-78.

Table 2-25. Summary of Historical Surface Water Budget

Water Budget Components		Historical Water Budget 1985-2018		Annual Average by Water Year Type (AF)			
Average Total for Historical Water Budget (AF)		Annual Average (AF)	Percent of Total Inflow or Outflow	Critically Dry	Dry	Normal	Wet
Inflows (120,300)	**Surface Water Inflow**	70,800	59%	37,900	54,100	72,500	109,500
	Runoff	28,300	23%	15,200	21,100	29,200	43,800
	Groundwater Discharge to Creeks	21,200	18%	18,000	19,400	21,500	25,100
Outflows (120,300)	**Surface Water Outflow**	111,700	93%	63,800	86,600	114,400	168,400
	Streambed Recharge	8,600	7%	7,400	8,200	8,800	9,800

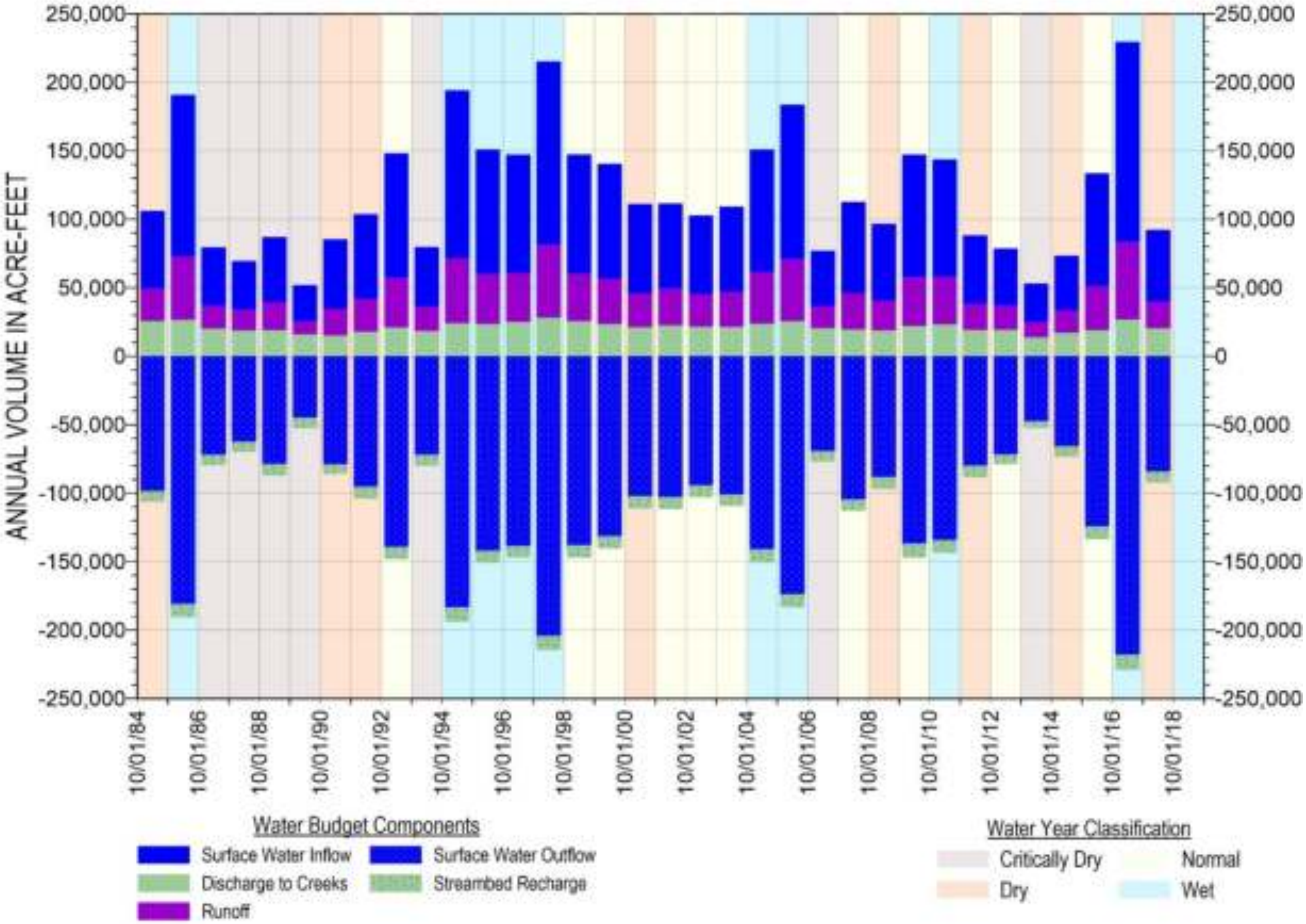

Figure 2-78. Historical Surface Water Budget

Average historical surface water inflow in the Basin is about 120,300 AFY. Water year type strongly influences the surface water inflows, averaging about 71,100 AF in critically dry years and 178,400 AF in wet years. Surface water inflows are mostly from the San Lorenzo River, Newell Creek, Bean Creek, and a few other smaller streams and tributaries originating outside of the Basin. Creeks originating outside the Basin make up 59% of the surface water inflow to the Basin during an average year. Runoff from precipitation to surface water comprises 23% of total precipitation during an average year. Groundwater discharge to creeks makes the smallest contribution to surface water budget inflow, with an average of only 18% of the total inflow.

Outflow from the surface water system is approximately balanced with inflow over time across all water year types. Like inflow, surface water outflow is strongly correlated with water year type. Nearly all (93%) of surface water flows out of the Basin, mostly in the San Lorenzo River and Carbonera Creek. Recharge of aquifers underlying the surface water system accounts for only 7% of surface water outflow from the system.

Although groundwater discharge to creeks and streambed recharge to groundwater make up the smallest percentages of the surface water inflow and outflow budgets, surface water and groundwater interaction is important for maintaining volumes of surface water baseflows in the summer and fall months and for providing some groundwater recharge. Although there are months where there are losing reaches, creeks in the Basin consistently have a net annual gain from groundwater contributions regardless of water year type. Overall, there is about 2.5 times more groundwater discharge to creeks than creek recharge of groundwater. This results in widespread gaining stream conditions and contributes to greater surface water outflow than inflow. Annual precipitation and lowered groundwater levels influence groundwater and surface water interactions. Groundwater discharge to creeks during average wet years is about 7,100 AF more than in average critically dry years. Similarly, streambed groundwater recharge is about 2,400 AF more in average wet years than critically dry years. The impact of surface water interaction and precipitation on groundwater is discussed further in Section 2.2.6.2.3 and 2.2.6.2.4.

2.2.6.2.3 Historical Groundwater Budget

The historical groundwater budget provides information on how groundwater is replenished and used. Groundwater pumping, groundwater and surface water interaction, and changes of groundwater in storage are particularly relevant to groundwater management. The historical groundwater budget is summarized in Table 2-26 and presented in a time series chart on Figure 2-79.

Table 2-26. Historical Groundwater Budget

Water Budget Components Average Total for Historical Water Budget (AF)		Historical Water Budget 1985-2018		Annual Average by Water Year Type (AF)			
		Annual Average (AF)	Percent of Total Inflow or Outflow	Critically Dry	Dry	Normal	Wet
Inflows (24,000)*	Precipitation Recharge	13,700	57%	7,300	10,200	14,600	20,700
	Subsurface Inflow	100	1%	100	100	100	100
	System Losses	200	1%	200	200	200	200
	Septic Return Flow	1,100	5%	1,100	1,100	1,100	1,200
	Quarry Return Flow	200	1%	300	200	200	200
	Streambed Recharge	8,700	36%	7,400	8,300	8,900	9,900
	Irrigation Return Flow	<100	<1%	<100	<100	100	<100
Outflows (25,200)*	Groundwater Pumping	3,700	15%	3,800	3,500	3,900	3,700
	Subsurface Outflow	100	<1%	100	100	100	100
	Discharge to Creeks	21,400	85%	18,200	19,600	21,600	25,300
Storage*	Average Annual Change in Storage	-1,100	--	-5,600	-3,000	-500	3,200
	Cumulative Change in Storage	-39,300	--	--	--	--	--

*Small discrepancies between total inflow and outflow may occur due to rounding.

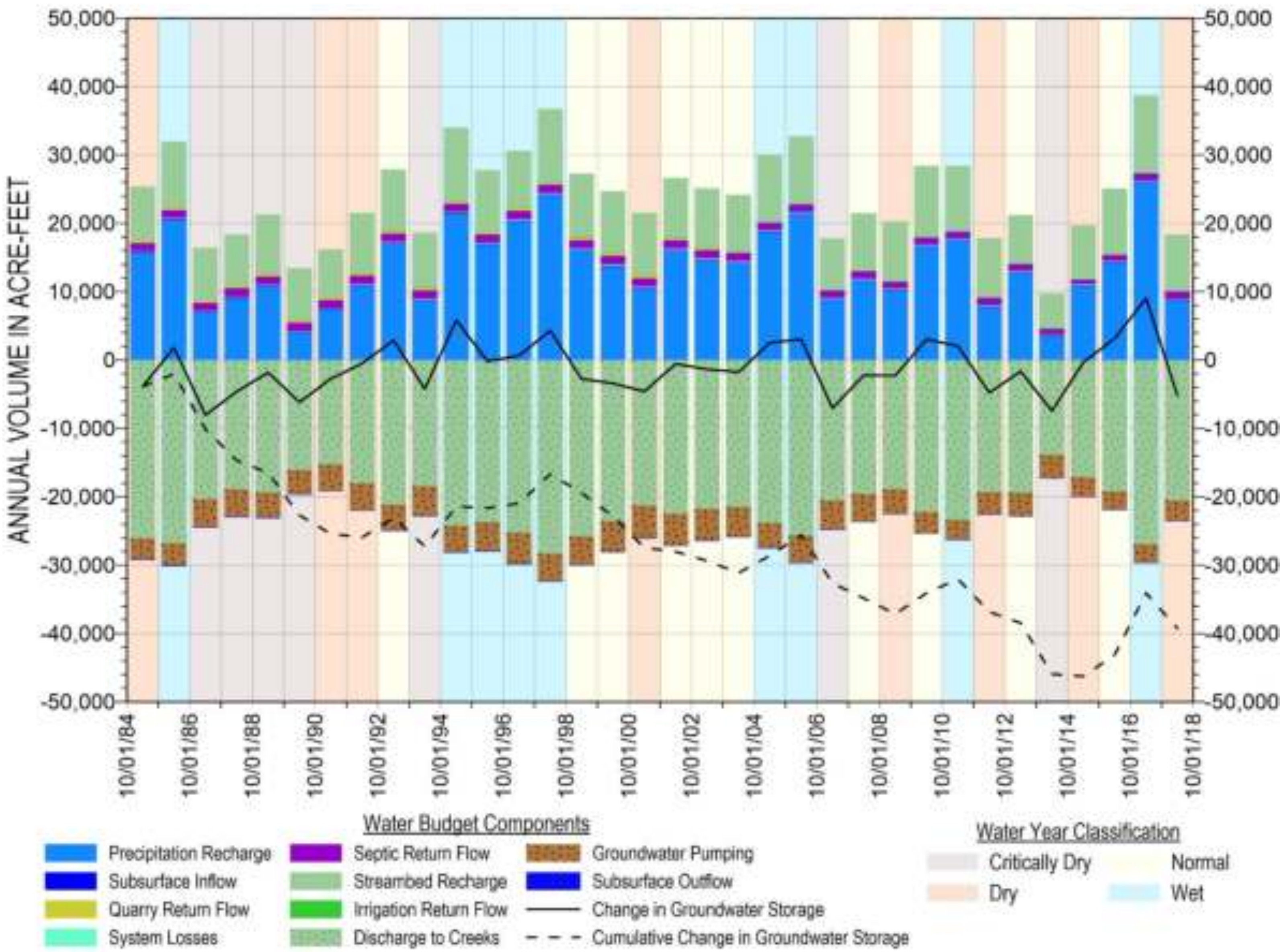

Figure 2-79. Historical Groundwater Budget

Groundwater inflow totals about 24,000 AFY on average and range from about 16,400 AF in average critically dry years to 32,300 AF in average wet years. Inflow to the groundwater system is dominated by precipitation and streambed recharge, which on average comprise 57% and 36% of total groundwater inflow, respectively. These 2 inflow components vary with climate, with significantly larger recharge volumes from both precipitation and creeks occurring during wet periods. Groundwater recharge from precipitation and streams combined ranges from about 14,700 AF in average critically dry years to 30,600 AF in average wet years.

Recharge to groundwater from septic systems, quarries, landscape irrigation, and other system losses make up only 7% of total annual inflow to groundwater. Groundwater return flows do not vary substantially with water year type but are correlated to population growth because more than half of the return flows are from septic systems. Septic return flows increased with population growth during the 1980s and early 1990s but decreased since the 2000s. due to expansion of wastewater treatment systems, and replacement of older septic systems with systems that have less discharge in part to mitigate increasing nitrate concentrations due to septic impacts.

The Basin is hydrogeologically isolated by the bounding faults and relatively impermeable basement rock beneath the Basin; therefore, subsurface inflow and outflow constitute only a very small fraction of the total groundwater budget.

Total outflow from the Basin's groundwater system is approximately 25,200 AFY on average and ranges between 22,100 AF in average critically dry years to 29,100 AF in average wet years. Outflow is dominated by groundwater discharge to creeks and groundwater pumping, which comprise roughly 85% and 15% of total groundwater outflow, respectively.

As discussed in the historical surface water budget section, groundwater discharge to creeks is controlled by climate. Average groundwater discharge to creeks in critically dry years was 18,200 AF and average discharge in wet years was 25,300 AF. In contrast to predominantly agricultural groundwater basins in the state, groundwater pumping in the Basin does not increase greatly in dry years as groundwater is mainly for municipal and private domestic purposes, which have more consistent year-round demands than agriculture. Municipal pumping in the Basin reached a high during a period of relatively rapid population growth in the 1980s and 1990s. Groundwater management adjustments particularly from around 2010 on have reduced total groundwater pumping. More details on changes in groundwater pumping and its impact on groundwater levels are provided in Section 2.2.5.1: Groundwater Elevations.

Given that the Basin is a relatively closed groundwater system, groundwater discharge to creeks comprises a major component of groundwater outflow, and the Basin's creeks are dependent on groundwater discharge to maintain baseflows in the summer and early fall months. As discussed in the surface water budget section, creeks consistently gain more water from groundwater than they lose to groundwater from streambed recharge, regardless of climate or anthropogenic factors.

The historical groundwater budget is indicative of a Basin not operating within its sustainable groundwater yield. Overall, historical groundwater outflow has been greater than inflow, resulting in a cumulative net decrease in groundwater in storage, which translates to falling groundwater levels. Between 1985 and 2018 the Basin cumulatively lost about 39,300 AF of groundwater in storage, or on average 1,100 AFY. While cumulative change in storage historically recovered during extended wet periods (notably WY1995 to WY1998 and WY2016 to WY2018), dry and normal years have historically resulted in large decreases in storage (notably WY1987 to WY1992 and the recent drought from WY2012 to WY2015). Improvements in groundwater supply management from 2010 onward appear to have slowed the decline in groundwater storage.

2.2.6.2.4 Historical Groundwater Budget by Aquifer

The historical groundwater budget was analyzed by aquifer to demonstrate how groundwater was used and recharged in the various formations. The historical groundwater budget by aquifer is summarized in Table 2-27 and in more detailed tables in Appendix 2E.

In general, groundwater inflows are mostly into the Santa Margarita and Butano aquifers as they are conductive sandstones with large outcrop areas in the Basin. They are recharged by direct percolation of precipitation and streambed recharge. The Quaternary alluvium also receives substantial streambed recharge where it is thickest along the Basin’s southern boundary, west of the Ben Lomond Fault near Felton. The alluvium is generally shallow across most of the Basin, but it is highly permeable and located in an area with relatively high streamflow where the San Lorenzo River flows out of the Basin.

In contrast to the other primary aquifers, the Lompico aquifer is recharged primarily from flow from overlying aquifers as it has limited surface outcrop in the Basin. It is readily recharged where Santa Margarita Sandstone directly overlies Lompico Formation in the Pasatiempo and Camp Evers areas. Elsewhere in the Basin, however, the presence of intervening Monterey Formation, an aquitard, limits the recharge of the Lompico aquifer.

Table 2-27. Summary of Historical Groundwater Budget by Aquifer

Groundwater Budget Components		Historical Water Budget: 1985- 2018 Annual Average (AF)				
		Santa Margarita Aquifer	Monterey Formation	Lompico Aquifer	Butano Aquifer	Other Formations
Inflows	**Precipitation Recharge**	6,500	1,500	1000	4,100	700
	Subsurface Inflow	0	0	0	100	<100
	Return Flows	800	200	200	200	200
	Streambed Recharge	1,700	800	400	3,400	2,500
	Flow from Other Aquifers	<100	300	1,900	700	Not calculated
	Total Inflow*	***9,000***	***2,800***	***3,700***	***8,500***	***3,400***
Outflows	**Groundwater Pumping**	1,100	300	1,800	500	<100
	Subsurface Outflow	0	0	0	100	<100
	Discharge to Creeks	6,800	2,300	1,500	7,400	3,400
	Flow to Other Aquifers	1,300	400	700	700	Not calculated
	Total Outflow*	***9,200***	***3,000***	***4,000***	***8,700***	***3,400***
Storage	**Average Annual Change in Storage***	-100	-100	-600	-200	-100
	Cumulative Change in Storage*	-3,600	-4,000	-20,400	-7,700	-3,600

*Small discrepancies between total inflow and outflow may occur due to rounding

Like the basin-wide groundwater inflow budget, groundwater outflow by aquifer is dominated by groundwater discharge to creeks, primarily from the Santa Margarita and Butano aquifers. There is also substantial flow between aquifers, with most of the flow being from the Santa Margarita aquifer to the deeper aquifers. The Lompico aquifer has smaller inflows than other aquifers, yet it supports almost half of the groundwater pumping in the Basin; the result is that about half the decline in storage in the Basin is in the Lompico aquifer.

2.2.6.2.5 Historical Groundwater Change in Storage by Subarea

To evaluate historical changes of groundwater in storage in different areas of the Basin and identify specific areas and aquifers that require projects and management actions, the Basin is divided into subareas as depicted on Figure 2-37 and Figure 2-38. The subareas do not represent management areas and are only used in this GSP to describe aquifer conditions for different parts of the Basin.

Santa Margarita aquifer subareas are 1) Quail Hollow, 2) Olympia/Mission Springs, 3) Mount Hermon/South Scotts Valley, and 4) North Scotts Valley (Figure 2-37). These subareas are described in Section 2.2.5.1.2.2: Santa Margarita Aquifer Groundwater Elevation Contours and Flow Directions. Unlike the Santa Margarita aquifer, the Basin's confined aquifers are more continuous throughout the Basin. The Monterey Formation and Lompico and Butano aquifers share the same subareas: 1) North of Bean Creek, 2) Mount Hermon/South Scotts Valley, and 3) North Scotts Valley (Figure 2-38).

Plots of change in aquifer storage by subarea on Figure 2-80 through Figure 2-83 show that the largest loss of groundwater storage in the Lompico aquifer in the Mount Hermon/South Scotts Valley subarea. The Monterey Formation and Butano aquifers in the Mount Hermon/South Scotts Valley subarea also have storage losses, but they are an order of magnitude smaller than in the Lompico aquifer. Depletions of groundwater in storage in this subarea correspond to lowered groundwater levels measured in wells screened in the Monterey Formation and Lompico aquifer as described in Sections 2.2.5.1.3 and 2.2.5.1.4. The Butano aquifer has storage losses in subareas where it outcrops along the Basin's northern boundary in the North of Bean Creek and North Scotts Valley subareas. In comparison, the Lompico aquifer in those same subareas has smaller storage losses than the Butano aquifer. Storage losses in the Butano aquifer appear due to groundwater discharge to creeks since pumping is much smaller than creek discharges (Table 2-27). Conclusions concerning the Butano aquifer cannot be made with confidence because there are only 2 Butano aquifer specific monitoring wells in the Basin. The Butano aquifer is not as well-calibrated in the groundwater model as the shallower aquifers for which there are more data, as described in Section 2.2.4.11 on hydrogeologic conceptual model data gaps.

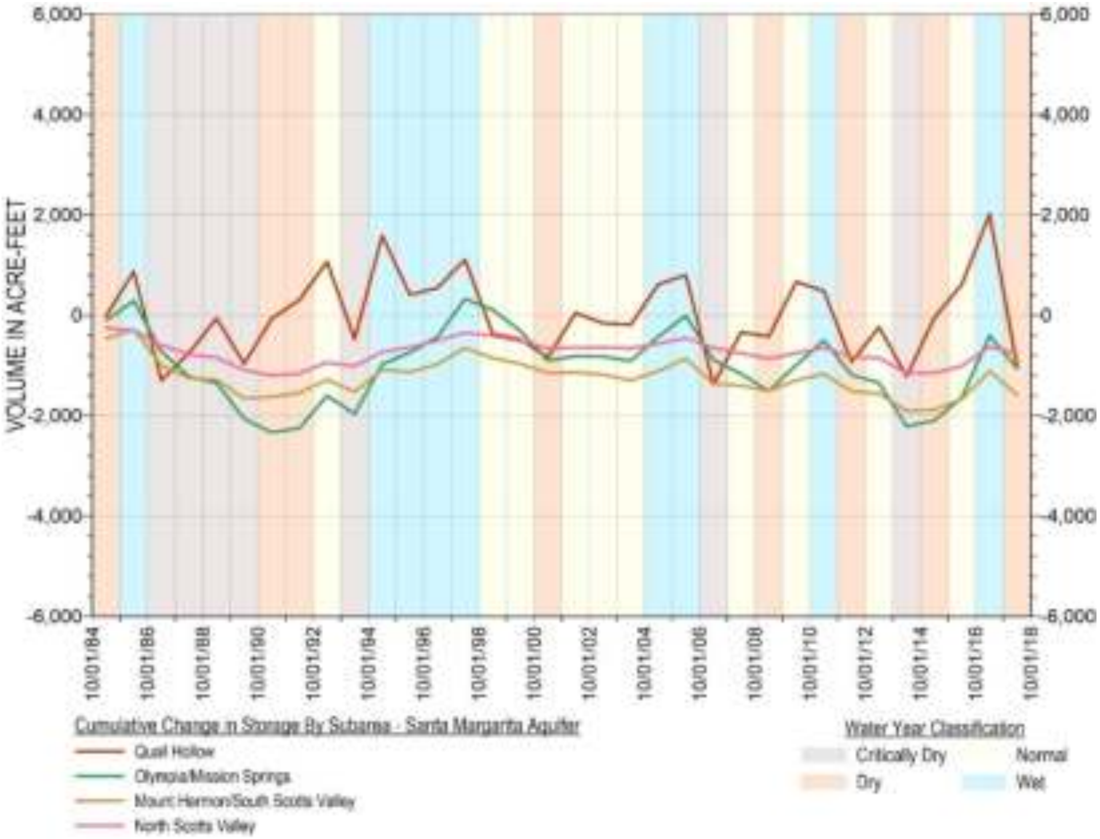

Figure 2-80. Historical Cumulative Change of Groundwater in Storage in the Santa Margarita Aquifer

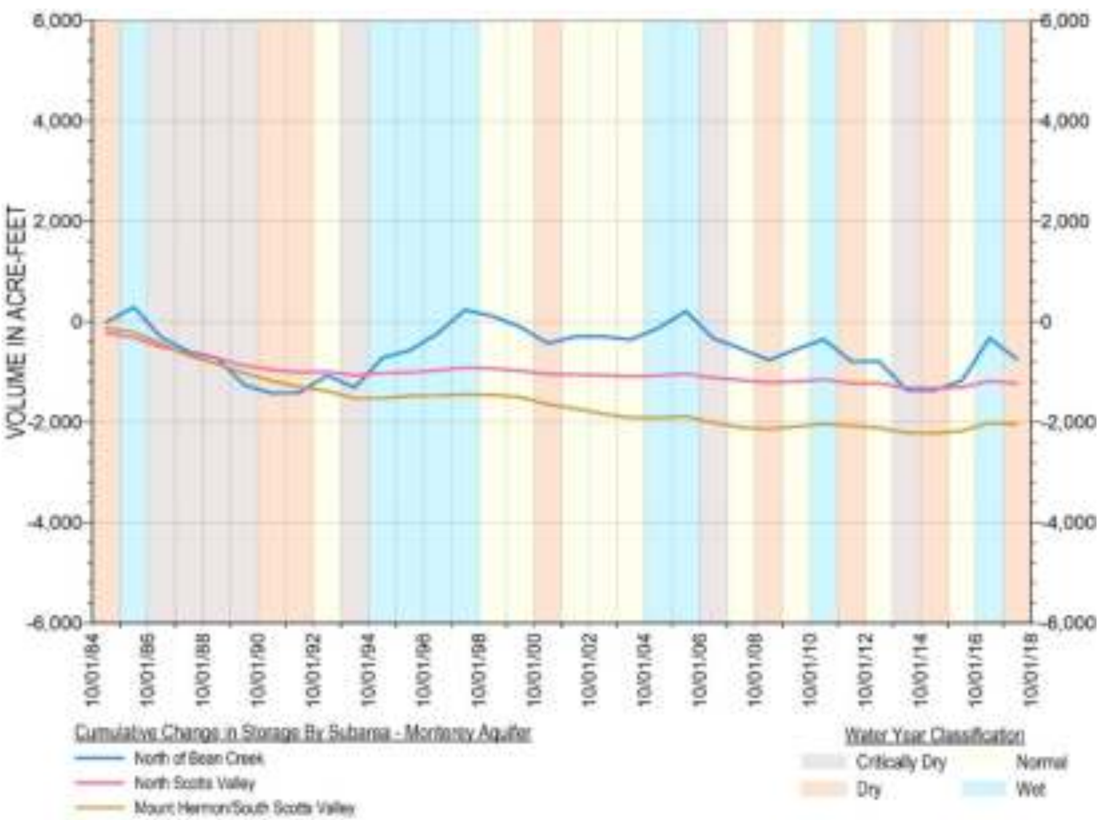

Figure 2-81. Historical Cumulative Change of Groundwater in Storage in the Monterey Formation

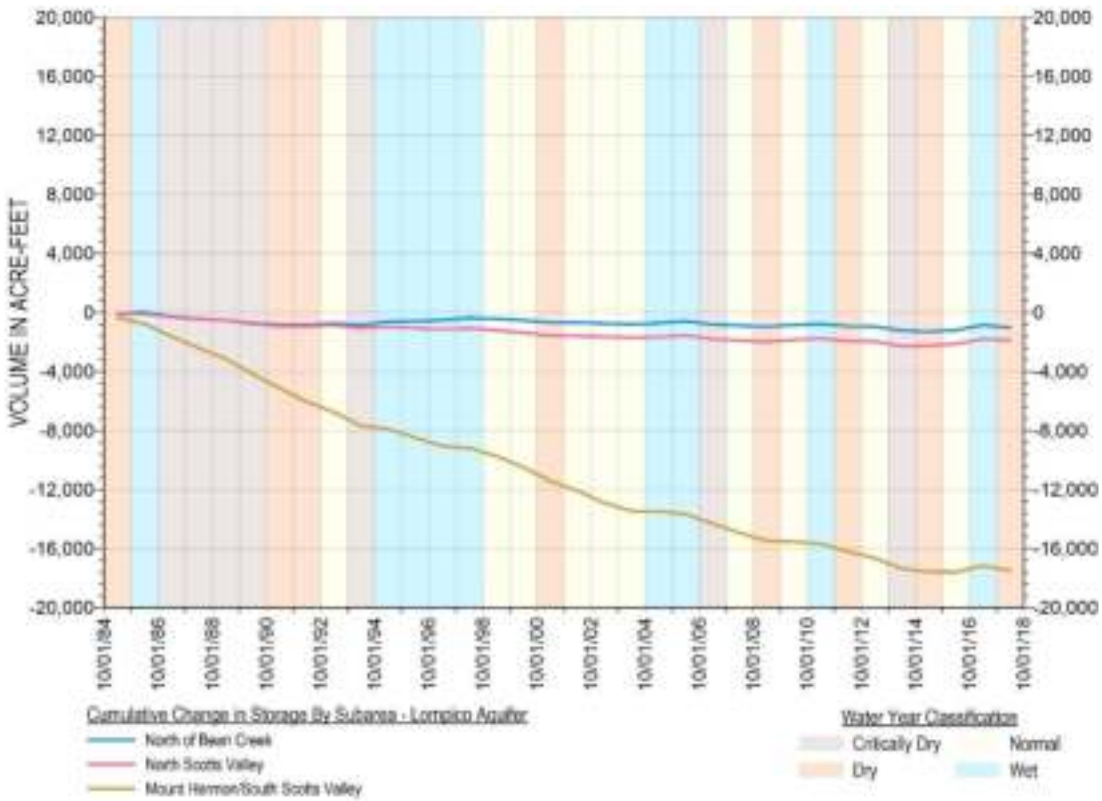

Figure 2-82. Historical Cumulative Change of Groundwater in Storage in the Lompico Aquifer

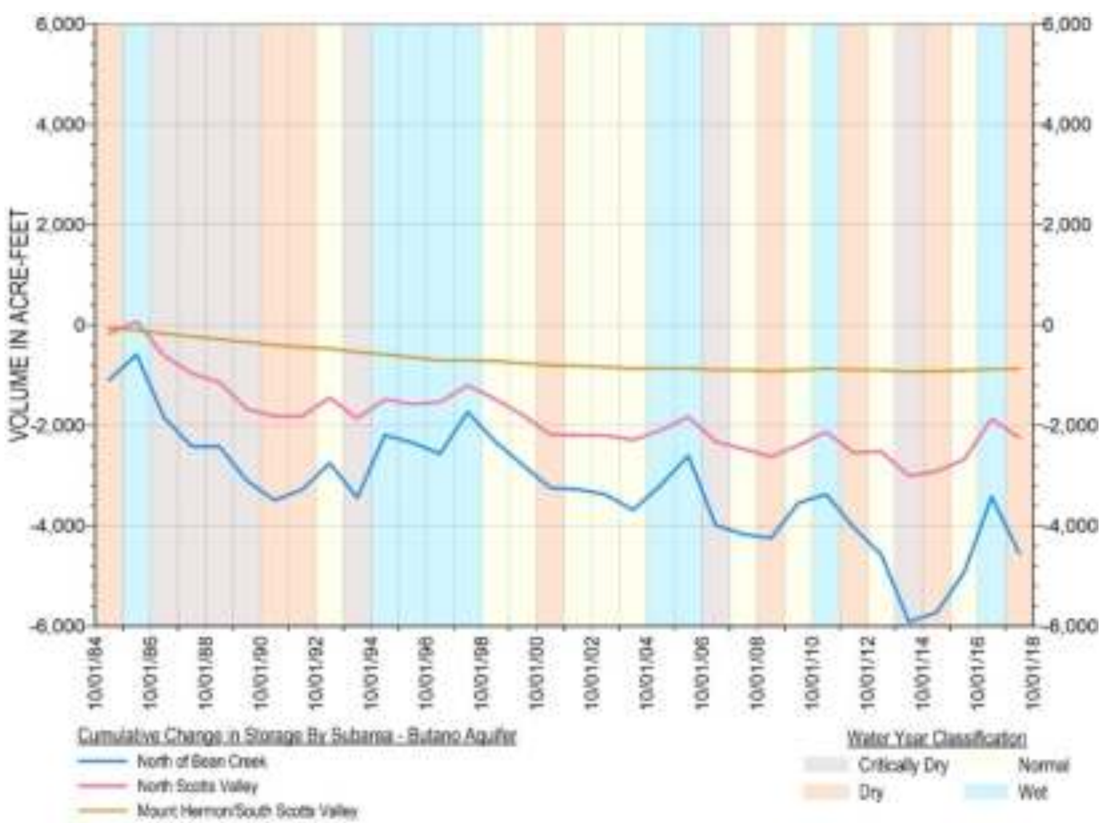

Figure 2-83. Historical Cumulative Change of Groundwater in Storage in the Butano Aquifer

2.2.6.3 Current Water Budget

Per GSP Regulations (§ 354.18), a current water budget is developed for the Basin based on the most recent land use, water use, and hydrologic conditions. The current water budget allows the SMGWA to assess the most recent water supply, demand, groundwater and surface water interaction, and aquifer conditions for implementing the GSP. What constitutes current conditions is not prescribed by DWR in the GSP Regulations. For this Basin's GSP, the current water budget period from WY2010 to WY2018 adopted is selected as it encompasses some extreme climatic conditions that are anticipated to become more typical in the future due to climate change: extended dry conditions from WY2012 to WY2015, normal conditions in WY2016, and historically wet conditions in WY2017. In addition, the current period starts in WY2010 to reflect reduced municipal water demands due to water use efficiency measures, and much reduced quarry and remediation extractions than in prior years.

2.2.6.3.1 Current Precipitation Budget

The current precipitation budget provides a recent record of precipitation inflow and outflow in the Basin. The current precipitation budget is summarized in Table 2-28 and presented as part of the time series chart on Figure 2-77.

Table 2-28. Summary of Current Precipitation Budget

Water Budget Components Average Total for Current Water Budget (AF)		Current Water Budget 2010-2018		Historical Water Budget 1985-2018	
		Annual Average (AF)	Percent of Total Inflow or Outflow	Annual Average (AF)	Percent of Total Inflow or Outflow
Inflows (79,600)*	**Precipitation**	79,600	100%	82,400	100%
Outflows (79,700)*	**Evapotranspiration**	37,100	47%	38,000	46%
	Direct Runoff	29,400	37%	30,800	37%
	Groundwater Recharge	13,200	16%	13,700	17%

*Small discrepancies between total inflow and outflow may occur due to rounding

Overall, total precipitation during the current period is slightly less than during the historical period and is more variable. On average, approximately 79,600 AFY of precipitation fell in the Basin during the current timeframe, which is about 2,500 AF less per year than the historical period. During the current period, average evapotranspiration, runoff, and groundwater recharge has similar modest overall reductions due to slightly lower precipitation and greater variability compared to the historical period. As with the historical period, evapotranspiration during the current period is relatively less responsive to extremes in climate than runoff and groundwater recharge. As a result, proportionally less precipitation enters the surface water and groundwater systems during critically dry years, and proportionally more precipitation enters the surface water and groundwater systems in wet years.

2.2.6.3.2 Current Surface Water Budget

The current surface water budget provides a recent record of surface water inflow and outflow in the Basin. The current surface water budget is summarized in Table 2-29 and presented as part of the time series chart on Figure 2-78.

Table 2-29.Summary of Current Surface Water Budget

Water Budget Components Average Total for Current Water Budget (AF)		Current Water Budget 2010-2018		Historical Water Budget 1985-2018	
		Annual Average (AF)	Percent of Total Inflow or Outflow	Annual Average (AF)	Percent of Total Inflow or Outflow
Inflows (115,600)*	Surface Water Inflow	68,500	59%	70,800	59%
	Runoff	27,000	23%	28,300	23%
	Groundwater Discharge to Creeks	20,100	18%	21,200	18%
Outflows (115,500)*	Surface Water Outflow	106,900	93%	111,700	93%
	Streambed Recharge	8,600	7%	8,600	7%

*Small discrepancies between total inflow and outflow may occur due to rounding

During the current period, average overall inflow and outflow is approximately 115,600 AFY, which is about 4,700 AF less per year than the historical period. Overall drier conditions during the current period compared to the historical period result in less surface water inflow and outflow. Groundwater discharge to creeks and streambed recharge to groundwater decreased proportionally with decreased inflow and outflow, especially during the drought from 2012 to 2015.

2.2.6.3.3 Current Groundwater Budget

The current groundwater budget provides a recent record of groundwater inflow and outflow in the Basin. The current groundwater budget is summarized in Table 2-30 and presented as part of the time series chart on Figure 2-79.

The inflows and outflows to the groundwater budget are similar in the historical and current periods. The total inflow is about 22,900 AF, which is about 1,100 AFY less than the historical period. The total outflow is about 23,300 AF, which is about 1,900 AFY less than the historical period.

Table 2-30. Current Groundwater Budget

Water Budget Components Average Total for Current Water Budget (AF)		Current Water Budget 2010-2018		Historical Water Budget 1985-2018	
		Annual Average (AF)	Percent of Total Inflow or Outflow	Annual Average (AF)	Percent of Total Inflow or Outflow
Inflows (22,900)*	**Precipitation Recharge**	13,100	54%	13,700	57%
	Subsurface Inflow	100	1%	100	1%
	System Losses	200	1%	200	1%
	Septic Return Flow	900	4%	1,100	5%
	Quarry Return Flow	<100	<1%	200	1%
	Streambed Recharge	8,600	36%	8,700	36%
	Irrigation Return Flow	<100	<1%	<100	<1%
Outflows (23,300)*	**Groundwater Pumping**	3,000	13%	3,700	15%
	Subsurface Outflow	100	<1%	100	<1%
	Discharge to Creeks	20,200	87%	21,400	85%
Storage*	**Average Annual Change in Storage**	-200	--	-1,200	--
	Cumulative Change in Storage	-2,100	--	-39,300	--

*Small discrepancies between total inflow and outflow may occur due to rounding

The main difference between the current and historical periods is that municipal pumping decreased. During the current period, outflow from groundwater pumping is 3,000 AFY on average, which is about 700 AF less than during the historical period. This reflects a reduction of average annual groundwater pumping of about 20% between the historical and current period. More details on groundwater pumping reductions are provided in Section 2.2.5.1: Groundwater Elevations.

During the current period groundwater discharge to streams decreased by about 1,200 AFY in comparison to the historical period. Less net groundwater discharge to streams is likely related to less precipitation and lower groundwater levels in the Santa Margarita aquifer between 2012 and 2015.

Change of groundwater in storage fluctuated over the current period, with a cumulative loss of 2,100 AF, and an average annual loss of 200 AF. The small overall change in storage during the current period indicates that groundwater inflow and outflow balanced since 2010. This is an improvement from the historical period during which average annual storage losses are about 1,200 AF. Groundwater in storage declines in dry and critically dry water years suggest that net groundwater recharge of the Basin’s aquifers is possible only in normal and wet years.

2.2.6.3.4 Current Groundwater Budget by Aquifer

The current groundwater budget is analyzed by aquifer to demonstrate changes in groundwater flows in the various aquifers relative to the historical period. The current groundwater budget by aquifer is summarized in Table 2-31 and in more detailed tables in Appendix 2E.

Table 2-31. Summary of Current Groundwater Budget by Aquifer

Groundwater Budget Components		Current Water Budget: 2010-2018 Annual Average (AF)				
		Santa Margarita Aquifer	Monterey Formation	Lompico Aquifer	Butano Aquifer	Other Formations
Inflows	Precipitation Recharge	6,200	1,400	900	3,900	700
	Subsurface Inflow	0	0	0	100	<100
	Return Flows	600	200	200	200	100
	Streambed Recharge	1,700	800	400	3,300	2,500
	Flow from Other Aquifers	<100	300	1,700	600	Not calculated
	Inflow*	**8,500**	**2,700**	**3,200**	**8,100**	**3,300**
Outflows	Groundwater Pumping	800	200	1,500	500	<100
	Subsurface Outflow	0	0	0	<100	<100
	Discharge to Creeks	6,400	2,100	1,300	7,100	3,400
	Flow to Other Aquifers	1,200	400	600	400	Not calculated
	Total Outflow*	**8,400**	**2,700**	**3,400**	**8,000**	**3,400**
Storage	Average Annual Change in Storage*	<100	<100	-200	<100	-100
	Cumulative Change in Storage*	800	100	-2,000	100	-1,100

*Small discrepancies between total inflow and outflow may occur due to rounding

There are a few notable differences between the aquifer-specific water budgets for current and historical periods. As noted in Section 2.2.5.1: Groundwater Elevations less groundwater is pumped now than prior to 2010. Despite less overall precipitation recharge during the current period, streambed recharge has remained approximately the same. Current groundwater discharge to creeks is about 1,200 AFY less than the historical budget. Like the historical budget, most of the surface water and groundwater interactions are in the Santa Margarita and Butano aquifers.

During the current period, inflows and outflows for each aquifer are close to balanced. This is an improvement from the historical period, when each aquifer underwent comparatively larger storage losses annually of 1,100 AFY for the entire Basin. Each principal aquifer, except the

Lompico aquifer, has a slight increase of groundwater in storage during the current period. The average annual loss in storage from the Lompico aquifer is about 200 AFY, which improves on the historical period where the average annual loss was about 600 AFY.

2.2.6.3.5 Current Groundwater Change in Storage by Subarea

The current groundwater change in storage is analyzed by subarea to assess where storage changes are occurring. Figure 2-80 through Figure 2-83 illustrate that cumulative change in storage has ceased declining in the current period with fluctuations in some aquifer subareas.

The amounts of groundwater in storage in the Santa Margarita aquifer subareas has remained approximately constant in the current period, although they are subject to large annual fluctuations as a function of precipitation, particularly in the Quail Hollow subarea. Similar results were found for the Santa Margarita aquifer as a whole for the current time frame. The relative constancy of the groundwater in storage is a result of the elevated conductivity in this unconfined aquifer allowing for rapid storage recovery during wet years.

Historical declines in groundwater in storage in the deeper, semi-confined, and confined aquifers stabilized during the current timeframe. The Lompico aquifer in the Mount Hermon/South Scotts Valley subarea, which had the greatest groundwater in storage losses during the historical timeframe, lost only about 2,000 AF of groundwater in storage during the eight most recent years. Where the Butano aquifer outcrops along the Basin's northern boundary, i.e., North of Bean Creek and North Scotts Valley subareas, groundwater in storage declined during the WY2012 to WY2015 drought.

2.2.6.4 Projected Water Budget

The GSP Regulations (§ 354.18) require the development of a projected water budget baseline to assess how water supply, surface water and groundwater interactions, and aquifer conditions will be impacted by future changes in climate and water demands if projects and management actions are not implemented. The projected baseline water budget presented in this subsection fulfills those requirements of the GSP. The projected water budget is developed for the period WY2020 to WY2072 per the GSP Regulations requirement that the projected period include a 50-year planning and implementation horizon over which the GSP and measures will be implemented to ensure that the Basin is operated within its sustainable yield.

Section 2.2.3.2 describes the climate projection used by the groundwater model to simulate and estimate water budget components. In addition to the climate projection, the projected baseline simulation assumes a small increase in urban growth. Water demands are projected to increase 8% for SLVWD and 7% for SVWD from 2020 through 2045 that continues linearly through the projected model period ending in 2072. Although it is not simulated in the projected groundwater model, the urban footprint in the service areas is projected to expand slightly, resulting in slightly more runoff and less recharge. As shown in the sections below, climate change is predicted to have a larger impact on the projected water budget than changes in water demand and runoff due to urban and residential development.

2.2.6.4.1 Projected Precipitation Budget

The projected precipitation budget provides a simulated outlook of precipitation inflow and outflow in the Basin. The projected precipitation budget is summarized in Table 2-32 and presented in a time series chart on Figure 2-84.

Table 2-32. Summary of Projected Precipitation Budget

Water Budget Components Average Total for Projected Water Budget (AF)		Projected Water Budget 2020-2072		Current Water Budget 2010-2018	Historical Water Budget 1985-2018
		Annual Average (AF)	Percent of Total Inflow or Outflow	Annual Average (AF)	Annual Average (AF)
Inflows (77,400)*	**Precipitation**	77,400	100%	79,600	82,400
Outflows (77,500)*	**Evapotranspiration**	37,600	48%	37,100	38,00
	Direct Runoff	27,700	36%	29,400	30,800
	Groundwater Recharge	12,200	16%	13,200	13,700

*Small discrepancies between total inflow and outflow may occur due to rounding

Projected precipitation in the Basin is on average about 3% less than the current period and 6% less than the historical period. Annual precipitation is predicted to average about 5,000 AF less than in the historical period. Future precipitation is predicted to be more variable year-to-year than in the historical period, with more wet and critically dry years, and extended periods of wet or dry conditions. The 4-model ensemble climate projection has 53% of the water years classified as critically dry, 11% are normal, and 36% are wet. There are no water years classified as dry in the projection. In comparison, historical precipitation is less variable with only 21% of water years classified as critically dry and 26% as wet, with the remainder classified as dry or normal.

Evapotranspiration over the projected period is similar to current and historical evapotranspiration. Evapotranspiration projections are stable despite lower precipitation mainly because temperature is anticipated to increase during the projected period. Higher temperature causes more vegetative growth and evaporation. The more or less constant evaporation, combined with a decrease in precipitation, result in simulated overland flow and groundwater recharge being about 10% less than in the historical period.

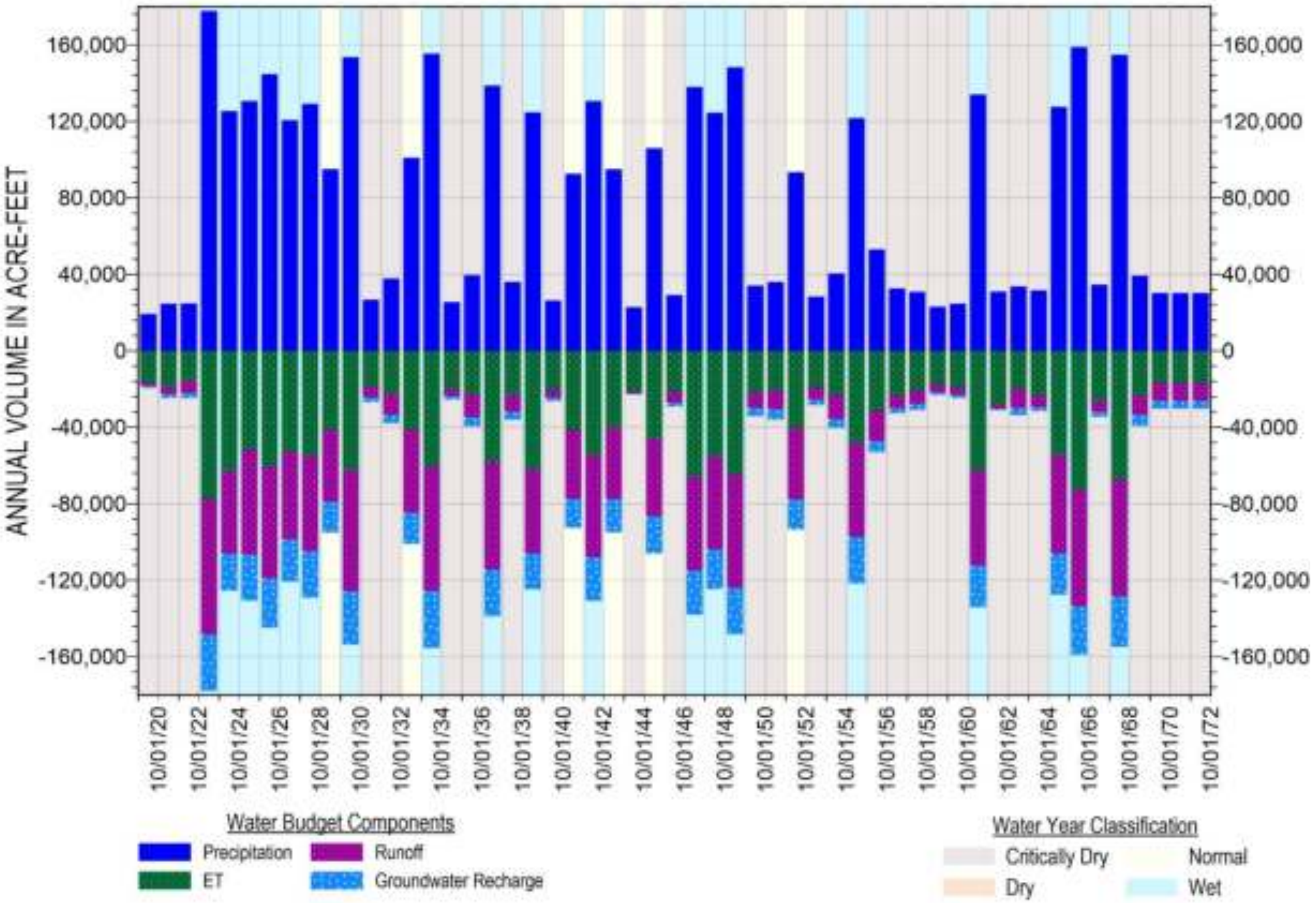

Figure 2-84. Projected Precipitation Budget

2.2.6.4.2 Projected Surface Water Budget

The projected surface water budget provides a simulated outlook for surface water inflow and outflow in the Basin in the future. The projected surface water budget is summarized in Table 2-33 and presented in a time series chart on Figure 2-85.

Table 2-33. Summary of Projected Surface Water Budget

Water Budget Components		Projected 2020-2072		Current 2010-2018	Historical 1985-2018
Average Total for Projected Water Budget (AF)		Annual Average (AF)	Percent of Total Inflow or Outflow	Annual Average (AF)	Annual Average (AF)
Inflows (109,600)	**Surface Water Inflow**	64,800	59%	68,500	70,800
	Runoff	25,400	23%	27,000	28,300
	Groundwater Discharge to Creeks	19,400	18%	20,100	21,200
Outflows (109,600)	**Surface Water Outflow**	101,200	92%	106,900	111,700
	Streambed Recharge	8,400	8%	8,600	8,600

During the projected period, average groundwater total inflow and outflow is approximately 109,600 AFY, which is about 10,700 AFY less than the historical period. Surface water inflows and outflows during the projected period decrease by about 9%, in comparison to the historical period, which reflects drier climatic conditions predicted in the future. Surface water and groundwater interaction reflected as discharge to creeks and streambed recharge to groundwater fluctuates proportionally with precipitation and surface water inflow, especially during periods of extended drought. Consequently, the amount of surface water and groundwater interaction decreases during the projected period.

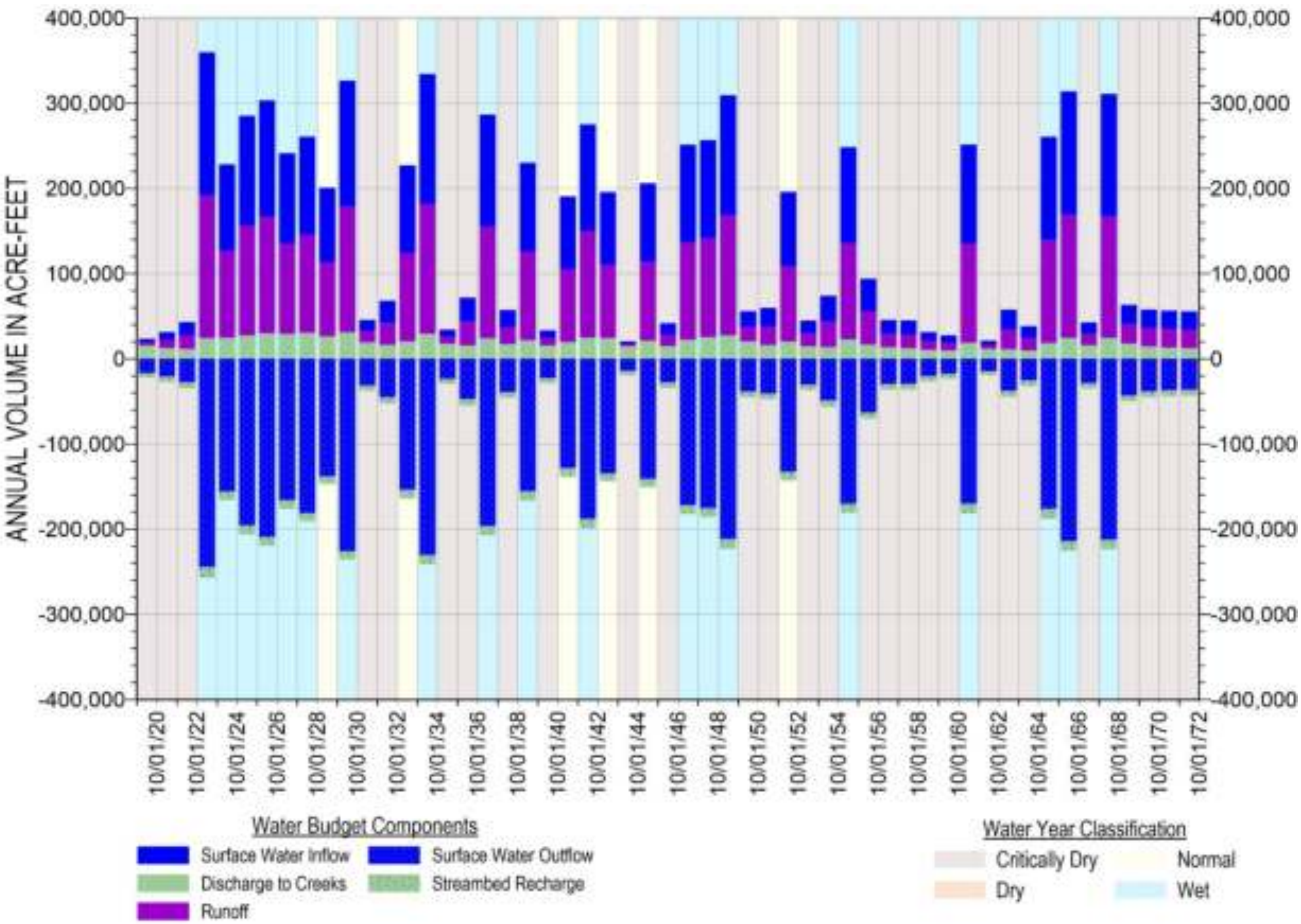

Figure 2-85. Projected Surface Water Budget

2.2.6.4.3 Projected Groundwater Budget

The projected groundwater budget provides a simulated outlook for groundwater inflow and outflow in the Basin. The projected groundwater budget is summarized in Table 2-34 and presented in a time series chart on Figure 2-86.

Table 2-34. Summary of Projected Groundwater Budget

Water Budget Components Average Total for Projected Water Budget (AF)		Projected 2020-2072		Current 2010-2018	Historical 1985-2018
		Annual Average (AF)	Percent of Total Inflow or Outflow	Annual Average (AF)	Annual Average (AF)
Inflows (21,700)*	**Precipitation Recharge**	12,100	56%	13,100	13,700
	Subsurface Inflow	100	<1%	100	100
	System Losses	300	1%	200	200
	Septic Return Flow	800	4%	900	1,100
	Quarry Return Flow	<100	<1%	<100	200
	Streambed Recharge	8,400	39%	8,600	8,700
	Irrigation Return Flow	<100	<1%	<100	<100
Outflows (22,300)*	**Groundwater Pumping**	2,800	12%	3,000	3,700
	Subsurface Outflow	100	1%	100	100
	Discharge to Creeks	19,400	87%	20,200	21,400
Storage*	**Average Annual Change in Storage**	-500	-	-200	-1,200
	Cumulative Change in Storage	-24,000	-	-2,100	-39,300

*Small discrepancies between total inflow and outflow may occur due to rounding

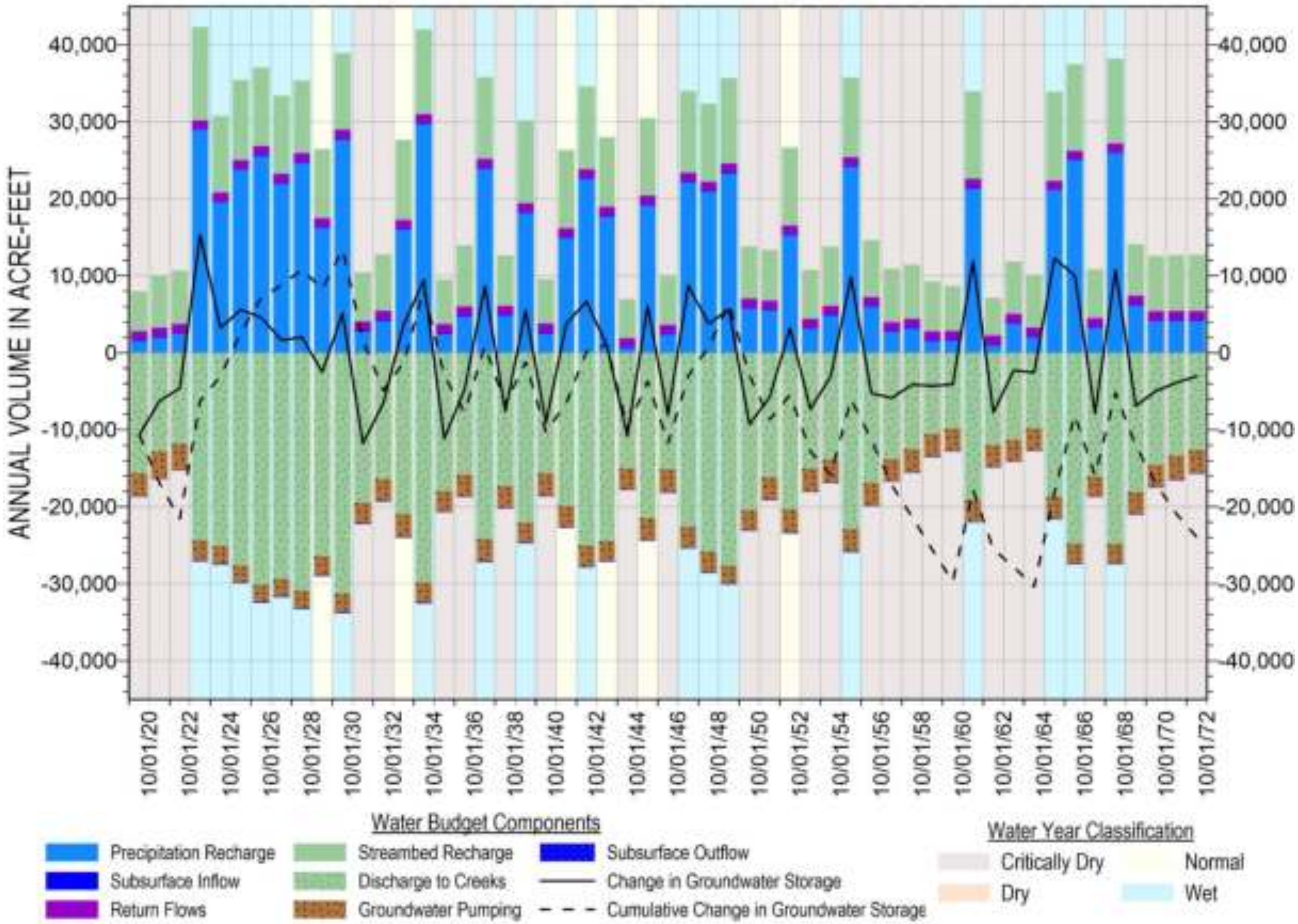

Figure 2-86. Projected Groundwater Budget

Total inflows and outflows to the groundwater budget are both smaller in the projected period than in the historical and current periods. Compared to the historical period, predicted total inflows and outflows are approximately 2,300 AFY and 2,900 AFY smaller, respectively.

Reduced recharge by precipitation is the largest source of the predicted decline in total groundwater inflows. Direct groundwater recharge from precipitation is projected to be about 1,600 AF less per year than the historical period; in comparison, streambed recharge is predicted to be about 300 AF less. Septic return flows to groundwater are expected to decrease about 28% with improved water efficiency as water fixtures are replaced, resulting in about 800 AFY of septic return flows compared to about 1,110 AF per over the historical period. Other components of projected groundwater inflow are expected to be similar to historical inflows.

Reduced projected groundwater outflow is mostly a result of less groundwater pumping and groundwater discharge to creeks. In the future, groundwater pumping is estimated to average about 2,800 AFY, which is about 200 AFY less than average current conditions and about 900 AFY less than average historical conditions. The reduced groundwater use is based on the assumption that SLVWD will use surface water more in wet years in place of groundwater. Future population growth is expected to be moderate and is expected to be offset with continued efficiency improvements in public water supply. It is projected that groundwater discharge to creeks will be about 19,400 AFY on average, which is 2,000 AF less than the historical annual average. The projected reduction in groundwater and surface water interactions is primarily due to overall drier conditions, which will reduce groundwater recharge and lower groundwater levels.

Under the 4-model ensemble climate projection used to simulate future groundwater conditions, the Basin will experience slightly less overall precipitation and greater precipitation variability resulting in longer periods of drought. Together, this causes losses of groundwater in storage and lower groundwater levels. Prolonged drought stresses the water supply in the Basin and requires greater groundwater banking and/or conjunctive use strategies to increase groundwater in storage in wetter years when water is available. The projected baseline simulation without implementing new projects or management actions results in a cumulative loss of groundwater in storage of about 24,000 AF between 2020 and 2072. The annual average decline in storage in this timeframe is about 500 AFY.

Given these results, projects and management actions will need to be implemented to achieve sustainability of groundwater conditions, as discussed further in Section 4. It is, however, important to recognize that the model projections are highly dependent on estimates of future precipitation. To the degree that actual future precipitation deviates from that predicted by the four-model ensemble, groundwater conditions could be better or worse than simulated.

2.2.6.4.4 Projected Groundwater Budget by Aquifer

The projected groundwater budget is analyzed by aquifer to demonstrate changes in groundwater flows in the various aquifers if no additional projects or management actions are implemented. The projected groundwater budget by aquifer is summarized in Table 2-35 and in more detailed tables in Appendix 2E.

Table 2-35. Projected Groundwater Budget by Aquifer

Groundwater Budget Components		Projected Water Budget: 2020-2072 Annual Average (AF)				
		Santa Margarita Aquifer	Monterey Formation	Lompico Aquifer	Butano Aquifer	Other Formations
Inflows	Precipitation Recharge	5,700	1,300	900	3,600	600
	Subsurface Inflow	0	0	0	100	<100
	Return Flows	500	200	200	200	100
	Streambed Recharge	1,600	800	400	3,300	2,300
	Flow from Other Aquifers	<100	300	1,600	600	Not calculated
	Total Inflow*	***7,800***	***2,600***	***3,100***	***7,800***	***3,100***
Outflows	Groundwater Pumping	900	100	1,200	500	<100
	Subsurface Outflow	0	0	0	100	<100
	Discharge to Creeks	6,100	2,100	1,300	6,900	3,000
	Flow to Other Aquifers	1,100	400	600	400	Not calculated
	Total Outflow*	***8,100***	***2,600***	***3,100***	***7,900***	***3,000***
Storage	Average Annual Change in Storage*	-200	-100	-100	-100	<100
	Cumulative Change in Storage*	-9,600	-2,900	-7,000	-5,100	600

*Small discrepancies between total inflow and outflow may occur due to rounding

There are a few notable differences between the aquifer-specific change in storage for the projected, current, and historical periods. The most notable difference between the water budget timeframes is changes to precipitation patterns due to climate change. Simulated precipitation in the projected timeframe is more variable and less than current and historical precipitation, translating to less recharge available for the Basin's aquifers. This change is anticipated to impact future recharge patterns in all aquifers, but especially the Santa Margarita and Butano aquifers which rely directly on recharge from precipitation and from streambeds. The Lompico aquifer is also impacted by reduced overall recharge, although to reach the Lompico aquifer, recharge water typically percolates through the overlying Santa Margarita aquifer and/or Monterey Formation, so the response to climatic patterns is muted. Recharge of the Lompico aquifer from the Santa Margarita aquifer is unimpeded in the Camp Evers area in south Scotts Valley where shale of the Monterey Formation is absent between the permeable Santa Margarita and Lompico aquifers. The result of more variable and less overall precipitation is that groundwater in storage is projected to decrease in each of the principal aquifers and the Monterey Formation.

The projected water budget assumes groundwater pumping will be on average 200 AFY less than current pumping (Table 2-31). This is because in the projection's very wet years, there will be more surface water available for municipal water supply. Slight increases in pumping are projected in the Santa Margarita and Butano aquifers, while slight decreases in groundwater pumping are projected in the Lompico aquifer in comparison to current pumping.

The average long-term annual change in storage is projected to be slightly negative for each of the principal aquifers. The greatest amounts of storage loss are projected for the Santa Margarita and Lompico aquifers. Storage is lost during dry periods and gained during wet periods. Since more dry years are projected than wet years, the result is a net overall loss of groundwater in storage.

2.2.6.4.5 Projected Groundwater Change in Storage by Subarea

Based on the projected baseline simulation the principal aquifers will all be affected by the drier projected climate simulated by the 4-model ensemble climate projection. This is especially the case in the multiple critically dry years towards the end of the projected period. Figure 2-87 through Figure 2-90 show each aquifer's projected cumulative change of groundwater in storage.

The Santa Margarita aquifer is the most sensitive to climatic changes and loses almost 6,000 AF from storage in the Quail Hollow subarea during the longest projected drought period from 2050 to 2064 (Figure 2-87). However, it recovers very quickly after several wet years. The same pattern of groundwater depletion and recovery occur in the other subareas, but at a lesser scale. The Quail Hollow and Olympia/Mission Springs subareas have the greatest losses and gains in storage because they contain municipal supply wells that pump most of the groundwater extracted from the Santa Margarita aquifer.

Monterey Formation projected change of groundwater in storage is shown on Figure 2-88. The Monterey Formation is not pumped by many wells in the area south of Bean Creek (North Scotts Valley and Mount Hermon/South Scotts Valley subareas) and even in the driest years, little change in storage is predicted. Figure 2-88 shows that there is more change in stored groundwater in the subarea north of Bean Creek where only *de minimis* users pump from the Monterey Formation. The very low rainfall predicted from 2050 onwards results in an overall loss of about 2,000 AF at the end of the projected period.

Up until 2048, groundwater in storage in the Lompico aquifer is generally consistent (Figure 2-89). This indicates that pumping from the Lompico aquifer is roughly in balance with its recharge. The extended drought projected after this period causes a significant loss of groundwater in storage, especially in the Mount Hermon/South Scotts Valley subarea where the majority of Lompico aquifer pumping occurs by Mount Hermon Association, SLVWD, and SVWD. Recovery from significant losses such as this, even in wet years, is not possible without projects or management actions because of the aquifer's limited recharge area and confined nature. Section 4 described potential projects that target the Lompico aquifer to both provide for some recovery from past losses of storage and to provide resiliency against prolonged future droughts.

The Butano aquifer is pumped only in the northern portions of the Basin, where it outcrops south of the Zayante-Vergeles fault and slightly farther south from the boundary where SVWD has 2 deep wells in Scotts Valley that extend down more than 1,000 feet. The projected modeled changes in storage depicted on Figure 2-90 reflect effects of recharge in wet years. This pattern is more like the Santa Margarita aquifer response to recharge events and less like the similarly confined Lompico aquifer responds. The 2 Butano aquifer monitoring wells in northern Scotts Valley do not appear to respond to wet years in the same way the model predicts (hydrographs are included on Figure 2-47). It is acknowledged in Section 2.2.4.11 that because of so few monitoring wells in the Butano aquifer, our current understanding of it is limited and assumptions made in the model may not be correct. Existing plans to install new Butano monitoring wells may increase hydrogeologic understanding, in turn informing the groundwater model.

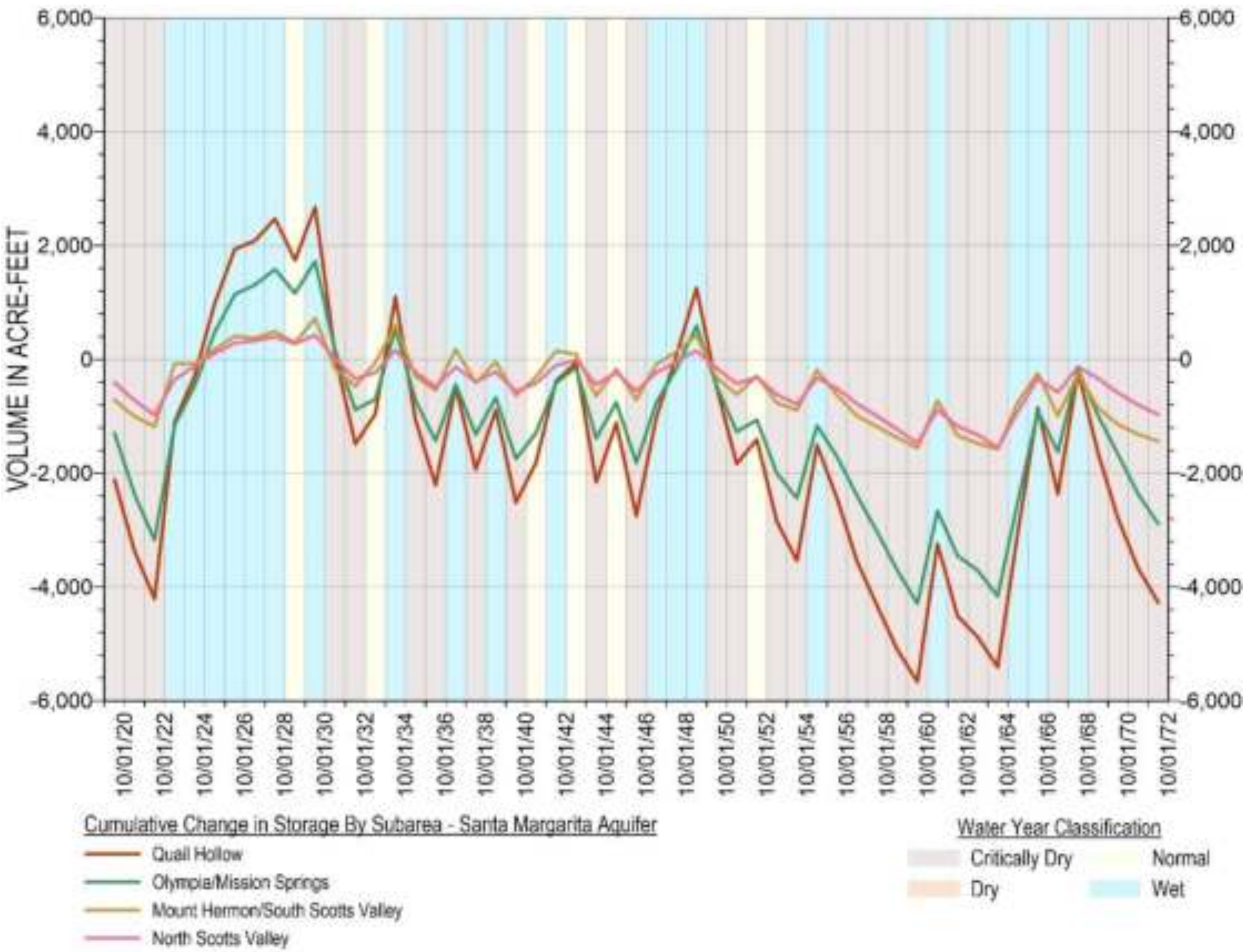

Figure 2-87. Projected Cumulative Change of Groundwater in Storage in the Santa Margarita Aquifer

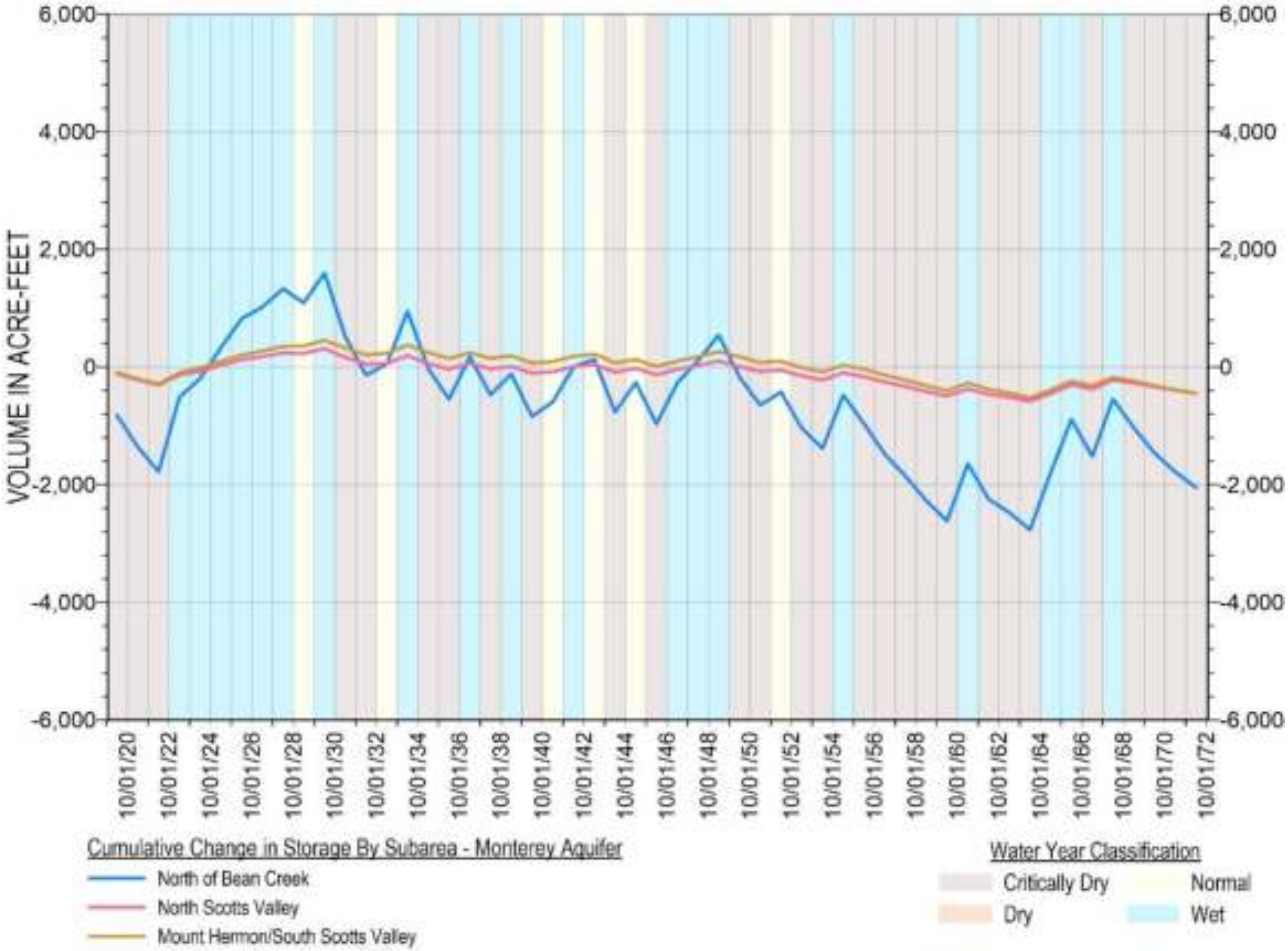

Figure 2-88. Projected Cumulative Change of Groundwater in Storage in the Monterey Formation

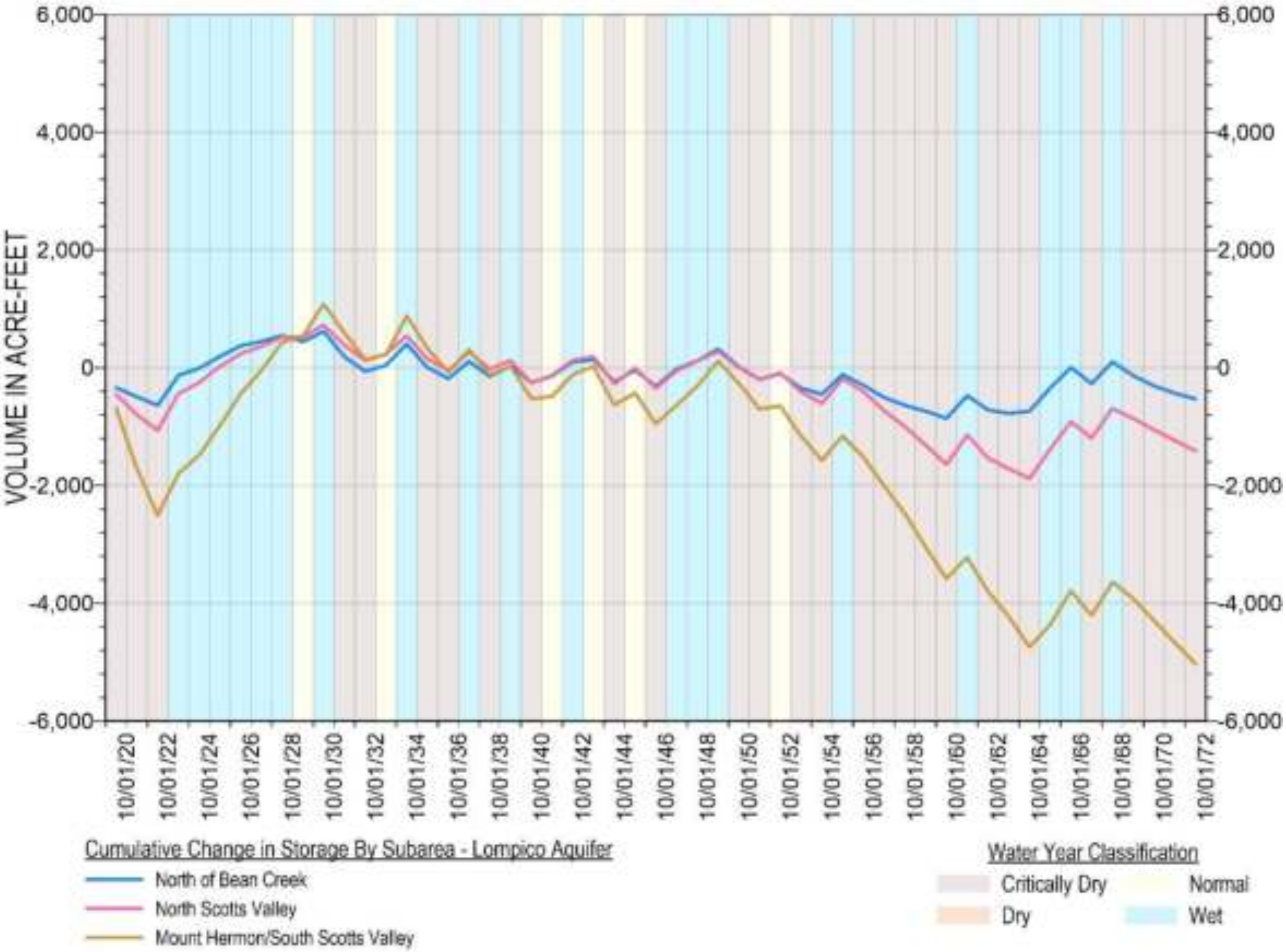

Figure 2-89. Projected Cumulative Change of Groundwater in Storage in the Lompico Aquifer

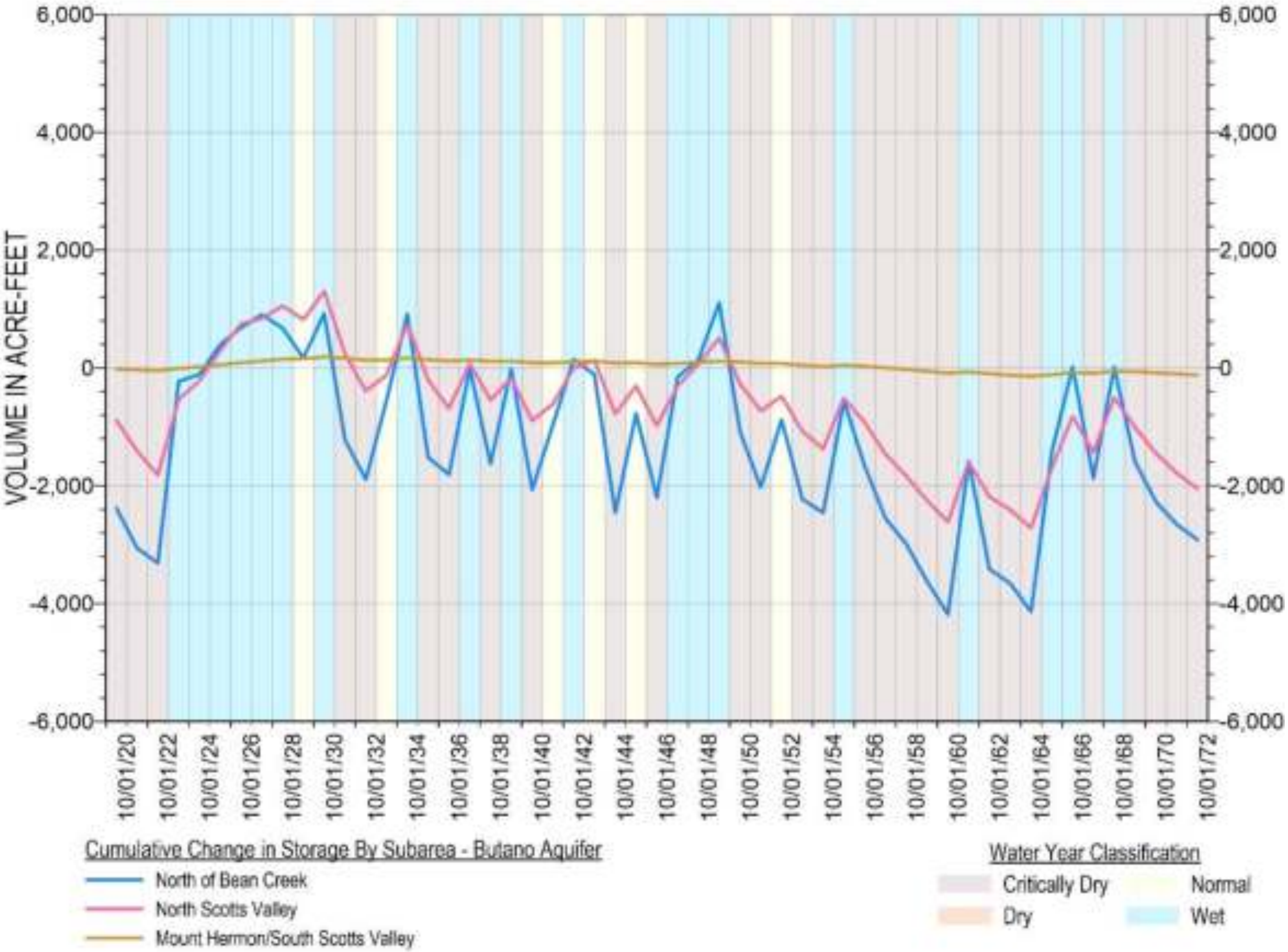

Figure 2-90. Projected Cumulative Change of Groundwater in Storage in the Butano Aquifer

2.2.6.5 Sustainable Yield

The Basin's sustainable yield is an estimated volume of groundwater that can be pumped on a long-term average annual basis without causing undesirable results. The role of sustainable yield estimates in SGMA as described in the Sustainable Management Criteria (SMC) BMP (DWR, 2016a) are as follows:

> *"In general, the sustainable yield of a basin is the amount of groundwater that can be withdrawn annually without causing undesirable results. Sustainable yield is referenced in SGMA as part of the estimated basinwide water budget and as the outcome of avoiding undesirable results.*
>
> *Sustainable yield estimates are part of SGMA's required basinwide water budget. Section 354.18(b)(7) of the GSP Regulations requires that an estimate of the basin's sustainable yield be provided in the GSP (or in the coordination agreement for basins with multiple GSPs). A single value of sustainable yield must be calculated basinwide. This sustainable yield estimate can be helpful for estimating the projects and programs needed to achieve sustainability."*

Basin-wide groundwater pumping within the sustainable yield does not constitute proof of sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for the sustainability indicators applicable to the Basin. Specific undesirable results for the chronic lowering of groundwater levels, reduction in groundwater storage, and depletion of interconnected surface water sustainability indicators are presented in Section 3. While GSP Regulations only require 1 sustainable yield volume for the entire basin, pumping within the sustainable yield may affect groundwater elevations in different aquifers and aquifer subareas differently depending on how pumping is distributed spatially. Therefore, sustainable yield volumes are estimated for each aquifer based on predictive model simulations that do not produce undesirable results.

The future baseline model simulation incorporating climate change and projected water use predicts undesirable results will not occur within the modeled 50-year interval. This means that groundwater pumping volumes used in the baseline simulation can be used to estimate sustainable yield. Given that groundwater pumping in the model is not specifically optimized to avoid undesirable results, it is possible that slightly more pumping than the estimated sustainable yield could avoid future undesirable results. Groundwater pumping in the projected baseline simulation, shown on Figure 2-91, is generally consistent after WY2022 in the Monterey Formation, and Lompico and Butano aquifers. The sustainable yield for those aquifers is therefore set as the average pumping after 2022 plus a 5% buffer to allow for pumping optimization during GSP implementation.

The amount of municipal groundwater pumped in the Santa Margarita aquifer is related to water year type and increases considerably during dry periods. When surface water supply is limited (Figure 2-89), SLVWD augments it with groundwater pumped from the Santa Margarita aquifer at the Quail Hollow and Olympia wellfields. For example, a substantial modeled increase in pumping during an extended simulated drought after WY2050 results in considerable loss of groundwater in storage in the Santa Margarita aquifer, and minimum thresholds to be exceeded (Figure 2-92). These exceedances are not considered undesirable results because they occur during an extended drought. In contrast, from WY2030-2049 the simulation shows in a non-drought period that the Santa Margarita aquifer does not have undesirable results. During this relatively wetter period, the Santa Margarita aquifer experiences almost no cumulative groundwater in storage losses, indicating sustainable groundwater conditions. Therefore, the sustainable yield for the Santa Margarita aquifer is set as the average pumping from 2030-2049 plus a 5% buffer to allow for pumping optimization during GSP implementation.

Historical pumping and estimate of sustainable yield for each aquifer is presented in Table 2-36. The estimates of sustainable yield for each aquifer are used as minimum thresholds for the reduction of groundwater storage sustainability indicator, described further in Section 3.

Five-year averages of historical pumping are compared with sustainable yield values on Figure 2-93. While pumping in all aquifers has declined over the historical period, current period pumping remains above sustainable yield in the Monterey and Lompico aquifers.

Table 2-36. Sustainable Yield by Aquifer Compared to Historical and Current Pumping

Aquifer	Historical Pumping 1985 – 2018 (AFY)	Current Pumping 2010 – 2018 (AFY)	Sustainable Yield (AFY)	Sustainable Yield Based on
Santa Margarita	1,070	770	850	Average pumping between 2030-2049 plus 5% buffer
Monterey	320	180	140	Average pumping after 2022 plus 5% buffer
Lompico	1,770	1,520	1,290	Average pumping after 2022 plus 5% buffer
Butano	530	480	540	Average pumping after 2022 plus 5% buffer

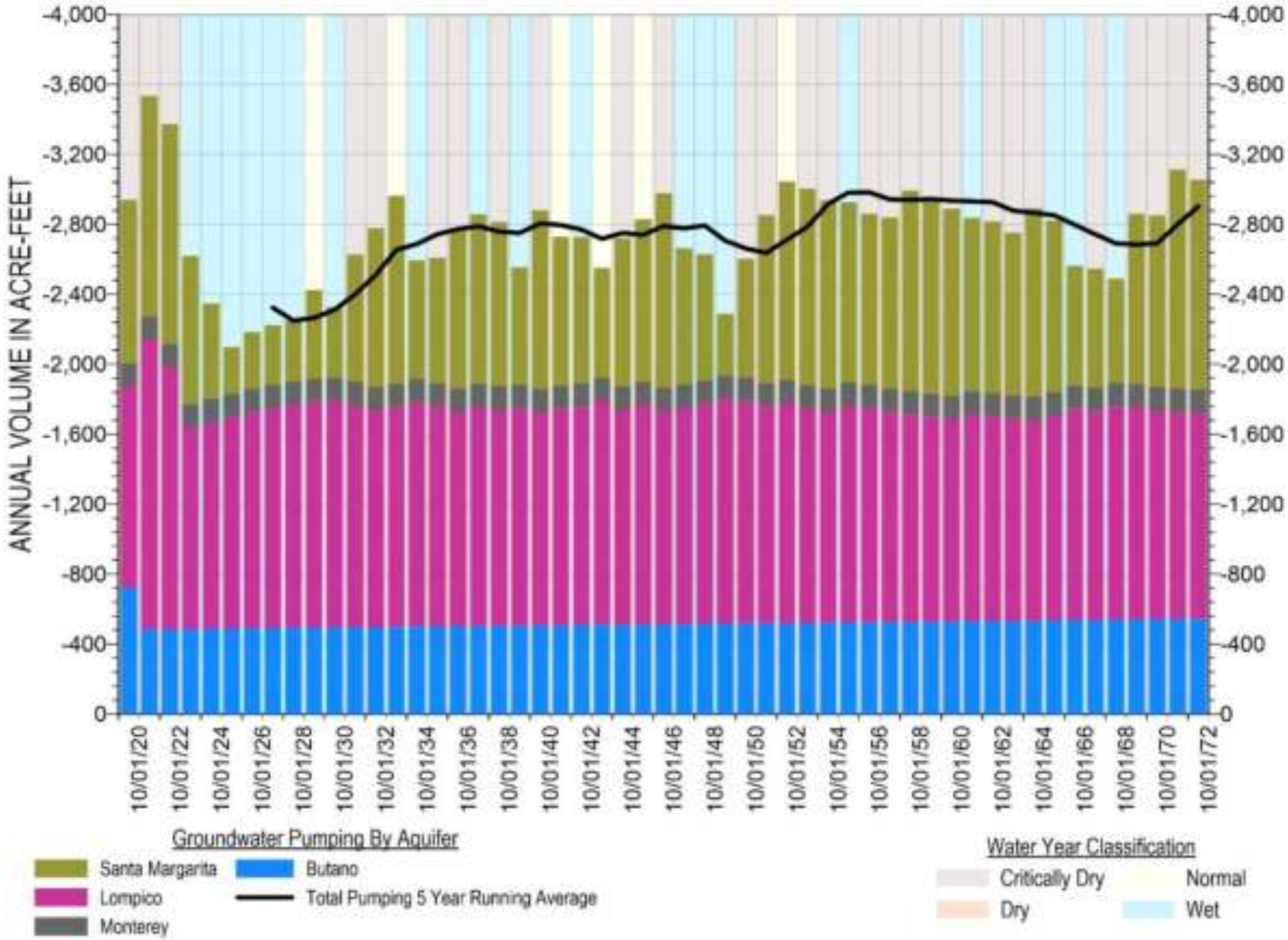

Figure 2-91. Projcted Baseline Simulation Groundwater Pumping by Aquifer

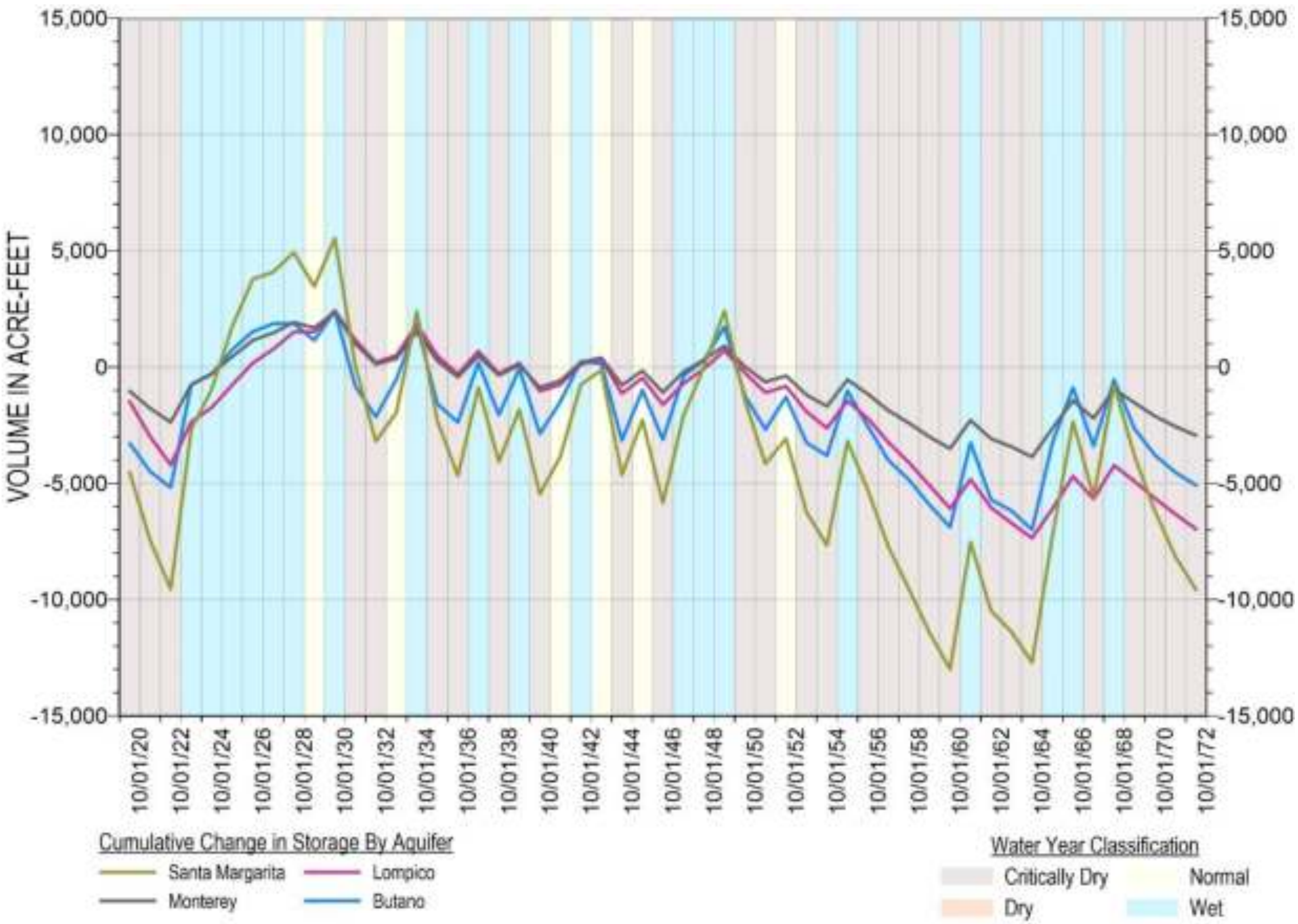

Figure 2-92. Projected Baseline Simulation Cumulative Change in Groundwater in Storage by Aquifer

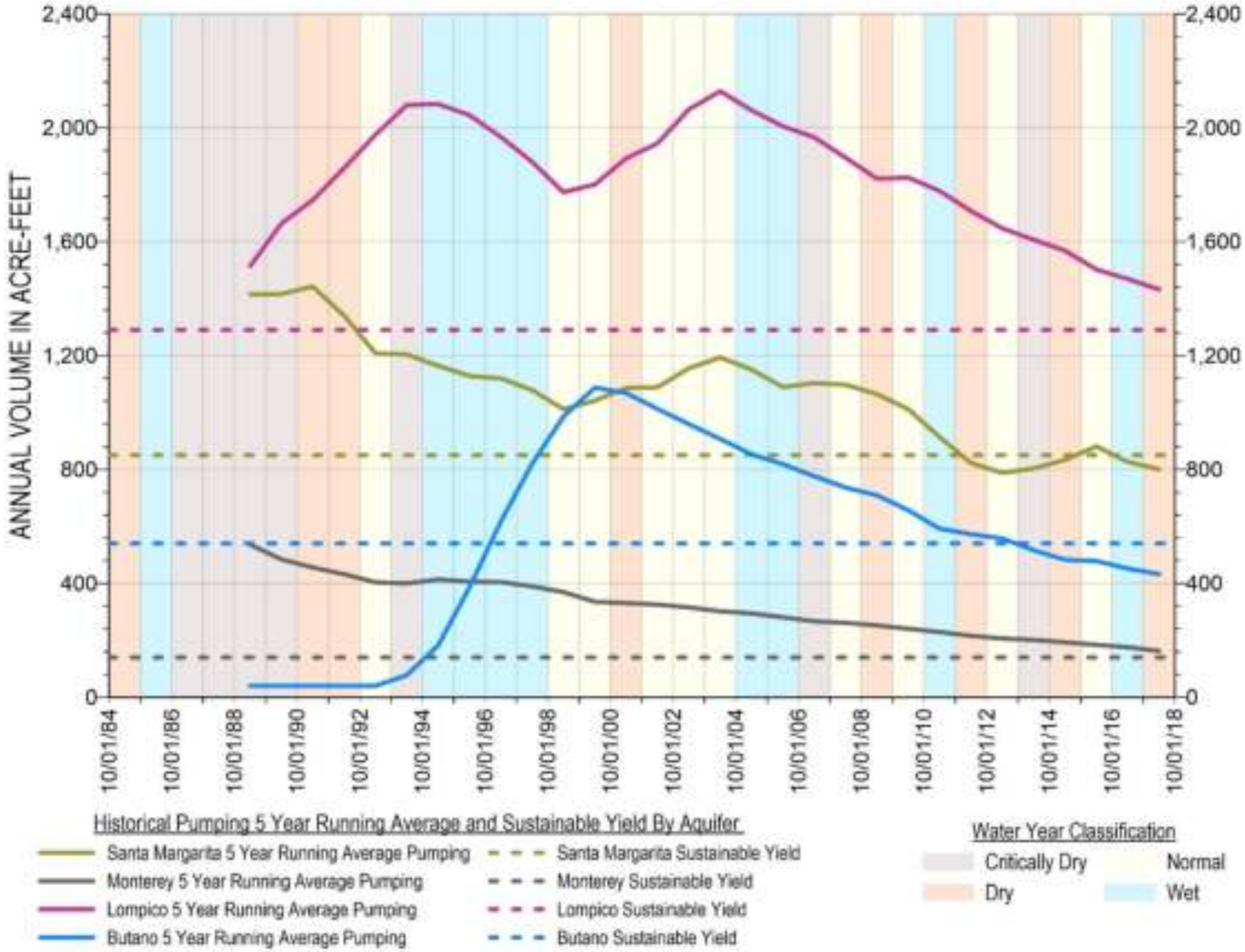

Figure 2-93. Historical Pumping 5-Year Running Average and Sustainable Yield by Aquifer

2.2.6.6 Description of Surface Water Supply for Groundwater Recharge or In-Lieu Supply

The sources of water supply in the Basin are discussed in Section 2.2.4.10: Sources and Points of Water Supply. Almost all water supply within the Basin is derived from surface water and groundwater, which is fed by precipitation in the Basin and the surrounding watershed. A very small amount (between 160 to 200 AFY) of recycled water is used by SVWD to supplement their water supply.

SLVWD has rights to divert water from tributaries of the San Lorenzo River located outside of the Basin. When surface water is available, SLVWD uses it in lieu of pumping its wells. This conjunctive use of surface water and groundwater is described in more detail in the baseline projects in Section 4. If SLVWD's water rights and place of use restrictions are revised per current requests to the State Water Resources Control Board, in wet years there will be more surface water available for conjunctive use by SLVWD and potentially SVWD.

SVWD has provided recycled water to its irrigation customers in lieu of pumping groundwater since 2002. Larger volumes of treated wastewater from outside of the Basin is another source of water that could be used for groundwater recharge in the future. Section 4 describes potential projects that would use treated wastewater for indirect potable reuse.

Currently, the City of Santa Cruz has water rights to divert water from the San Lorenzo River. Between October 1 and May 31, the San Lorenzo River and its tributaries are not fully appropriated, and at times have streamflow in excess of minimum bypass flows; these excess flows could be used for groundwater recharge and conjunctive use projects. Appendix 2D: Section 7.3.3 describes an estimated total of 540 AFY for excess flows within the water rights of SLVWD and City of Santa Cruz. This potential source and volume of water is used for an expanded conjunctive use project described in Section 4 on projects and management actions. The 540 AFY estimate may change subject to applications by the City of Santa Cruz and SLVWD to change their water rights.

2.2.7 Management Areas

SGMA allows GSAs to define 1 or more management areas within a groundwater basin if the agency determines that the creation of management areas will facilitate implementation of its GSP. Management areas may have different minimum thresholds and be operated to different measurable objectives than the basin at large, provided that undesirable results are defined consistently throughout the basin. The SMGWA found no additional benefit to establishing separate management areas within the Basin at this time, although management areas may be needed in the future.

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SANTA MARGARITA
Groundwater Agency

Public Review Draft

Section 3. Sustainable Management Criteria

Santa Margarita Basin
Groundwater Sustainability Plan

July 23, 2021

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Acronyms & Abbreviations

AF ....acre-feet
AFY................acre-feet per year
amsl................above mean sea level
BMP...............Best Management Practice
COC...............chemical of concern
DDW.............Division of Drinking Water
DMS...............data management system
EH..................Environmental Health
EVI.................Enhanced Vegetation Index
GDE...............groundwater dependent ecosystems
GSP................Groundwater Sustainability Plan
ID...................identifier
NAVD 88.......North American Vertical Datum of 1988
NMFS.............National Marine Fisheries Service, formerly NOAA Fisheries
NDMI.............Normalized Difference Moisture Index
NDVI.............Normalized Difference Vegetation Index
QA..................quality assurance
QC..................quality control
RMP...............Representative Monitoring Points
RP...................Reference Point
RWCQB.........Regional Water Quality Control Board
SGMA............Sustainable Groundwater Management Act
SLVWD.........San Lorenzo Valley Water District
SMC...............sustainable management criteria
SMGWA........Santa Margarita Groundwater Agency
SVWD............Scotts Valley Water District
SWRCB..........State Water Resources Control Board
SWS...............Small Water Systems
TAG...............Technical Advisory Group
TMDL............total maximum daily load
VOC...............volatile organic compound
WISKI............Water Information Systems by Kisters
WY.................Water Year

3 SUSTAINABLE MANAGEMENT CRITERIA

This section defines the groundwater conditions that constitute sustainable groundwater management, discusses the process by which the Santa Margarita Groundwater Agency (SMGWA) characterizes undesirable results, identifies the monitoring networks used to assess conditions, and establishes minimum thresholds and measurable objectives for each applicable sustainability indicator. Undesirable results, minimum thresholds, and measurable objectives together define the sustainable management criteria (SMC) and commit the SMGWA to actions that will achieve those conditions. These Sustainable Groundwater Management Act (SGMA) specific terms and others are defined in the Glossary.

Defining SMC requires significant analysis and scrutiny. This section presents the data and methods used to develop SMC and demonstrates how they influence beneficial uses and users. The SMC are based on currently available data and the application of best available science. As noted in this GSP, data gaps exist in the hydrogeologic conceptual model related to the interconnection of surface water and groundwater. Uncertainty caused by these data gaps was considered when developing the SMC. Due to uncertainty in the hydrogeologic conceptual model, the SMC are considered initial criteria that will be reevaluated and potentially modified in the future as new data becomes available.

This section is organized to address all the SGMA regulations regarding SMC. The Sustainability Goal guides development of the SMC and the monitoring network describes the monitoring features used to track progress toward meeting interim milestones and measurable objectives and what data gaps still exist. To retain an organized approach, the description of the Monitoring Network and SMCs are grouped by each individual sustainability indicator. Each subsection follows a consistent format that contains the information required by Section §354.22 *et. seq* of the SGMA regulations and outlined in the Sustainable Management Criteria Best Management Practice (BMP) (DWR, 2017). Each SMC subsection includes a description of how the following SMC were developed:

- Qualitative, locally defined significant and unreasonable conditions
- Quantitative description of undesirable results, including:
    - The criteria defining when and where the effects of the groundwater conditions cause undesirable results based on a quantitative description of the combination of minimum threshold exceedances (§354.26 (b)(2))
    - The potential causes of undesirable results (§354.26 (b)(1))
    - The effects of these undesirable results on the beneficial users and uses (§354.26 (b)(3))

- Quantitative minimum thresholds, including:
    - The information and methodology used to develop minimum thresholds (§354.28 (b)(1))
    - The relationship between minimum thresholds and the relationship of these minimum thresholds to other sustainability indicators (§354.28 (b)(2))
    - The effect of minimum thresholds on neighboring basins (§354.28 (b)(3))
    - The effect of minimum thresholds on beneficial uses and users (§354.28 (b)(4))
    - How minimum thresholds relate to relevant Federal, State, or local standards (§354.28 (b)(5))
    - The method for quantitatively measuring minimum thresholds (§354.28 (b)(6))
- Quantitative measurable objectives, including:
    - The methodology for setting measurable objectives (§354.30)
    - Interim milestones (§354.30 (a), §354.30 (e), §354.34 (g)(3))

3.1 Sustainability Goal

Per Section 1 of this GSP, the SMGWA's sustainability goals are to:

- Implement the SGMA, which requires the management and use of groundwater in the Basin in a manner that can be maintained during the planning and implementation horizon without causing undesirable results.
- Provide a safe and reliable groundwater supply that meets the current and future needs of beneficial users.
- Support groundwater sustainability measures and projects that enhance a sustainable and reliable groundwater supply in the Basin, utilizing integrated water management principles by:
    - Safeguarding water supply availability for public health and welfare
    - Maintaining and enhancing groundwater availability for municipal, private, and industrial users and uses
    - Maintaining and enhancing groundwater contributions to streamflow, where beneficial users are dependent upon such contributions (fish, frogs, salamanders, dragonflies etc.)
    - Maintaining and enhancing groundwater levels that support groundwater dependent ecosystems

    - Maintaining and enhancing groundwater quality for existing and future beneficial uses
- Provide for operational flexibility within the Basin by supporting a drought supply reserve that takes into account future climate change.
- Plan and implement projects and activities to achieve sustainability that are cost effective and do not place undue financial hardship on the SMGWA, its cooperating agencies, or basin stakeholders. A cost-benefit analysis, taking into consideration financial, social, environmental, and adverse consequences, may be conducted to evaluate whether a project or activity results in undue financial hardship.

Measures that SMGWA cooperating agencies will take to achieve Basin sustainability are primarily focused on increasing Lompico aquifer groundwater levels in the Mount Hermon / South Scotts Valley area. The most immediate action will be to expand conjunctive use of surface water and groundwater using existing infrastructure. It is likely that this measure will be followed by development of infrastructure to gain access to San Lorenzo Valley Water District's (SLVWD) entitlement of 313 AFY of Loch Lomond water for further conjunctive use opportunities. Combining the 2 projects would potentially provide for a long-term average of 540 acre-feet per year (AFY) of in-lieu recharge by SLVWD and Scotts Valley Water District (SVWD) resting their extraction wells during the wet seasons when surface water is available for conjunctive use. Groundwater modeling has demonstrated the combined projects will raise Mount Hermon / South Scotts Valley area Lompico aquifer groundwater levels by 20 to 50 feet and Monterey Formation levels by 20 feet. Additionally, resting SVWD wells extracting from the Butano aquifer may raise Butano aquifer groundwater levels by 20 to 50 feet in the central to northern Scotts Valley areas. The anticipated increases in groundwater levels from 540 AFY of conjunctive use enables the SMGWA to meet its long-term measurable objectives for chronic lowering of groundwater levels, depletion of interconnected surface water, and reduction of groundwater in storage, while having no impact on groundwater quality.

Larger, more costly projects using either treated surface water or purified wastewater imported from outside the Basin, as described in Section 4, will be evaluated during the first 5 years of GSP implementation. The larger projects will provide the SMGWA cooperating agencies additional water supply resiliency and drought protection, beyond the level likely needed for sustainable management of groundwater in the Basin.

3.2 Process of Developing Sustainable Management Criteria

3.2.1 SMGWA Board Involvement

SMC were developed for the Basin based on historical data and desired future conditions. The SMC decision making process involved guidance by SMGWA staff, stakeholder outreach, and discussion and refinement over multiple SMGWA Board meetings. Prior to discussing SMC for a particular sustainability indicator with the SMGWA Board, Directors were provided background information describing the sustainability indicator including the past and present groundwater conditions associated with it. Discussion during the meeting was facilitated by David Ceppos from Consensus and Collaboration Program at the College of Continuing Education, Sacramento State. Facilitation focused on information sharing, topic understanding, and public participation.

Once there was comfort in understanding Basin conditions related to the sustainability indicator, the technical consultant described potential options for SMC. First, a statement that identified significant and unreasonable, or unsustainable conditions, was drafted. The statement was revisited multiple times in subsequent Board meetings until the Board was satisfied with the definition.

The significant and unreasonable conditions statement for each sustainability indicator guided development of the other SMCs, including undesirable results, minimum thresholds, and measurable objectives. Options for each SMC were provided to the SMGWA Board for consideration. This approach was taken so that the Board could understand the relative levels of protectiveness for each indicator before making decisions. Interim milestones were developed based on current conditions, measurable objectives, and future groundwater conditions predicted by the groundwater model and did not have direct SMGWA Board input.

Meeting summaries and video recordings posted on the SMGWA website reflect the discussions that took place for each sustainability indicator. The SMC were developed over several meetings of the SMGWA Board, which allowed for continual improvements to the criteria. Additionally, opportunities for public comment on the topics being discussed at the SMGWA Board meetings were provided and taken into consideration during development of the SMC.

3.2.2 Surface Water Technical Advisory Group

Representatives from the following organizations and agencies participated in 2 technical Surface Water Technical Advisory Group (TAG) meetings to provide their perspectives on the approach for development of depletion of interconnected surface water SMC and identification of groundwater dependent ecosystems (GDEs):

- Balance Hydrologics (consultant to the SMGWA)
- California Department of Fish and Wildlife
- California Department of Water Resources
- City of Santa Cruz Water Department
- County of Santa Cruz Environmental Health
- Environmental Defense Fund
- Land Trust of Santa Cruz County
- Montgomery & Associates (consultant to the SMGWA)
- National Marine Fisheries Service (NMFS, formerly NOAA Fisheries)
- The Nature Conservancy
- Resource Conservation District of Santa Cruz County
- San Lorenzo Valley Water District staff
- Santa Margarita Groundwater Agency Board (2 directors)
- Scotts Valley Water District staff
- US Fish and Wildlife Service

The 2 meetings, held on August 14, 2020, and February 24, 2021, provided the TAG background information on the hydrogeological setting of the Basin, City of Santa Cruz habitat conservation planning, Santa Cruz County fish monitoring, potential conjunctive use opportunities for SLVWD, water budget, and current understanding of the relationship between surface water and groundwater. Based on the background information available, the technical team shared potential approaches for developing SMC for the depletion of interconnected surface water and plans for GDE monitoring. The TAG was asked to provide specific input on the SMGWA Board's statement of significant and unreasonable, potential SMC approaches, and GDE monitoring plan. Their expert input was taken into account in the development of SMC and the GDE monitoring plan.

3.3 Monitoring Networks

This section describes the monitoring networks and protocols that the SMGWA will use to assess groundwater conditions and the Basin's sustainability during GSP implementation. The monitoring networks included in this subsection are based, to the extent possible, on existing monitoring networks described in Section 2.1.2: Water Resources Monitoring and Management Programs. The subsections below describe how the existing networks are adapted to meet the SGMA requirements for each applicable sustainability indicator. A subset of monitoring wells from the existing monitoring network are selected as Representative Monitoring Points (RMPs) at which to establish SMC for measuring progress towards sustainability. Finally, this section identifies monitoring network data gaps and proposed improvements for networks that are insufficient for assessing current and future conditions.

3.3.1 Description of Monitoring Networks

The SGMA regulations require that monitoring networks be developed to promote the collection of data of sufficient quality, frequency, and spatial distribution to characterize groundwater and related surface water conditions, and to evaluate changing conditions that occur during GSP implementation. Monitoring networks should accomplish the following:

- Demonstrate progress toward achieving interim milestones and measurable objectives described in the GSP
- Monitor impacts to beneficial uses and users of groundwater
- Monitor changes in groundwater conditions relative to measurable objectives and minimum thresholds
- Quantify annual changes in water budget components

The Basin’s existing monitoring networks have been used for many decades to collect information to demonstrate short-term, seasonal, and long-term trends in groundwater and related surface water conditions. The existing networks can be used to collect data relevant to the Basin’s applicable groundwater sustainability indicators including chronic lowering of groundwater levels, depletion of interconnected surface water, reduction of groundwater in storage, and degraded groundwater quality (Table 3-1).

Table 3-1. Applicable Sustainability Indicators in the Santa Margarita Basin

Sustainability Indicator	Metric	Proxy
Chronic Lowering of Groundwater Levels	Groundwater elevation	---
Reduction of Groundwater in Storage	Volume of groundwater extracted	---
Degraded Groundwater Quality	Concentration	---
Depletion of Interconnected Surface Water	Volume or rate of streamflow	Groundwater elevation

3.3.1.1 Groundwater Level Monitoring Network

Each SMGWA member agency has its own network of dedicated monitoring wells and extraction wells that monitor groundwater elevations in their respective jurisdictions. These wells have been used for decades to evaluate short-term, seasonal, and long-term groundwater trends for groundwater management purposes, and will be incorporated into the GSP groundwater level monitoring network.

There are currently 35 wells used to monitor groundwater levels at least twice a year. Clusters of monitoring wells completed in different aquifers at the same location are used to understand changes in vertical gradients between aquifers. Table 3-2 summarizes the wells in the existing monitoring network by aquifer. Figure 3-1 shows the basin-wide distribution of groundwater level monitoring wells.

Table 3-2. Summary of Groundwater Level Monitoring Network Wells

Aquifer Unit	Well Name	Well Type	Monitoring Agency	Sounding Frequency	Data Logger
Santa Margarita Aquifer	**SLWVD Quail MW-A**	**Monitoring**	**SLVWD**	**Monthly**	**N**
	SLVWD Quail MW-B	**Monitoring**	**SLVWD**	**Monthly**	**N**
	SLVWD Quail MW-C	Monitoring	SLVWD	Monthly	N
	SLVWD Quail Hollow #4A	Extraction	SLVWD	Monthly	N
	SLVWD Quail Hollow #5A	Extraction	SLVWD	Monthly	N
	SLVWD Olympia #2	Extraction	SLVWD	Monthly	N
	SLVWD Olympia #3	**Extraction**	**SLVWD**	**Monthly**	**N**
	SLVWD Pasatiempo MW-2	**Monitoring**	**SLVWD**	**Monthly**	**N**
	SVWD AB303 MW-1	Monitoring	SVWD	Daily	Y
	SVWD AB303 MW-3B	**Monitoring**	**SVWD**	**Daily**	**Y**
	SVWD SV1-MW INACTIVE	Monitoring	SVWD	Inactive	Y
	SVWD SV3-MW A	Monitoring	SVWD	Daily	Y
	SVWD SV3-MW B	Monitoring	SVWD	Daily	Y
	SVWD SV4-MW	**Monitoring**	**SVWD**	**Daily**	**Y**
	SVWD TW-18	**Monitoring**	**SVWD**	**Daily**	**Y**
	Hidden Meadows Mutual Water Co #2	Extraction	County	Semi-annually	N
	Ruins Creek	*Monitoring*	*County*	*Daily*	Y
	Bahr Drive	*Monitoring*	*SLVWD*	*Daily*	Y
	Glen Arbor Road	*Monitoring*	*SLVWD*	*Daily*	Y
	Bean Creek ds of Mackenzie Creek	*Monitoring*	*County*	*Daily*	Y
	Nelson Road/Lockhart Gulch	*Monitoring*	*County*	*Daily*	Y
Monterey Formation	**SVWD #9**	**Extraction**	**SVWD**	**Daily**	**Y**
	Weston Road	*Monitoring*	*County*	*Daily*	Y
	Smith Creek	*Monitoring*	*SLVWD*	*Daily*	Y

Aquifer Unit	Well Name	Well Type	Monitoring Agency	Sounding Frequency	Data Logger
	Near SV4-MW	*Monitoring*	*SVWD*	*Daily*	*Y*
Lompico Aquifer	Mount Hermon #1	Inactive	MHA	Semi-annually	N
	Mount Hermon #2	Extraction	MHA	Semi-annually	N
	Mount Hermon #3	Extraction	MHA	Semi-annually	N
	MHA-MW1	Monitoring	MHA	Semi-annually	N
	SLVWD Pasatiempo MW-1	**Monitoring**	**SLVWD**	**Monthly**	**N**
Lompico Aquifer	SLVWD Pasatiempo #5A	Extraction	SLVWD	Monthly	N
	SLVWD Pasatiempo #7	Extraction	SLVWD	Monthly	N
	SLVWD Pasatiempo #8	Extraction	SLVWD	Monthly	N
	SVWD #10	**Monitoring**	**SVWD**	**Monthly**	**N**
	SVWD #10A	Extraction	SVWD	Monthly	Y
	SVWD #11A	**Extraction**	**SVWD**	**Monthly**	**Y**
	SVWD #11B	Extraction	SVWD	Monthly	Y
	SVWD AB303 MW-3A	Monitoring	SVWD	Semi-annually	**Y**
	SVWD TW-19	**Monitoring**	**SVWD**	**Semi-annually**	**Y**
	SVWD SV3-MW C	Monitoring	SVWD	Semi-annually	Y
	Graham Hill Rd/Conference Drive	*Monitoring*	*SLVWD*	*Semi-annually*	*Y*
Lompico/ Butano Aquifer	SVWD #3B	Extraction	SVWD	Monthly	Y
	SVWD Orchard Well	Extraction	SVWD	Monthly	Y
	SVWD #15 Monitoring Well	Monitoring	SVWD	Monthly	Y
Butano Aquifer	**SVWD Canham Well**	**Monitoring**	**SVWD**	**Semi-annually**	**Y**
	SVWD Stonewood Well	**Monitoring**	**SVWD**	**Semi-annually**	**Y**
	Polo Ranch Road	*Monitoring*	*SVWD*	*Daily*	*Y*

Notes: Wells in bold are Representative Monitoring Points; wells in italics are to be installed in 2022

The monitoring network contains wells within each principal aquifer in areas where municipal extraction takes place. Areas where groundwater is used but there is no groundwater level monitoring typically occur where there are a significant number of domestic supply wells or there are GDEs. Potential additions to the monitoring network that would be required to meet the goals of the GSP are discussed in Section 3.3.5.

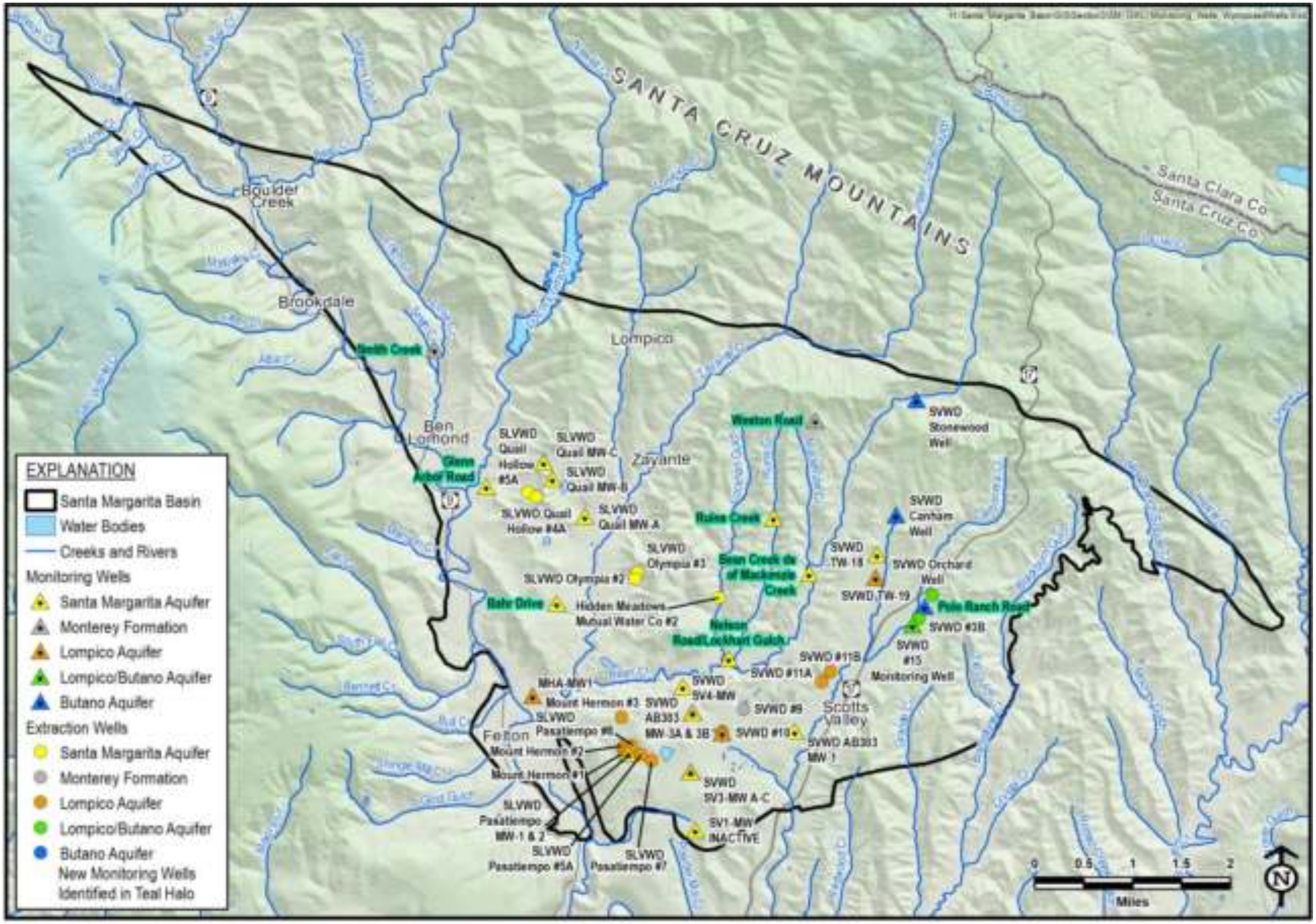

Figure 3-1. Location of Wells Used for Groundwater Level Monitoring with Proposed New Wells Labeled in Teal

Table 3-3. Summary of SMGWA Groundwater Level Monitoring Networks

Agency	Number of Wells			
	Monitoring	Extraction	Total	Representative Monitoring Points
San Lorenzo Valley Water District	5	7	12	5
Scotts Valley Water District	15	6	21	9
Mount Hermon Association	2	2	4	0
Total	*20*	*15*	*35*	*14*

The proposed groundwater level monitoring network shown on Figure 3-1 will be used to assess progress toward achieving interim milestones and measurable objectives with respect to chronic lowering of groundwater levels, and will serve as a proxy in assessing the depletion of interconnected surface water described in the GSP.

The chronic lowering of groundwater levels sustainability indicator will be monitored using existing monitoring wells, focused in areas of municipal groundwater extraction: Quail Hollow, Olympia, and Scotts Valley. In addition to existing wells, Section 3.3.4.1: Groundwater Level Monitoring Improvements describes 4 new monitoring wells that will be installed to address identified data gaps using Proposition 68 and SMGWA member agency match funds.

The depletion of interconnected surface water sustainability indicator will be monitored using 2 existing shallow monitoring wells: SVWD SV4-MW near Bean Creek and SLVWD Quail MW-A near an unnamed tributary of Zayante Creek. Recognizing that the Basin does not have enough shallow wells on the major creeks in the Basin to monitor and evaluate the effects of groundwater extractions on streamflow in interconnected surface waters, up to 5 new shallow monitoring wells will be installed using Proposition 68 and agency match funds to complete the monitoring network. The proposed new monitoring well general locations and intended use are described in more detail in Section 3.3.4.1.3.

Each agency will continue to monitor existing and new wells as the GSP is implemented. All groundwater level data collected, both hand soundings and pressure transducer records, will be stored in a regional data management system (DMS) to be managed by the County. All monitoring data uploaded to the DMS will be analyzed, compared to SMC, and included on hydrographs in the annual reports. The DMS is described in more detail in Section 3.3.2.5.

3.3.1.2 Groundwater Extraction Monitoring

Per GSP regulations, the quantitative metric for reduction of groundwater in storage is an annual volume of groundwater extracted. The volume of groundwater extracted will be measured using flow meters where available. For extraction wells that do not have flow meters, assumptions are made about water demand to estimate a volume of groundwater extracted. The location of the groundwater extraction well monitoring network is shown on Figure 3-2.

3.3.1.2.1 Metered Groundwater Extraction

The SLVWD, SVWD, and Mount Hermon Association measure monthly extraction by individual well using totalizer readings. Public Small Water Systems (SWS) with between 5 and 199 connections are required to measure and report monthly extraction data to Santa Cruz County Environmental Health (EH). Table 3-4 lists the extraction wells that are metered. All metered monthly extraction data will be stored in the DMS.

Table 3-4. Metered Extraction Wells

Aquifer	Well Name
Santa Margarita	SLVWD Quail Hollow #4A
	SLVWD Quail Hollow #5A
	SLVWD Olympia #2
	SLVWD Olympia #3
	Fernbrook Woods Mutual Water Company
	Fern Grove Water Club
	Hidden Meadows Mutual Water Company
	Karl's Dell
	Mission Springs Conference Center Well
	Vista Robles Association
Monterey	SVWD #9
	Love Creek Heights Mutual Water Association
	Moon Meadows Water Company
Lompico	SLVWD Pasatiempo #5A
	SLVWD Pasatiempo #7
	SLVWD Pasatiempo #8
	SVWD #10A
	SVWD #11A
	SVWD #11B
	Mount Hermon #2
	Mount Hermon #3
	Roaring Camp
Lompico/Butano	SVWD #3B
	SVWD Orchard Well

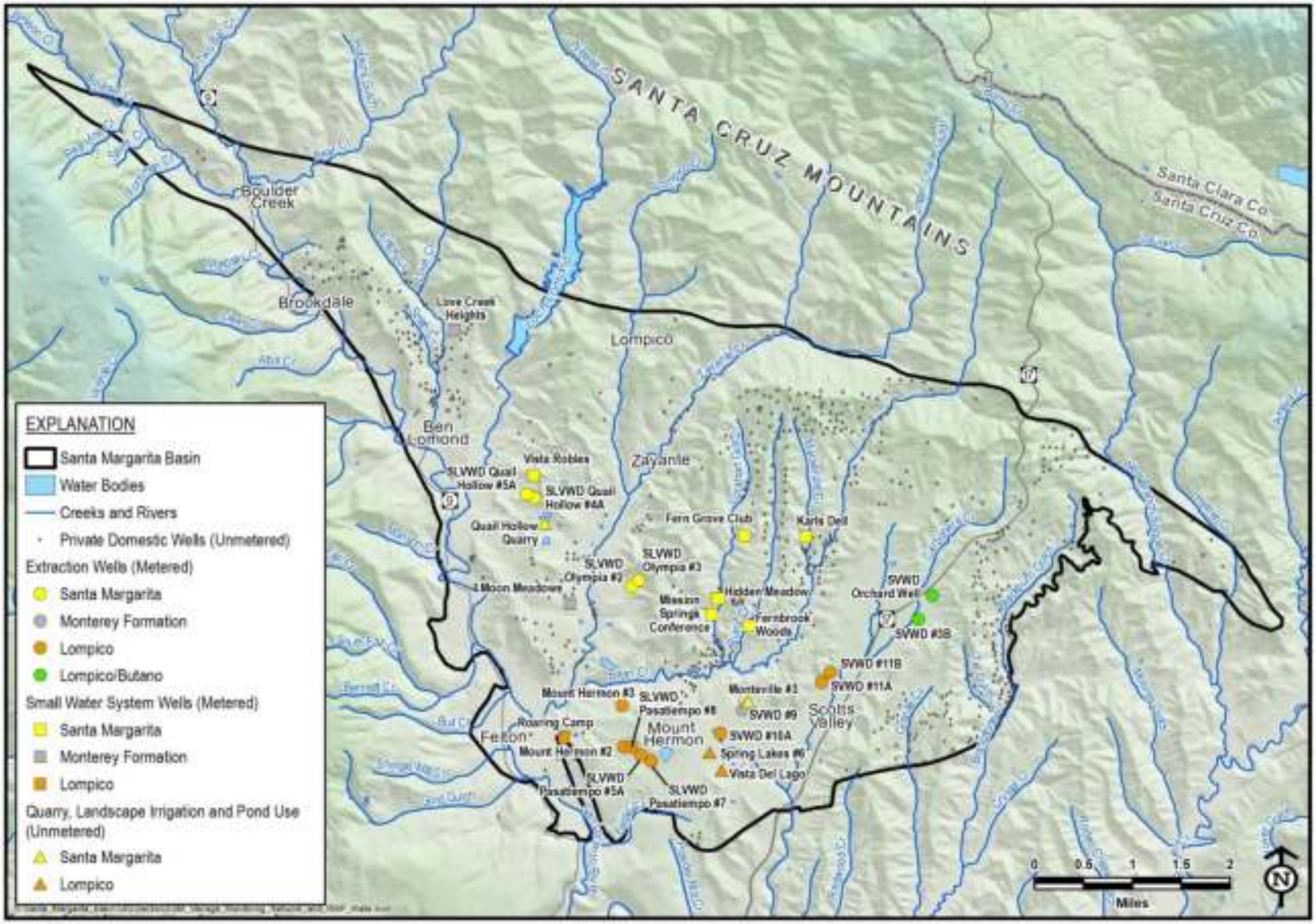

Figure 3-2. Location of Wells Used for Groundwater Extraction Monitoring

3.3.1.2.2 Unmetered Groundwater Extraction

Unmetered groundwater extraction includes pumping for private domestic supply, irrigation, and landscaping, and industrial water uses.

There are approximately 777 residential parcels throughout the Basin that are not supplied by public water agencies, and where unmetered groundwater pumping for domestic use takes place. These users are considered *de minimis* users, which is defined by the SGMA legislation as "a person who extracts, for domestic purposes, 2 acre-feet (AF) or less per year." Under SGMA, *de minimis* groundwater pumping (less than 2 AFY) is exempted from metering. This exemption, however, does not exempt *de minimis* pumpers from addressing impacts they may have on the Basin, including cumulative impacts. Collective pumping from *de minimis* wells for domestic supply is estimated to be around 233 AFY based on an annual water use factor of 0.3 AFY, which is approximately 8% of extraction from the Basin. An update of the number of residential parcels that are not served by public water supply agencies will be updated for the GSP's 5-year updates. During GSP implementation, the amount of water extracted for domestic use will be estimated based on the number of rural parcels with domestic wells, approximate population counts for people using domestic wells for water supply, and per connection water use estimates from small water systems and individual households that are metered.

Similar to domestic pumping, industrial groundwater extraction at Quail Hollow Quarry and irrigation by other larger private pumpers is currently unmetered. As part of GSP implementation, the SMGWA will implement a metering program that will require non-*de minimis* users who pump more than 2 AFY to meter their wells and provide records to the SMGWA. The number and location of industrial, pond filling, agricultural, and landscape irrigation non-*de minimis* pumpers are known based on land use maps.

Estimated groundwater extractions will not be included in the DMS as the data are not measured. Instead, estimated extraction data will be compiled and stored in tabular format. These data will be included in GSP 5-year updates and will be used to update the model. The frequency of future groundwater model updates during GSP implementation has not yet been determined.

3.3.1.3 Groundwater Quality Monitoring Network

Routine groundwater quality monitoring is almost entirely limited to public water agencies and SWS with 15 or more connections. Table 3-5 summarizes the 21 wells that are monitored most frequently in the Basin. Well locations are shown on Figure 3-3 and sampling frequency requirements for individual wells are summarized in Table 3-6. There are no dedicated monitoring wells that are used for groundwater quality monitoring, therefore all wells shown on Figure 3-3 are extraction wells.

Private domestic wells and SWS with 5 to 14 connections are generally not sampled routinely, as described in Sections 2.1.2.4.2.1 and 2.1.2.4.2.2. These wells are typically required by Santa Cruz County EH to be sampled after installation and before use. After initial sampling, there are no sampling requirements for domestic wells and limited and sporadic requirements for SWS with fewer than 15 connections. Data for domestic and SWS wells are reported to Santa Cruz County EH. Domestic wells and SWS with less than 15 connections are not included in the GSP's groundwater quality monitoring network, though the SMGWA will evaluate options for incorporating these limited data, if available, during future GSP updates. Should more water quality data be needed, the SMGWA could partner with the County on a free or reduced cost groundwater quality testing program for private well owners willing to share their data.

Table 3-5. Summary of Groundwater Quality Monitoring Network Wells

Member Agency	Number of Wells			
	Monitoring	Extraction	Total in Network	Representative Monitoring Points
San Lorenzo Valley Water District	0	7	7	3
Scotts Valley Water District	0	6	6	6
Mount Hermon Association	0	2	2	0
Fern Grove Club	0	2	2	0
Hidden Meadows Mutual Water Co.	0	1	1	0
Mission Springs Conference Center	0	2	2	0
Vista Robles Association	0	1	1	0
Total	*0*	*21*	*21*	*9*

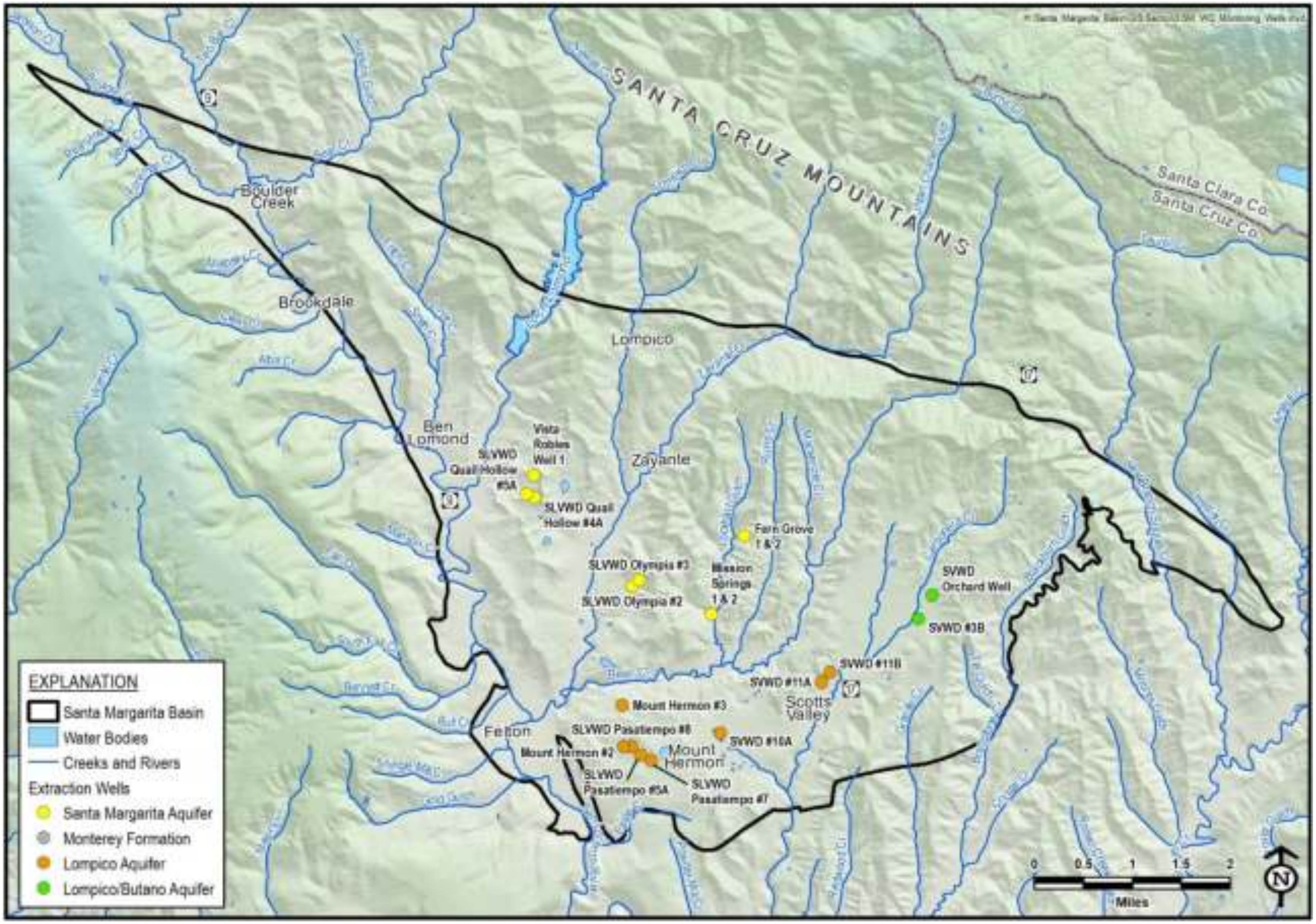

Figure 3-3. Location of Wells Used to Monitor Groundwater Quality

Table 3-6. Current Sampling Frequency of Groundwater Quality Monitoring Wells

Aquifer	Extraction Well	Inorganics	Inorganics with More Frequent Sampling				Volatile (VOC) & Synthetic (SOC) Organics
			Nitrate as N	Arsenic	Iron	Manganese	
Santa Margarita	SLVWD Olympia #2	Every 3 years	1 x year	Every 3 years	4 x year	4 x year	Every 3 years
	SLVWD Olympia #3	Every 3 years	1 x year	Every 3 years	4 x year	4 x year	Every 3 years
	SLVWD Quail Hollow #4A	Every 3 years	1 x year	Every 3 years	4 x year	4 x year	Every 3 years
	SLVWD Quail Hollow #5A	Every 3 years	1 x year	Every 3 years	4 x year	4 x year	Every 3 years
	Mission Springs Conference Center #1	Every 9 years	1 x year	Every 3 years	Every 3 years	Every 3 years	SOCs = 9 years VOCs = 6 years
	Mission Springs Conference Center #2	Every 9 years	1 x year	Every 3 years	Every 3 years	Every 3 years	SOCs = 9 years VOCs = 6 years
	Hidden Meadows Mutual Water Co #2	Every 9 years	1 x year	Every 3 years	Every 9 years	Every 9 years	SOCs = 3 years VOCs = 6 years
	Fern Grove #1	Every 3 years	1 x year	Every 3 years	Every 3 years	Every 3 years	SOCs = 3 years VOCs = 6 years
	Fern Grove #2	Every 3 years	1 x year	Every 3 years	Every 3 years	Every 3 years	SOCs = 3 years VOCs = 6 years
	Vista Robles Association #1	Every 3 years	1 x year	Every 3 years	Every 9 years	Every 9 years	SOCs = 9 years VOCs = 6 years
Monterey	**SVWD #9 (standby well)**	1 x year	1 x year	1 x year	1 x year	1 x year	1 x year
Lompico	MHA #2	Every 3 years	1 x year	Every 3 years	4 x year	Every 3 years	SOCs = 3 years VOCs = 6 years
	MHA #3	1 x year	1 x year	1 x year	1 x year	1 x year	SOCs = 3 years VOCs = 6 years
	SLVWD Pasatiempo #5A	Every 3 years	1 x year	12 x year	12 x year	12 x year	Every 3 years
	SLVWD Pasatiempo #7	Every 3 years	1 x year	12 x year	12 x year	12 x year	Every 3 years
Lompico (cont'd)	SLVWD Pasatiempo #8	Every 3 years	1 x year	12 x year	12 x year	12 x year	Every 3 years
	SVWD #10A	4 x year	4 x year	4 x year	4 x year	4 x year	2 x year
	SVWD #11A	4 x year	4 x year	4 x year	4 x year	4 x year	4 x year
	SVWD #11B	4 x year	4 x year	4 x year	4 x year	4 x year	4 x year
Lompico/ Butano	**SVWD #3B**	4 x year	4 x year	4 x year	4 x year	4 x year	4 x year
	SVWD Orchard Well	4 x year	4 x year	4 x year	4 x year	4 x year	4 x year

Notes: Wells in bold are Representative Monitoring Points

3.3.1.4 Streamflow Monitoring Network

Stream stage and discharge will be assessed in areas where groundwater pumping occurs in the vicinity of streams connected to groundwater. Streamflow monitoring gauges are located throughout the Basin, especially in the southern portion, where tributaries consolidate into the larger stream reaches and groundwater and surface water interactions occur due to aquifers exposed at the ground surface.

There are 7 active stream gauges within the Basin that will continue to be used as part of the GSP monitoring network. An additional 8th gauge is planned for installation in late 2021. One of the existing gauges is maintained and operated by the USGS (streamflow gauge No. 11160500, San Lorenzo River at Big Trees) with funding from the City of Santa Cruz. The other active stream gauges are funded and maintained by the City of Santa Cruz and the County. The USGS and City of Santa Cruz stream gauges are measured monthly throughout the year and the County stream gauges are typically operational during the seasonal baseflow period (approximately May to November) to record flow during the driest time of year. The stream gauge network is summarized in Table 3-7 and shown on Figure 3-4. A few of the recently inactivated gauges have also been included on Figure 3-4 and Table 3-7 for reference.

Beginning in 2017, Balance Hydrologics conducted annual late-season stream observation walks called accretion runs to help determine where groundwater is contributing flow to the stream, and where the stream is replenishing groundwater. Accretion studies were performed at locations along the San Lorenzo River and its tributaries shown on Figure 3-4. Results of accretion studies are described in Section 2.2.4.6. The SMGWA will evaluate whether further accretion studies would provide additional value based on changes observed in the groundwater levels, streamflow, and GDE health over the 5-year monitoring period before the first GSP update in January 2027.

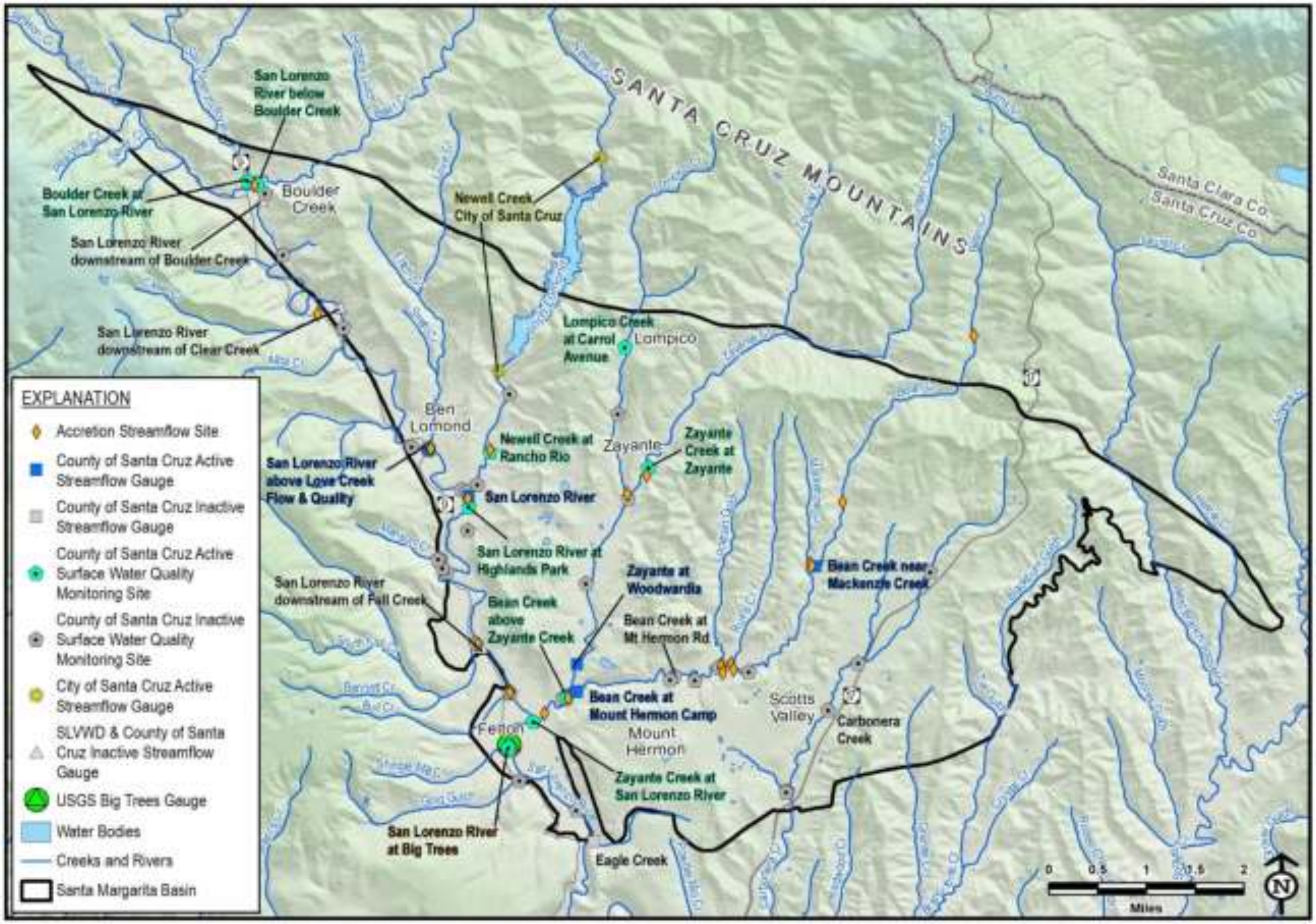

Figure 3-4. Location of Streamflow Gauges and Surface Water Quality Monitoring Sites

Table 3-7. Summary of Streamflow Gauges

Monitoring Agency	Streamflow Gauge Name	Status	Parameters Measured	Frequency Measured
USGS	USGS 11160500 San Lorenzo River at Big Trees	Active	Streamflow	Approximately monthly
City of Santa Cruz	Newell Creek below Loch Lomond	Active	Streamflow	Approximately monthly
	Newell Creek above Loch Lomond	Active	Streamflow	Approximately monthly
San Lorenzo Valley Water District	San Lorenzo River Downstream of Fall Creek	Inactive	Streamflow, Temperature	Approximately monthly during seasonal baseflow
	San Lorenzo River Downstream of Clear Creek	Inactive	Streamflow, Temperature	Approximately monthly during seasonal baseflow
	San Lorenzo River Downstream of Boulder Creek	Inactive	Streamflow, Temperature	Approximately monthly during seasonal baseflow
County of Santa Cruz	San Lorenzo River above Love Creek	Active	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Newell Creek upstream of San Lorenzo River	Active	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Zayante at Woodwardia	Active	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Bean Creek at Mount Hermon Camp	Active	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Bean Creek near Mackenzie Creek	Planned in late 2021	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow
	Eagle Creek Gauge	Inactive after October. 2020	Streamflow, Specific Conductance, Temperature	Approximately monthly during seasonal baseflow

3.3.1.5 Groundwater Dependent Ecosystem Monitoring

As part of GSP implementation, the SMGWA will evaluate potential impacts to GDEs from groundwater use, projects, or management actions. The GDEs will be evaluated using surface water measurements, field observations, and vegetation index mapping. Groundwater and surface water monitoring networks described in Sections 3.3.1.1 and 3.3.1.4, respectively, will be an integral part of GDE monitoring. GDE monitoring protocols are described generally below; other routine GSP monitoring protocols are described in Section 3.3.2.

Work in the Basin over the past few decades indicates surface water characteristics are directly related to what is occurring in the aquifer underlying the surface water during the dry season. Surface water observations for GDE assessment will include visual inspection and water level, specific conductance, and temperature measurements at representative sites. Decades of monitoring by Santa Cruz County and other agencies have shown that these metrics vary seasonally with wet and dry periods and are resilient to most other watershed surface disturbances but are still susceptible to changes in conditions of the aquifers that control them. The timing of observations will be standardized, and field visits will occur twice a year, once in late spring/early summer (early May) and again in late summer/early fall (late September to early October). Timing may need to be adjusted slightly depending on the type of water year, and if there is late season rain, to capture the range of baseflow conditions. Measurements and observations will be documented in a standard format that will be uploaded to the DMS. Qualitative metrics, such as photo monitoring and general site observations, will also be collected during site visits to further evaluate site conditions within the context of the direct measurements. This information will be provided in annual GSP updates.

Vegetation vigor is affected by changes in groundwater, climate, and physical conditions (erosion, sedimentation, mass wasting, wildfire, etc.). Vegetation vigor datasets are generated through processing satellite imagery. State agencies have made these datasets publicly available thereby making them a cost-effective indicator of change in groundwater levels and GDE vegetation quality. The common vegetation vigor indices include Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and Normalized Difference Moisture Index (NDMI)[1,2]. Within the Basin, the diversity in GDE types and the natural high NDVI values, make vegetation vigor a suitable long-term tool for analysis of vegetation impacts from changing groundwater levels. Remote sensing tools, such as the Nature Conservancy's GDE Pulse or Google Earth Engine will be used to qualitatively assess the health of vegetation surrounding lakes and ponds by evaluating changes in vegetation vigor indices, such as NDVI, EVI, and NDMI, over time. This information is available online and is free for the SMGWA to

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[1] https://www.usgs.gov/core-science-systems/nli/landsat/landsat-enhanced-vegetation-index?qt-science_support_page_related_con=0#qt-science_support_page_related_con
[2] https://gde.codefornature.org/#/methodology

access. Vegetation vigor analysis by remote sensing methods will be conducted every 5 years using annual remote sensing data available over that 5-year period. Results of the analysis will be included in the GSP's 5-year updates. Table 3-8 summarizes GDE monitoring frequency.

Table 3-8. Summary of GDE Monitoring Frequency

Monitoring Type	Frequency
GDE Field Assessment	Twice per Year, Late Spring/Early Summer and Late Summer/Early Fall
Vegetation Vigor	Every Five Years

3.3.1.5.1 Groundwater Dependent Ecosystem Monitoring Network

As described in Section 2.2.3.10, GDEs are classified into categories: springs, open water, riverine/riparian, and other groundwater-supported wetlands. Monitoring objectives will be specific for each type of GDE summarized below, with monitoring at representative GDE monitoring sites occurring semi-annually or every 5-years, depending on the objective. Monitoring objectives and frequency are summarized in Table 3-9, and monitoring locations are summarized in Table 3-10 and shown on Figure 3-5.

Table 3-9. Groundwater Dependent Ecosystems Monitoring Objectives and Frequency

GDE Classification	Semi-Annual Frequency Late Spring/Early Summer and Late Summer/Early Fall	Frequency of Every Five Years
	Monitoring Objectives	
Springs	Flow, specific conductance, temperature, and shallow groundwater monitoring	Vegetation vigor
Open Water (lakes and ponds)	Photo monitoring, water level and shallow groundwater monitoring	Vegetation vigor
Riverine/ Riparian (perennial and ephemeral streams, riparian corridors, on-channel ponds, wetlands)	Streamflow and shallow groundwater monitoring	Vegetation vigor
Other Groundwater-Supported Wetlands (seeps, quarry floor, willow, shrub, and scrub vegetation)	Photo monitoring, shallow groundwater monitoring	Vegetation vigor

Table 3-10. Groundwater Dependent Ecosystem Representative Monitoring Sites

Site	GDE Types	Selection Rationale
Glenwood Preserve and Canham Springs	Springs and Other Groundwater-Supported Wetlands	Near SVWD pumping, near contact between Santa Margarita aquifer and Santa Cruz Mudstone
Quail Hollow	Springs, Open Water, and Other Groundwater-Supported Wetlands	Near SLVWD pumping in Santa Margarita aquifer
Zayante Creek south of Quail Hollow	Springs, Riverine and Riparian	Near SLVWD and private pumping, near contact between Santa Margarita aquifer and Monterey Formation
Redwood and Ferndell Springs	Springs	Near Mount Hermon Association pumping, springs are in the Santa Margarita aquifer
Eagle Creek Springs	Springs	At southern extent of Basin, springs are in the Santa Margarita aquifer
San Lorenzo River, Zayante Creek, and Bean Creek	Riverine and Riparian	Primary streams in the Basin that are connected to groundwater, with nearby municipal and private pumping wells

3.3.1.5.1.1 Springs

Monitoring of representative springs listed in Table 3-10 and shown on Figure 3-5 will include measurements of flow, specific conductance, and temperature, along with general observations of the spring and surrounding vegetation. These physical measurements and records will be the clearest link between hydrologic support for GDEs and groundwater management. Monitoring will occur semi-annually during the first 10 years of the monitoring program to document the relationship between surface water flow, groundwater levels, and GDE health. Springs located near streamflow gauges will additionally be monitored during regular streamflow gauge calibration site visits.

3.3.1.5.1.2 Open Water

Monitoring of representative open water sites listed in Table 3-10 and shown on Figure 3-5 will consist of evaluating vegetation vigor of fringe vegetation, photo monitoring, and measurements of surface water level. As previously discussed, remote sensing methods will be used to assess the changes in vegetation vigor surrounding open water GDEs during the period leading up to the GSP's 5-year update. To monitor the water surface level of the water body, a staff plate or measuring stick, will be installed at representative open water sites to document changes in water surface level at the site over time. Photos will be collected at established photo points, measurements of specific conductance and temperature will be taken, and observations of surface water stage and surrounding vegetation will be noted. Monitoring will occur semi-annually during the first 10 years of the monitoring program.

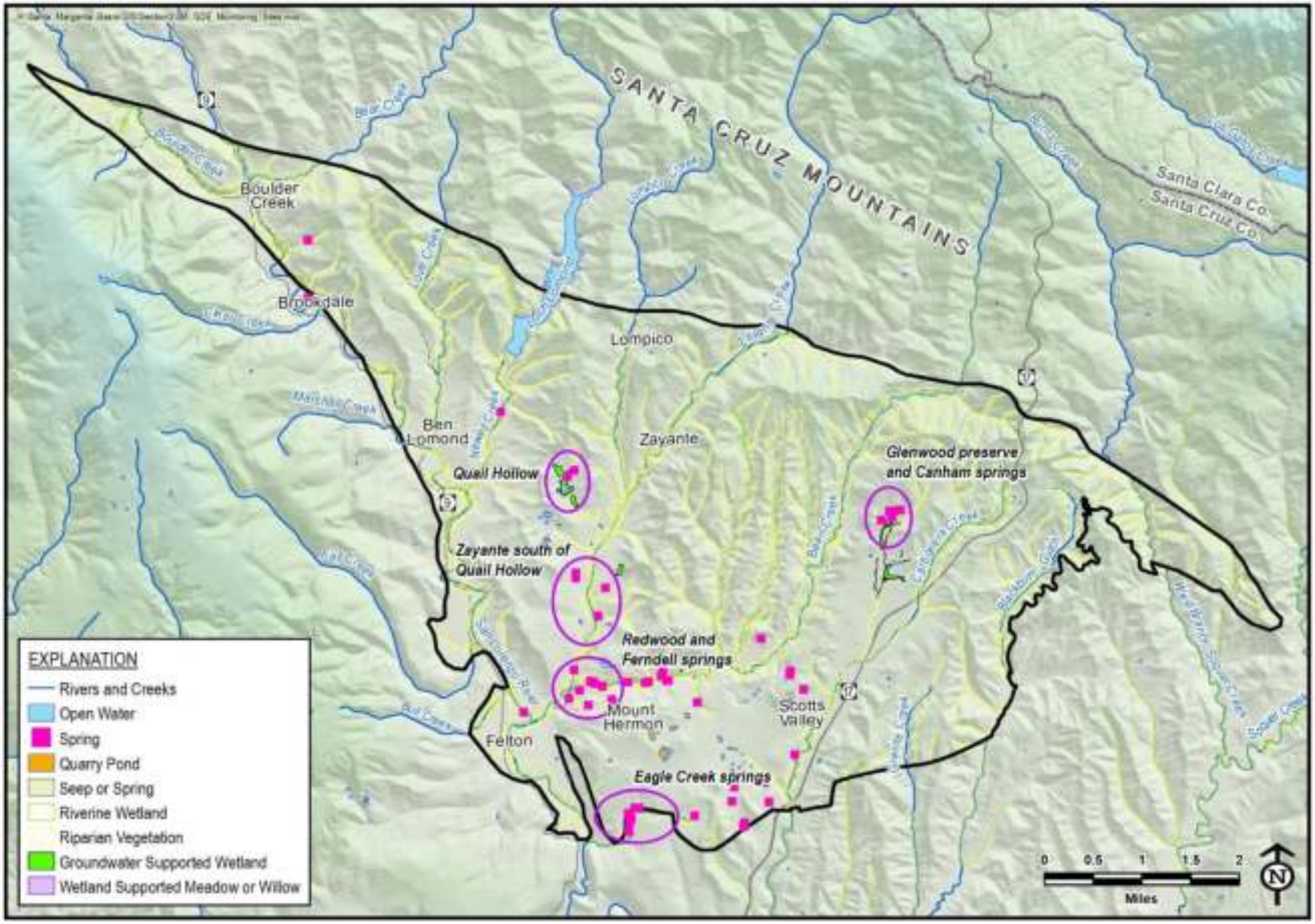

Figure 3-5. Location of Groundwater Dependent Ecosystem Monitoring Sites

3.3.1.5.1.3 Riverine and Riparian

Monitoring of representative riverine and riparian areas listed in Table 3-10 and shown on Figure 3-5 will consist of seasonal streamflow monitoring to document changes in baseflow in selected streams during a given year and compared to other years (see Section 3.3.1.4). Riverine and riparian monitoring will include evaluation of vegetation vigor along riparian corridors. Field observations will be compared with remote sensing data to assess annual changes in vegetation vigor within the riparian corridor, which can be an indicator of shallow groundwater availability for plants. The evaluation of vegetation vigor using remote sensing data will occur during the period leading up to the GSP 5-year update.

3.3.1.5.1.4 Other Groundwater-Supported Wetlands

Monitoring of representative other groundwater-supported wetland sites listed in Table 3-10 and shown on Figure 3-5 will consist of photo monitoring and evaluating vegetation vigor. As previously discussed, remote sensing methods will be used to assess the changes in vegetation vigor within representative other groundwater-supported wetlands during the period leading up to the GSP 5-year update. Semi-annual site visits during the first 10 years of the monitoring program will include collecting photos at photo monitoring locations, as well as general and qualitative site observations of the wetland and vegetation.

3.3.1.5.1.5 Representative Groundwater Dependent Ecosystem Sites

Specific sites are selected to be representative of the GDEs within the Basin (Table 3-10 and Figure 3-5). These sites will be monitored to evaluate the impacts by groundwater use, projects, or management actions on GDEs. These sites were selected based on their proximity to pumping areas, the underlying geology, and inferred or modeled stream connectivity with groundwater. The GDE data collected at representative sites will be supplemented by groundwater level and stream stage monitoring networks presented in Sections 3.3.1.1 and 3.3.1.4, respectively.

3.3.1.5.2 Groundwater Dependent Ecosystems and Priority Species

GDE monitoring will focus on areas most likely to support priority species habitat. For example, streamflow and temperature are critical components of habitat for many of the priority species within the Basin. Observations of changes in vegetation health, through monitoring vegetation vigor and photo monitoring, will indicate changes in groundwater availability for plants.

Table 3-11 lists priority species for the Basin selected for GDE management, the locations of those species, and the habitat components that will be measured through the GDE monitoring plan. Section 2.1.4.2.8 describes more broadly ecological beneficial users of groundwater including other priority species that may be found within the Basin. Other species of importance in the Basin not listed in Table 3-11 are believed to either not be dependent on groundwater or have similar needs as the priority species identified for GDE monitoring. For example, multiple plant species are included in each GDE type but are not specifically considered priority species for GDE monitoring.

Table 3-11. Priority Species Monitoring

Priority Species common name	Type of species	Location(s)	Habitat components monitored through SMGWA
Steelhead	Fish	Bean Creek, Zayante Creek, Lompico, MacKenzie, San Lorenzo River, Newell Creek, Love Creek, Boulder Creek	Streamflow, temperature
Coho Salmon	Fish	Bean Creek, Zayante Creek, San Lorenzo River	Streamflow, temperature
Lamprey	Fish	Bean Creek, Zayante Creek, Newell Creek, San Lorenzo River	Streamflow, temperature
California Red-Legged Frog	Amphibian	Bean Creek, Mountain Charlie Gulch	Streamflow, temperature, water level in open water and seeps/springs
Western Pond Turtle	Reptile	Zayante Creek, Newell Creek, San Lorenzo River	Streamflow, temperature, water level in open water and seeps/springs
California Giant Salamander	Amphibian	Probably distributed widely in basin. Bean Creek, Lockhart Gulch, Ruins Creek, Zayante Creek, Lompico Creek, San Lorenzo River	Streamflow, temperature, water level in open water and seeps/springs

3.3.1.5.3 Biological Responses

Ongoing studies, conducted by the County, SLVWD, and the City of Santa Cruz, will assist in data interpretation by providing additional information on the anticipated biological responses to surface water fluctuations and variability in GDE conditions. The Santa Cruz County Juvenile Steelhead and Stream Habitat Monitoring Program, a multi-agency partnership, has measured steelhead population density at more than 40 sites throughout the San Lorenzo, Soquel, Aptos, and Pajaro watersheds since 1989. Additionally, the County occasionally monitors riparian vegetation using the Riparian Rapid Assessment Method, a monitoring method developed by the Central Coast Wetlands Group to assess physical and biological complexity, and to infer ecological functioning and benefits (City of Santa Cruz Water Department et al., 2018). Data from these monitoring programs are anticipated to generally inform the SMGWA's ongoing consideration of potential groundwater management impacts to groundwater dependent ecosystems.

3.3.1.6 Climate Monitoring

Precipitation and temperature data are collected by the Basin's 2 municipal water agencies. The County of Santa Cruz has a county-wide rainfall sensor network (https://santacruz.onerain.com) with 1 sensor in the Basin at Ben Lomond. The collected data will be used to estimate precipitation and evapotranspiration which help refine estimates of groundwater recharge, runoff, and surface water and groundwater interactions. Climate stations are summarized on Table 3-12 and their locations are provided on Figure 2-12.

Table 3-12. Climate Stations in the Santa Margarita Basin

Monitoring Entity	Station Name	Parameters
San Lorenzo Valley Water District	Boulder Creek	Daily precipitation, daily minimum, maximum and average temperature
Scotts Valley Water District	El Pueblo Yard	Daily precipitation, daily minimum, maximum and average temperature
Santa Cruz County	Ben Lomond	Daily precipitation

3.3.2 Protocols for Data Collection and Monitoring

Pursuant to the goals of SGMA, agencies monitoring groundwater in the Basin endeavor to use reliable and effective data collection protocols to monitor groundwater conditions. Use of the monitoring protocols contained within this GSP ensures data are consistently collected thereby increasing the reliability of data used to evaluate GSP implementation. There are 5 types of data collected: groundwater level, groundwater quality, streamflow, groundwater extraction volume, and climate conditions.

3.3.2.1 Groundwater Level Measurement Protocols

Groundwater level monitoring is conducted to evaluate Basin conditions relative to the sustainable management criteria for chronic lowering of groundwater levels and depletion of interconnected surface water, as shown in Table 3-1. Groundwater levels in some wells are measured and recorded at least daily using pressure transducers with data loggers. Groundwater level measurement in wells without data loggers are collected monthly.

All groundwater level measurements are referenced to a consistent elevation datum, known as the Reference Point (RP). For monitoring wells, the RP is typically a mark on the top of the well casing. For extraction wells, the RP is typically the top of the well's concrete pedestal. Per GSP regulations, the elevation of the RP of each well is to be surveyed to the North American Vertical Datum of 1988 (NAVD 88). Currently, the elevation of the monitoring well RPs 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. Groundwater elevation is calculated using the following equation:

$$GWE = RPE - DTW$$

where:

GWE = groundwater elevation

RPE = reference point elevation

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

3.3.2.1.1 Manual Groundwater Level Measurement

All manual groundwater level measurements will use the following protocols:

- Measurements will be collected using an electronic sounder or steel tape. Electronic sounders consist of a 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 groundwater. This is the preferred method for monitoring groundwater levels, but other methods may be used. For instance, some extraction wells may have lubricating oil floating on top of the groundwater column; oil and groundwater levels in these wells will be gauged with an oil water interface probe or steel tape with oil and water indicator paste. Equipment usage will follow manufacturer specifications for procedure and maintenance.
- In wells that have been subject to recent pumping, a measurement will be taken after pumping has ceased and the water level has recovered to a stable level. If a well pump cannot be turned off during the scheduled monitoring event, then a measurement will be collected if possible, and accompanied by an explanatory note.
- For each well, multiple measurements will be collected to ensure the well has reached equilibrium such that no significant changes in groundwater level are observed.
- Equipment will be thoroughly cleaned after measurements at each well location in order to prevent cross-contamination among wells.

- The groundwater level measurement will be collected from a permanent reference mark. If a well is found to not have a permanent reference mark, one will be made on the north side of the casing to ensure subsequent measurements reference the same point.

3.3.2.1.2 Groundwater Level Measurement with Continuous Recording Devices

In addition to manual groundwater level measurements, some wells in the Basin are equipped with pressure transducers to collect more frequent data. These include SVWD extraction wells and most monitoring wells. Installation and use of pressure transducers abide by the following protocols:

- In order to calibrate the transducer data, the sampler will use a water level measurement device to measure the current groundwater level prior to installation of the probe. The groundwater level will be measured following the protocols listed above.
- All transducer installations will follow manufacturer specifications for installation and calibration. The time on the transducer internal clock will be synchronized with the computer satellite time.
- The well name, transducer name, transducer range, transducer accuracy, and cable serial number will be recorded in any log or datasheet used to document measurements.
- The sampler will note whether the pressure transducer uses a vented or non-vented cable for barometric compensation. If non-vented units are used, data will be corrected for natural barometric pressure changes using a barometric pressure logger or if unavailable, weather station data.
- All transducer cables will be secured to the well head with a well dock or another reliable method. This cable will be marked at the elevation of the reference point to allow estimates of future cable slippage (as needed).
- Transducer data will be periodically checked against manually measured groundwater levels to identify electronic drift, cable movement, and transducer failure. These checks will occur at least annually, typically during routine site visits.
- Transducer data will be downloaded when water levels are measured. Transducer data will be entered into the regional DMS as soon as possible. Once the transducer data has been successfully downloaded and stored, the data will be deleted or overwritten to ensure adequate data logger memory.
- Desiccant for vented transducers will be replaced as needed, or at least annually, in order to prevent failure of the transducers. Non-vented transducers are preferred for this reason as they do not require routine maintenance.

3.3.2.2 Groundwater Quality Monitoring Protocols

Monitoring of groundwater quality in the Basin will rely on existing sampling programs. All public water supply agencies and SWS are responsible for sampling and testing groundwater from wells used for drinking water.

For purposes of GSP implementation, groundwater quality monitoring is required to provide data to assess whether projects and/or management actions implemented to achieve sustainability are degrading groundwater quality (Table 3-1). While specific groundwater sampling protocols vary depending on the constituent and the hydrogeologic context, the protocols contained herein provide guidance which is applied to all groundwater quality sampling:

- All groundwater quality analyses will be performed by laboratories certified under the State Environmental Laboratory Accreditation Program.
- Prior to sampling, the sampler will contact the laboratory(s) to schedule sample analysis, obtain appropriate sample containers, and clarify any sample holding times or sample preservation requirements. Laboratory(s) must be able to provide a calibration curve for the desired analyte and are instructed to use reporting limits equal to or less than the applicable data quality objectives, regional water quality objectives, or screening levels.
- Each well used for groundwater quality monitoring will have a unique identifier (ID). This ID will be written on the well housing or the well casing (if not there already) to avoid confusion.
- Sample containers will be labeled prior to sample collection if possible. The sample label will include the sample ID, sample date and time, sample personnel, sample location, preservative used, analyte, and analytical method.
- Prior to any sampling, the sampler will clean the sampling port and/or sampling equipment so that it is free of any contaminants and also decontaminate sampling equipment between sampling locations to avoid cross-contamination between samples. Cleaning should be conducted using a phosphate-free detergent, such as Alconox® or Liquinox®, followed by a rinse with distilled, deionized, or purified water.
- In the case of wells with dedicated pumps, samples will be collected at or near the wellhead. Samples will not be collected from storage tanks, at the end of long pipe runs, or after any water treatment. Samples from active extraction wells that are continuously purging may be collected after flushing the sample tap.
- Should monitoring well or inactive extraction well sampling be required, sampling should follow either low-flow or three well casing volume sampling methods. Low-flow sampling consists of purging at a low rate less than 0.13 gallons per minute and measuring water quality parameters until they stabilize within a specific range (Puls and Barcelona, 1996). Low-flow sampling is best suited for wells with short well screens less

than 20 feet in length. Three well casing volume sampling will consist of purging 3 standing volumes of water from the well to ensure that the groundwater sample is representative of ambient groundwater and not stagnant water in the well casing. If pumping causes a well to go dry, the condition will be documented, and the well will be allowed to recover to within 90% of the original level prior to sampling. For deep and large casing diameter wells, purging 3 well volumes may not always be applicable, so professional judgment will be practiced for purging and sampling.

- For low-flow and three well casing volume sampling protocols, field parameters including dissolved oxygen, electrical conductivity, temperature, oxidation reduction potential and pH may be collected during well purging. Samples should not be collected until these parameters stabilize. Parameters will be considered stabilized at the following ranges for 10 to 15 minutes: dissolved oxygen and oxidation reduction potential, ±10%; temperature and electrical conductivity, ±3%; and pH ±0.2%.
- All field instruments will be calibrated each day of use, cleaned between samples, and evaluated for drift throughout the day of use.
- Samples will be collected under laminar flow conditions if possible (i.e., without turbulence and bubbles). This may require reducing pumping rates prior to sample collection. For extraction wells, purging at laminar flow rates is not always an option, so professional judgment will be practiced.
- All samples requiring preservation will be preserved as soon as practically possible and filtered appropriately as recommended for the specific constituent.
- Samples will be chilled and maintained at 4 °C to prevent degradation of the sample prior to analysis.
- Samples must be promptly shipped or delivered in person to the appropriate laboratory to avoid exceeding holding times. The sampler will be responsible for providing proper chain of custody documentation for sample delivery.

3.3.2.3 Groundwater Extraction Measurement Protocols

Groundwater extraction volumes are collected to provide data for water demand operations, wellfield management, and estimate the GSP water budget. Additionally, the volume of groundwater extracted is the metric for the reduction of groundwater in storage sustainability indicator. Municipal SMGWA member agencies measure discharge from their individual extraction wells with calibrated flow meters and totalizers. SVWD and SLVWD also use SCADA systems to monitor and control extraction from individual wells in close to real time. Small water systems report monthly extractions to the County of Santa Cruz on an annual basis. the amount of water extracted for domestic use will be estimated based on the number of rural parcels with domestic wells, approximate population counts for people using domestic wells for water supply, and per connection water use estimates from small water systems that are metered.

3.3.2.4 Streamflow Monitoring Protocols

3.3.2.4.1 Stream Gauge Measurements

Stream stage and discharge measurements are collected by SMGWA cooperating agencies to monitor streamflow interaction related to groundwater extractions, monitor stream conditions related to fish habitat, and help preserve other beneficial uses of surface water. The Big Trees gauge on the San Lorenzo is operated and monitored by the USGS according to procedures outlined by USGS (1982).

Surface water is most easily measured using a stream gauge and stilling well system, which requires development of a ratings curve between stream stage and total discharge. Several measurements of discharge at a variety of stream stages are taken to develop an accurate ratings curve. This relationship is sometimes developed with assistance from Acoustic Doppler Current Profilers. Following development of an accurate ratings curve, streamflow is evaluated on a frequent basis using a stilling well and pressure transducer.

The following stream gauge monitoring protocols will be followed:

- Streamflow gauges within the basin are equipped with a staff plate and pressure transducer(s), housed in a stilling well.
- Most of the gauges are equipped with non-vented pressure transducers, which measure pressure, temperature, and specific conductance and are usually set to log at 15-minute intervals. All transducer installations follow manufacturer specifications for installation, calibration, data logging intervals, battery life, and anticipated life expectancy. Non-vented pressure transducers are properly corrected for natural barometric pressure changes. See Section 3.3.2.1.2 for pressure transducer installation protocol.
- Streamflow measurements are regularly made at gauging locations following the methods established by the Federal Interagency Sedimentation Program. All field measurements are documented by date in station observers' logs, which are included with data submittals.
- Streamflow velocities are measured using a bucket-wheel meter, either a full-size Type AA ("Price"), bucket-wheel current meters, or a 60% scale smaller meter ("pygmy meter"). Flow meters must meet and exceed the required calibration test of that type of meter prior to measuring flow.
- Measurements of streamflow are taken at a variety of stream stages to develop an accurate rating curve, which establishes the relationship between stream stage and total

discharge. The rating curve is used to create a continuous record of flow from the record of water depth collected by the pressure transducers.

3.3.2.4.2 Stream Accretion

To ensure consistency with previous accretion studies, any additional studies will follow the general protocol described below:

- Streamflow measurements and velocities will be collected per the protocols described in the Section above. To increase accuracy for the accretion studies, 30 or more "verticals," or discrete velocity measurements are typically collected across each stream transect.

- Streamflow velocities are measured using a bucket-wheel meter, either a full-size Type AA ("Price"), bucket-wheel current meters, or a 60% scale smaller meter ("pygmy meter"). For low flow stream discharge (less than 50 gallons per minute), measurements are taken using a bag with graduated cylinder or bucket. Flow from seeps is measured with a bucket and stopwatch or Ziploc bag and graduated cylinder where appropriate.

- Specific Conductance is measured with a calibrated specific conductance meter at field temperature and at 25 °C. Specific conductance is measured in the center of flow in the stream profile.

- Water quality samples, such as nitrate and phosphate, are collected in Polyethylene bottles. Each bottle and cap are triple rinsed at the site before sample collection. Each sampling team will collect at least 1 field duplicate per day. Samples are stored in a cooler with ice and kept at or below 4° C. Samples and the chain-of-custody forms are delivered to a state-certified laboratory at the end of the sampling day.

- All field measurements are documented by date in station observers' logs, which are included with data submittals.

3.3.2.5 Climate Monitoring Protocols

The SLVWD and SVWD both use weather stations manufactured by Davis Instruments. Instrument models include Vantage Pro and Vantage Pro2. The rain sensor is a self-emptying tipping bucket, with each tip occurring after 0.01 inches of rain. District staff operate and maintain the stations according to the user manual: https://www.davisinstruments.com/product_documents/weather/manuals/07395-333_IM-6322C-6334.pdf

3.3.3 Data Management System

A regional DMS has been developed jointly by the member agencies of the SMGWA and Santa Cruz Mid-County Groundwater Agency. The DMS platform is WISKI (Water Information Systems by Kisters) developed by KISTERS North America. WISKI also the DMS used by Soquel Creek Water District and the City of Santa Cruz Water Department for their own monitoring and operational purposes.

The DMS has been developed specifically to support water resource management that meets requirements outlined by the DWR for GSAs and can act as a regional platform for data management and access to data. It includes the following elements:

- Data repository and storage
- Data uploading using file importers
- Data quality assurance (QA) and control (QC) measures and features
- Management of multiple levels of user access with accessibility controls to ensure confidential data entered by one agency is not available to other agencies unless it relates to one of the GSAs
- Analytical and customizable reporting tools for time series and tabular data
- Capacity to accommodate system modifications and expansion to incorporate additional geographic areas or additional datasets
- Conformity with and enforcement of metadata standards
- Audit tracking options for particular data sets (i.e., a record of changes to a data set by a named user, when changes were made and what was changed)
- Potential for web portal options
- Migration of historical data into DMS

Complete end-user and technical support staff training is provided by Kisters. Under an annual support and maintenance agreement, ongoing support services and training are accessible to all end-users and IT staff.

The costs for development of the DMS is funded 83% by the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Sustainable Groundwater Planning Grant Program), administered by DWR, and 27% by the member agencies of both GSAs. Ongoing maintenance will be shared by the member agencies of both GSAs. Details on estimated cost to the SMGWA member agencies over the next 5 years are provided in Section 5 on Plan Implementation.

Cooperating agencies will be required to upload groundwater level data to the DMS twice a year quarter using simple tools developed by KISTERS for that purpose. These data are required for reporting to the SGMA portal and are also used to report on basin conditions for the Annual Reports required to be submitted to DWR by April 1 of each year following the SMGWA's adoption of the GSP. Each of the submitting agencies are responsible for QA/QC of their data, and barometric compensation and correction of data logger records prior to upload to the DMS.

Apart from groundwater level data, other data stored in the DMS include groundwater quality, streamflow stage and flow rate, GDE observations, rainfall, and groundwater extraction data. These data will also be uploaded by cooperating agencies twice a year prior to the SGMA required uploads to the SGMA portal before January 1 and July 1 of each year.

3.3.4 Assessment and Improvement of Monitoring Network

The monitoring networks will continue to be evaluated and refined during the GSP process. The following sections describe the current data gaps and how they may be improved during GSP implementation.

3.3.4.1 Groundwater Level Monitoring Improvements

There are areas of the Basin where groundwater is being used, but there are no historical or current groundwater level data. These are areas where monitoring network improvements are needed as soon as possible. Data gap areas identified include: 1) communities where there are a large number of private domestic wells pumping from either the Santa Margarita Sandstone or Monterey Formation; 2) deep Butano aquifer; and 3) areas where shallow groundwater is connected to surface water and groundwater pumping may be causing depletion of surface water. Up to 8 new monitoring wells are scheduled to be installed in 2022. The exact locations of new monitoring wells have not been finalized yet, but locations will be in the general vicinity described in Table 3-13 and depicted on Figure 3-6. Installation of the new monitoring wells is funded using Proposition 68 and SMGWA member agency match funds.

Table 3-13. Rationale for Proposed New Monitoring Well Locations

Location Type	Aquifer	General Location	Purpose
Monitoring in Areas of Concentrated Private Domestic Pumping	Santa Margarita	Near Ruins Creek (Ruins Creek on Figure 3-6)	Address a data gap in the aquifer where there is no historical groundwater level data
	Monterey	At the headwaters of Mackenzie Creek (Weston Road on Figure 3-6)	Collect data from an area with a high concentration of private domestic pumping and no records of historical groundwater levels
	Monterey	Northwest of Basin, near Love Creek (Smith Creek on Figure 3-6)	Collect data from an area with a high concentration of private domestic pumping and no records of historical groundwater levels
Deep Butano Sandstone	Butano	In the vicinity of SVWD Orchard and #3B extraction wells which are screened in both the Lompico and Butano aquifers (Polo Ranch Road on Figure 3-6)	Establish a monitoring well screened only in the Butano aquifer near SVWD extraction wells
Shallow wells to Monitor Surface Water / Groundwater Interactions	Santa Margarita	Bean Creek, downstream of Mackenzie Creek	Collect groundwater data near a portion of Bean Creek that periodically runs dry in summer months
	Santa Margarita	Bean Creek, near its confluence with Ruins/ Lockhart Creek (Nelson Road/Lockhart Gulch on Figure 3-6)	Monitor an area that has a high concentration of private domestic pumping and is the location where Bean Creek flow resurfaces when the upgradient reach is dry
	Santa Margarita	Zayante Creek, above confluence with Bean Creek (Bahr Drive on Figure 3-6)	Monitor an area where groundwater seeps out of the valley side and into Zayante Creek
	Santa Margarita	Newell Creek, between SLVWD Quail Hollow #8 extraction well and lower Newell Creek (Glen Arbor Road on Figure 3-6)	Monitor groundwater levels in the Quail Hollow subarea

3.3.4.1.1 Monitoring in Areas of Concentrated Private Domestic Pumping

A large proportion of private well owners pump from either the very productive Santa Margarita aquifer or the considerably less productive Monterey Formation. Monitoring both aquifers is critical to understanding the collective impact of individual private wells on GDEs, as well as the vulnerability of private well owners to groundwater level declines.

Relative to the Monterey Formation, the Santa Margarita Sandstone is less extensive across Basin, so only a single new monitoring well in the Santa Margarita is proposed, near Ruins Creek in an area with no historical groundwater level data (Table 3-13 and Figure 3-6). There are an additional 4 new Santa Margarita aquifer shallow monitoring wells proposed near private domestic wells to evaluate surface water/groundwater interactions as described in Section 3.3.4.1.3.

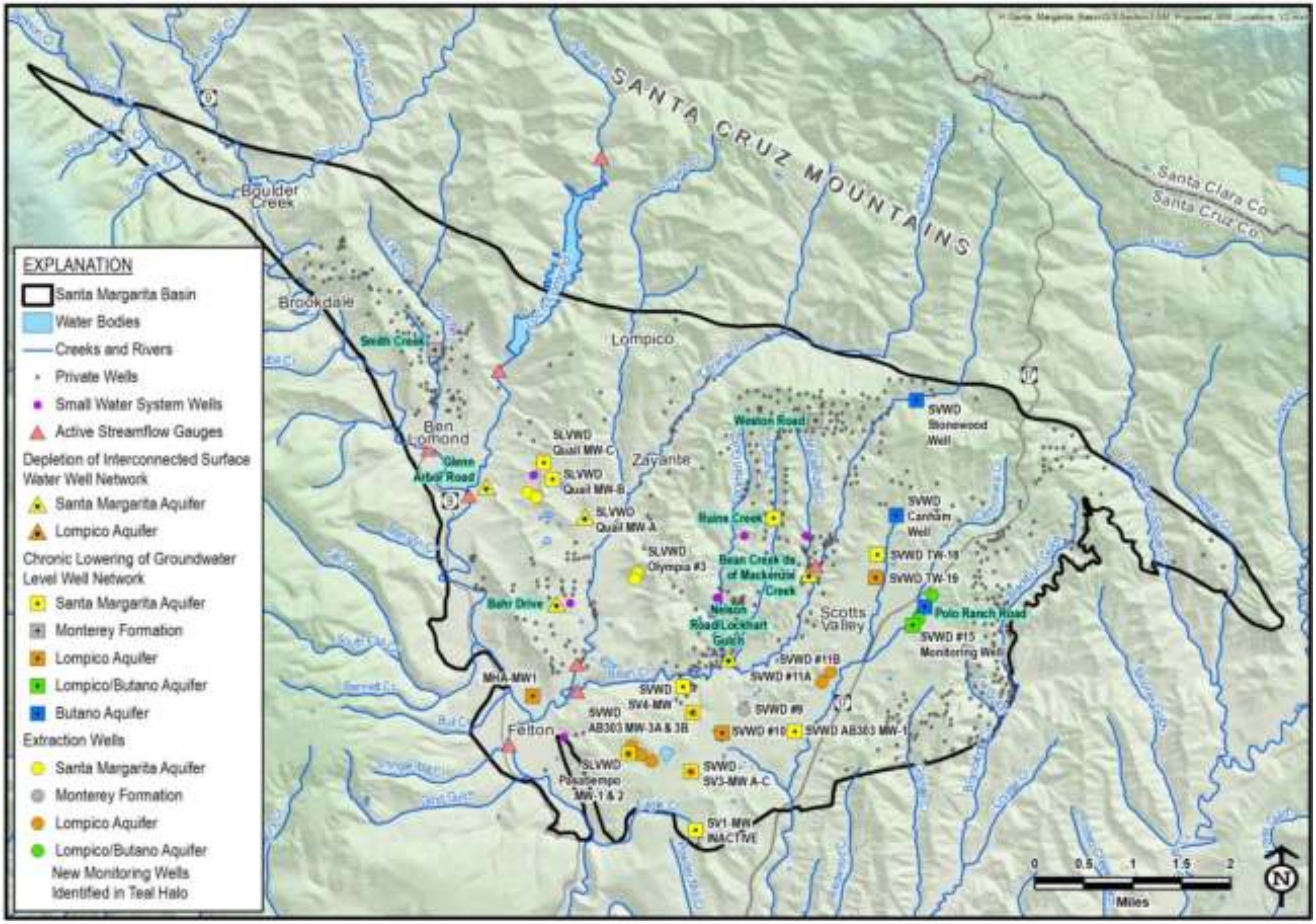

Figure 3-6. New Monitoring Wells (Teal Label) in Relation to Existing Monitoring Features

There is only a single groundwater level monitoring well located in the Monterey Formation within the Basin. Although not a principal aquifer, many private domestic wells extract their supply from the Monterey Formation because it is the only aquifer available to them. The largest concentrations of private domestic wells in the Monterey Formation are located where it crops out in the northwestern and northern parts of the Basin. Given that there are no long-term records of the groundwater levels in these areas, it is proposed to install 2 new monitoring wells. One well is near Love Creek and a second near the headwaters of Mackenzie Creek (Table 3-13 and Figure 3-6) in order to better understand how pumping and direct recharge effect groundwater levels.

3.3.4.1.2 Groundwater Levels in the Butano Aquifer

Groundwater level data from the Butano aquifer is limited because there are currently only 2 monitoring wells screened exclusively in the aquifer. Two municipal extraction wells and 1 monitoring well screened the Butano aquifer, are also screened in the Lompico aquifer. The 2 monitoring wells (Canham and Stonewood) screened exclusively in the Butano aquifer are located in northern Scotts Valley fairly distant from the municipal pumping center at SVWD's #3B and Orchard wells (Figure 3-1). A well dedicated to monitoring groundwater elevation in the Butano aquifer near these municipal wells (Figure 3-6) is necessary to further understand groundwater level responses to pumping and recharge in this poorly understood aquifer.

3.3.4.1.3 Shallow Monitoring Wells to Evaluate Surface Water/Groundwater Interactions

As the existing distribution of monitoring wells is largely limited to monitoring wells close to municipal pumping, additional shallow monitoring wells are required to 1) better understand the interactions between groundwater and surface water, 2) become RMPs for the depletion of interconnected surface water sustainability indicator, and 3) provide measured groundwater level data to improve simulation of groundwater and surface water interactions in the groundwater model. The 2 existing monitoring wells used as RMPs for the depletion of interconnected surface water sustainability indicator are inadequate to represent the entire Basin and it is expected that new shallow monitoring wells will become RMPs after several years of data collection.

Areas where the existing network should be improved by installation of shallow groundwater monitoring wells are listed in Table 3-13 and locations shown on Figure 3-6. There are a total of 5 proposed shallow wells: 4 monitoring wells in the Santa Margarita aquifer which contributes the greatest amount of groundwater to surface water in the Basin and 1 in the Lompico Sandstone near where the Lompico aquifer discharges to the San Lorenzo River. The locations of these new monitoring locations, although not yet finalized, are selected specifically to be paired with either existing or soon-to-be installed streamflow gauges. The intent is that data from the paired monitoring features will be used to quantify surface water depletions from groundwater pumping.

3.3.4.2 Groundwater Extraction Monitoring Improvements

Where groundwater extraction is unmetered, assumptions on water usage are used in this GSP to estimate the volume of extractions by private *de minimis* (2 AFY or less) or non-*de minimis* pumpers (more than 2 AFY). SGMA does not authorize GSAs to require metering of *de minimis* extractions, however, non-*de minimis* may be required to be metered by the SMGWA.

As part of GSP implementation, the SMGWA will initiate a new well metering program requiring measurement and reporting of all non-*de minimis* groundwater extraction greater than 2 AF annually. Groundwater pumpers using more than 2 AFY include the Quail Hollow Quarry, those that pump groundwater for large scale irrigation or to fill landscape ponds, environmental remediation pump and treat operations, and SWSs with more than 5 connections. The SWS with more than 5 connections have been metered since 2015. A planned non-*de minimis* metering program is described in more detail in Section 5 on Plan Implementation.

3.3.4.3 Groundwater Quality Monitoring Improvements

Groundwater quality sampling is conducted routinely in public drinking water supply wells; therefore, there are no spatial data gaps in this network. However, the sampling frequency in some municipal extraction wells is insufficient because specific analytes are only sampled once every 4 years per DDW requirements. Increasing the frequency of groundwater quality sampling will generate current water quality information that can be used to detect degradation of groundwater quality from projects and management actions implemented to achieve the Basin's sustainability goals. SLVWD intends to increase the sampling frequency on the water quality RMP wells for chemicals of concern (COC) identified in Section 2.2.4.4.

3.3.4.4 Streamflow Monitoring Improvements

As shown on Figure 3-4 there are currently no active surface water monitoring sites on Carbonera Creek within the Basin. As GDEs have been identified on Carbonera Creek within the Basin (Figure 2-28), streamflow monitoring should be established for potential correlation with nearby groundwater elevations. A new gauge on Carbonera Creek will be installed within the first 5 years of GSP implementation.

3.3.5 Representative Monitoring Points

Representative Monitoring Points (RMPs) are a subset of the Basin's overall monitoring network where numeric values for SMCs, including minimum thresholds, measurable objectives, and interim milestones, are set. Per the GSP regulations, designation of an RMP must be supported by adequate evidence demonstrating that the site reflects general aquifer conditions in the area.

Groundwater levels may be used as a proxy for sustainability indicators if the following can be demonstrated:

1. Significant correlation exists between groundwater elevations and the sustainability indicators for which groundwater elevation measurements serve as a proxy.

2. Measurable objectives established for groundwater elevation include a reasonable margin of operational flexibility taking into consideration the basin setting to avoid undesirable results for the sustainability indicators for which groundwater elevation measurements serve as a proxy.

Table 3-1 lists the metrics for each of the Basin's applicable sustainability indicators. The SMC for depletion of interconnected surface water sustainability indicator were developed using groundwater levels as a proxy.

3.3.5.1 Chronic Lowering of Groundwater Level Representative Monitoring Points

The selection of RMPs used to evaluate compliance with chronic lowering of groundwater level SMC are based on considerations that they:

- Have a relatively long-term historical record
- Are representative of the aquifer in which they are screened
- Are preferably not an extraction well

Based on an evaluation of spatial well distributions, available measured groundwater level data, and groundwater level trends, RMPs listed in Table 3-14 are selected as points for assessment of chronic lowering of groundwater sustainability indicator. These wells will be used for long-term monitoring and to compare against SMC established in this GSP. The rationale for selecting each RMP is provided in Table 3-14 and the well locations are shown on Figure 3-7.

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Table 3-14. Representative Monitoring Points for Chronic Lowering of Groundwater Levels

Aquifer	Well Name	Screen Interval (feet below ground)	Rationale
Santa Margarita	SLVWD Quail MW-A	38 – 88	Upgradient of Quail Hollow municipal wells, 1,600 feet from Zayante Creek, in an area with private domestic wells. Also, a depletion of interconnected surface water RMP due to shallow screen interval and proximity to the creek.
	SLVWD Quail MW-B	95 – 195	24-year record that is representative of nearby pumping wells SLVWD Quail Hollow #4A and #5A; screen overlaps with Quail Hollow #4A and just above Quail Hollow #5A (Figure 3-8)
	SLVWD Olympia #3	230 – 300	No dedicated monitoring wells in this area so an extraction well is the only option; It is selected because is screened shallower than Olympia #2 and for a greater thickness of the aquifer
	SLVWD Pasatiempo MW-2	280 – 340	30-year record in an area with historical Santa Margarita aquifer pumping. Westernmost active Santa Margarita monitoring well south of Bean Creek.
	SVWD TW-18	285 – 345	Northernmost monitoring well screened in the Santa Margarita aquifer
	SVWD SV4-MW	50 – 60	Also, a depletion of interconnected surface water RMP due to shallow screen interval and proximity to the creek. Representative of AB303 MW 3B (Figure 3-9).
Monterey	SVWD #9	155 – 195, 315 – 365	Only well screened in Monterey Formation with a long-term record that has a deep enough screened interval that has not gone dry
Lompico	SLVWD Pasatiempo MW-1	600 – 660	Representative of aquifer from which nearby extraction wells pump: Mount Hermon #2 and #3, and SLVWD Pasatiempo #5A, #7 and #8 (Figure 3-10).
	SVWD #10	190 – 220	Representative of AB303 MW-2 and AB303 MW-3A (Figure 3-11).
	SVWD #11A	399 – 419, 459 – 469, 495 – 515	No dedicated monitoring wells in this area so an extraction well is the only option; representative of SVWD #11B screened similarly (Figure 3-12).
	SVWD TW-19	960 – 1,050	Northernmost Lompico monitoring well
Lompico/ Butano	SVWD #15 Monitoring Well	700 – 1,100	Possibly convert to Butano only monitoring well. On the same site as pumping well SVWD #3B and therefore influenced by pumping
Butano	SVWD Stonewood Well	799 – 859	Northernmost Butano aquifer monitoring well in an area with private domestic pumping
	SVWD Canham Well	1,281 – 1,381	Closest Butano monitoring well to SVWD pumping in the Butano aquifer

Well names in italics are active extraction wells

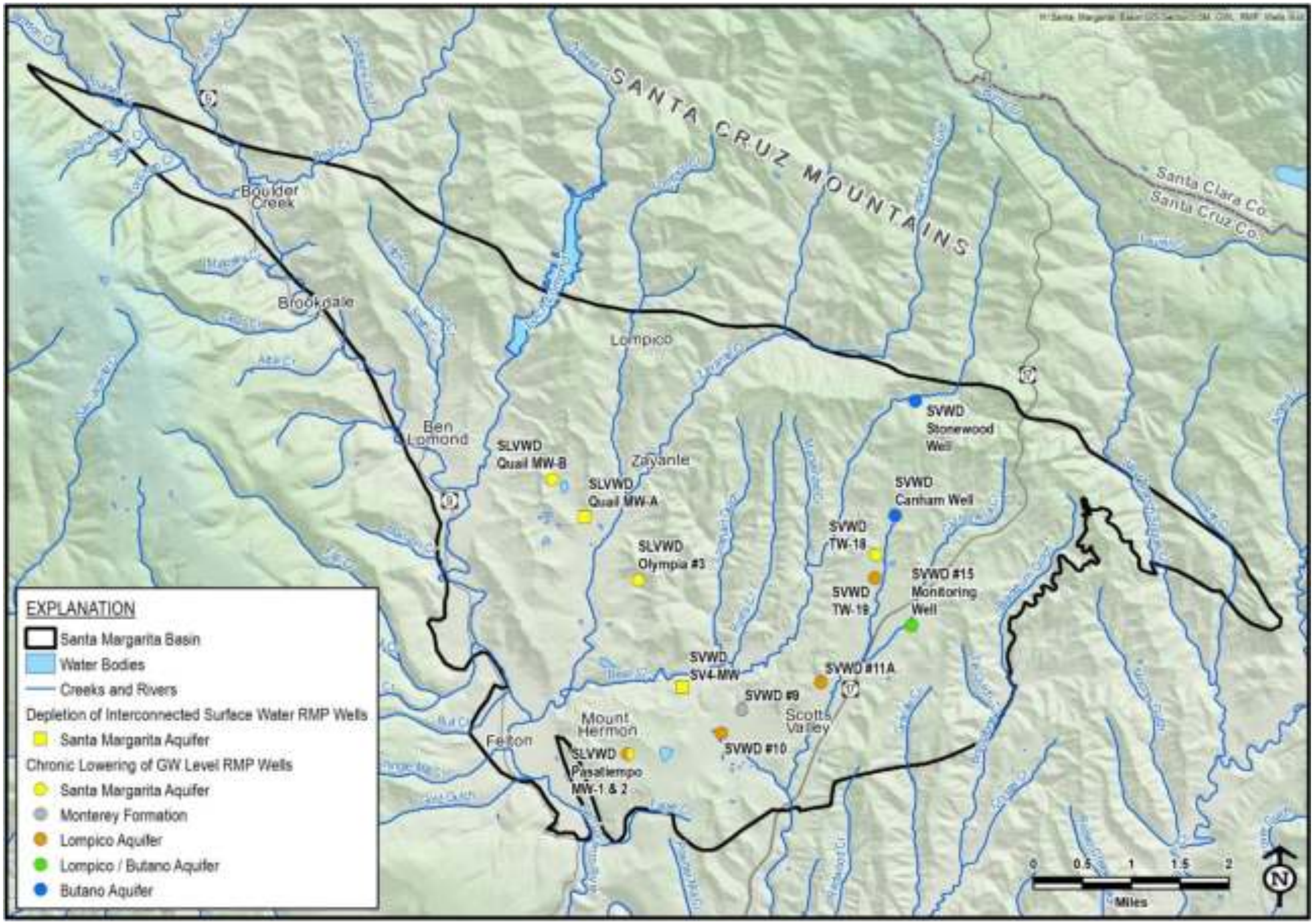
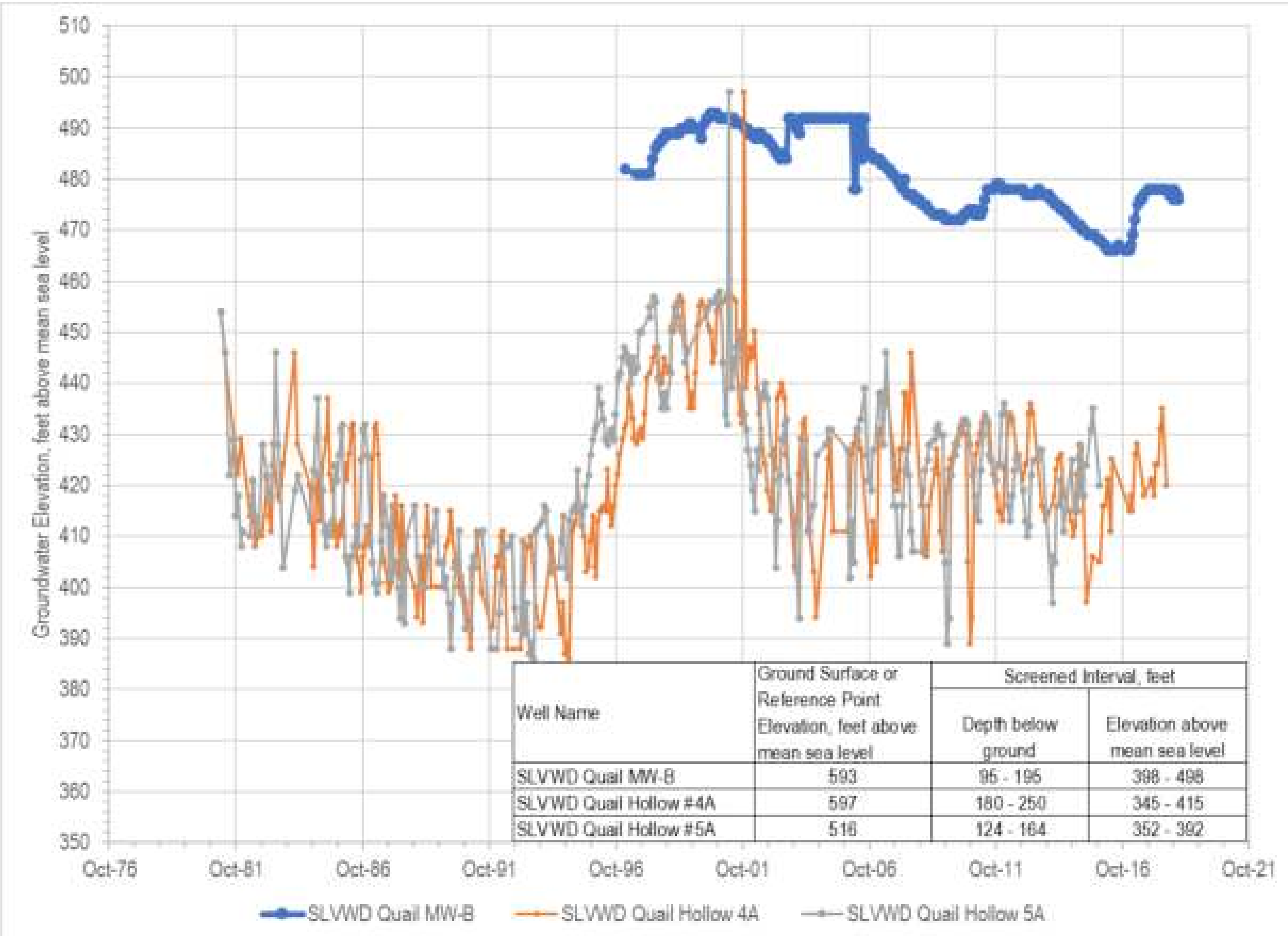


Figure 3-7. Representative Monitoring Points for Groundwater Levels



Well Name	Ground Surface or Reference Point Elevation, feet above mean sea level	Screened Interval, feet	
		Depth below ground	Elevation above mean sea level
SLVWD Quail MW-B	593	95 - 195	398 - 498
SLVWD Quail Hollow #4A	597	180 - 250	345 - 415
SLVWD Quail Hollow #5A	516	124 - 164	352 - 392

Figure 3-8. Hydrographs Showing Groundwater Elevations in Nearby Wells Relative to Representative Monitoring Point SLVWD Quail MW-B

Figure 3-9. Hydrographs Showing Groundwater Elevation in Nearby Well Relative to Representative Monitoring Point SVWD SV4-MW

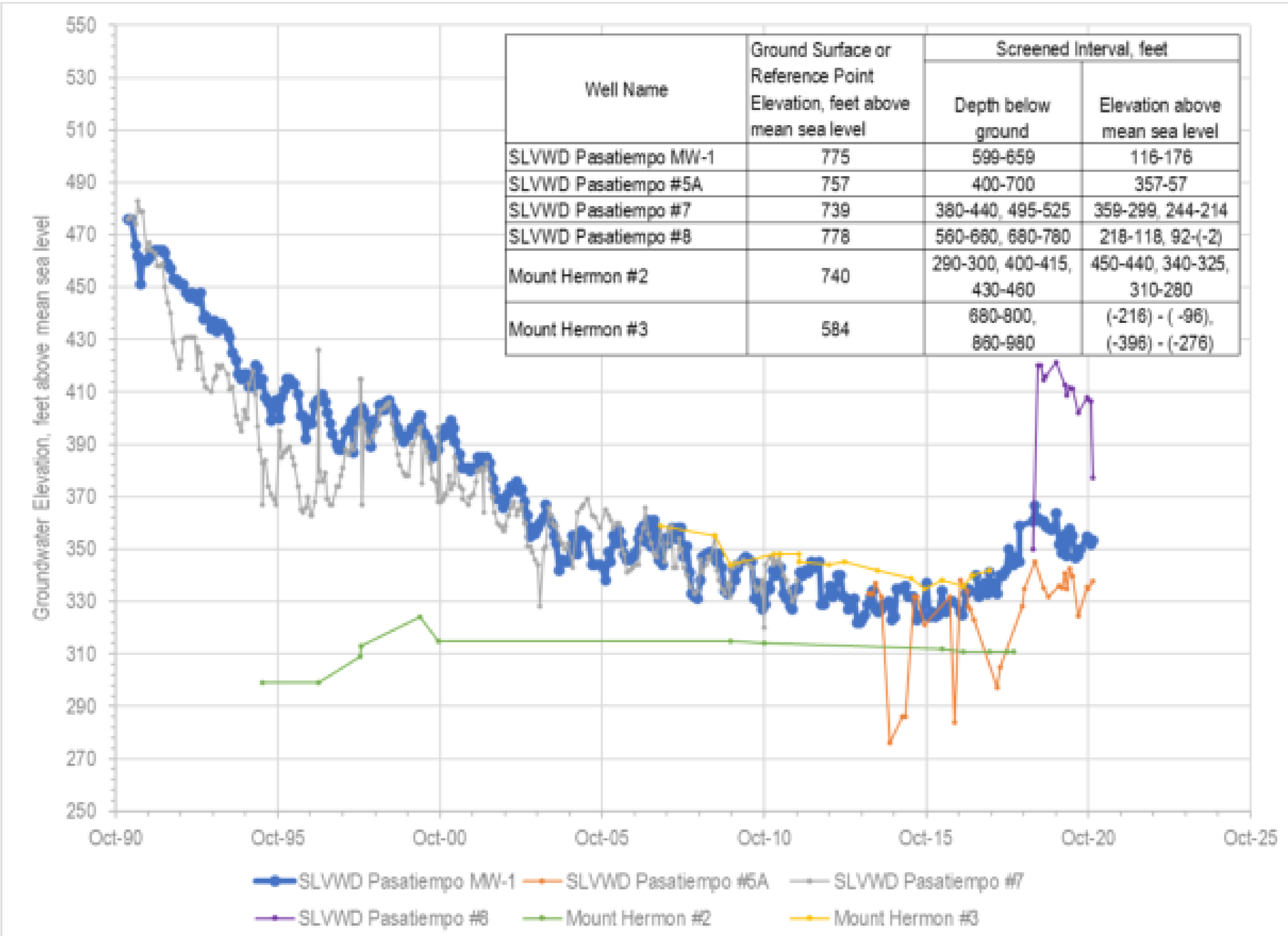
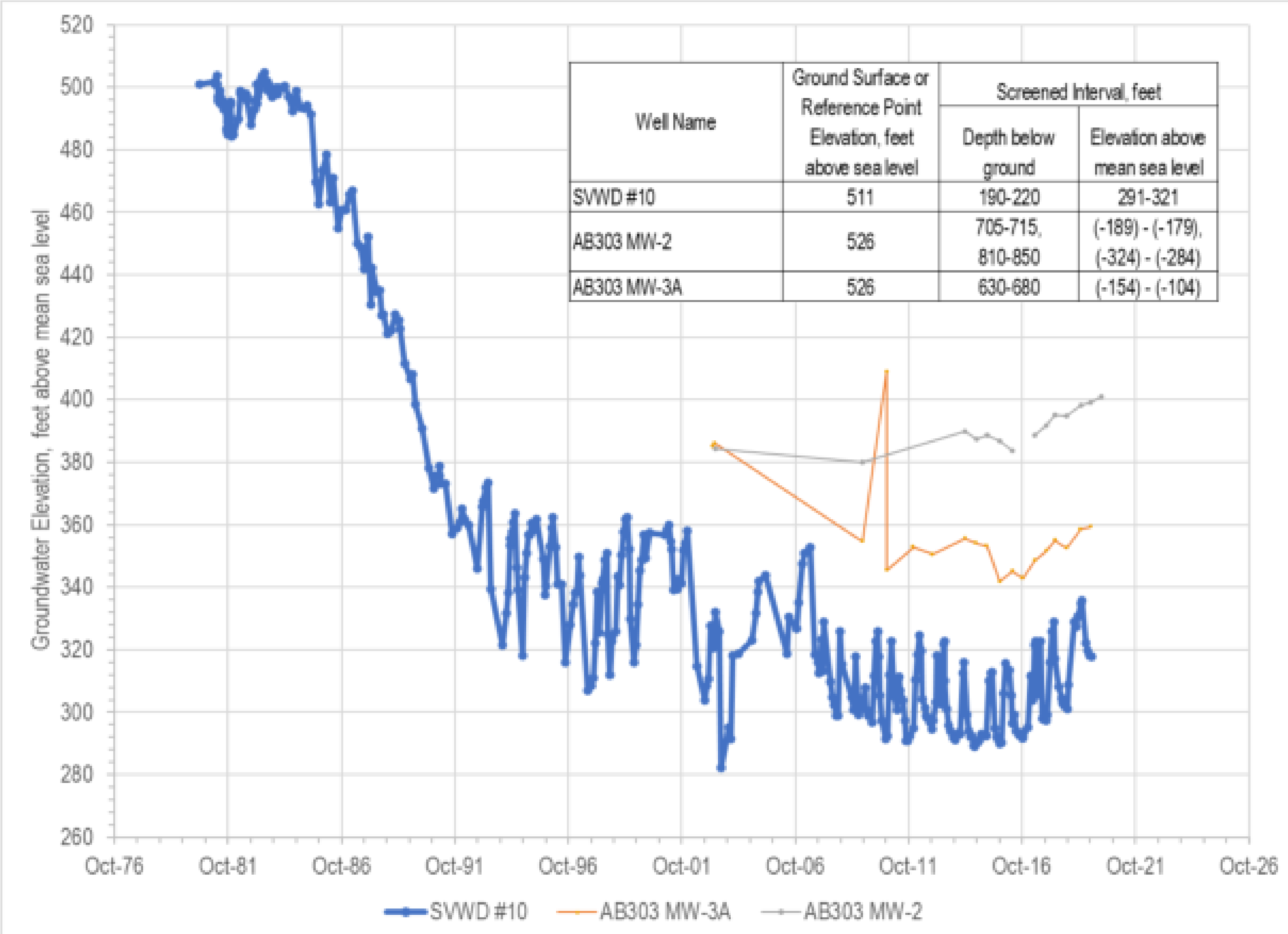
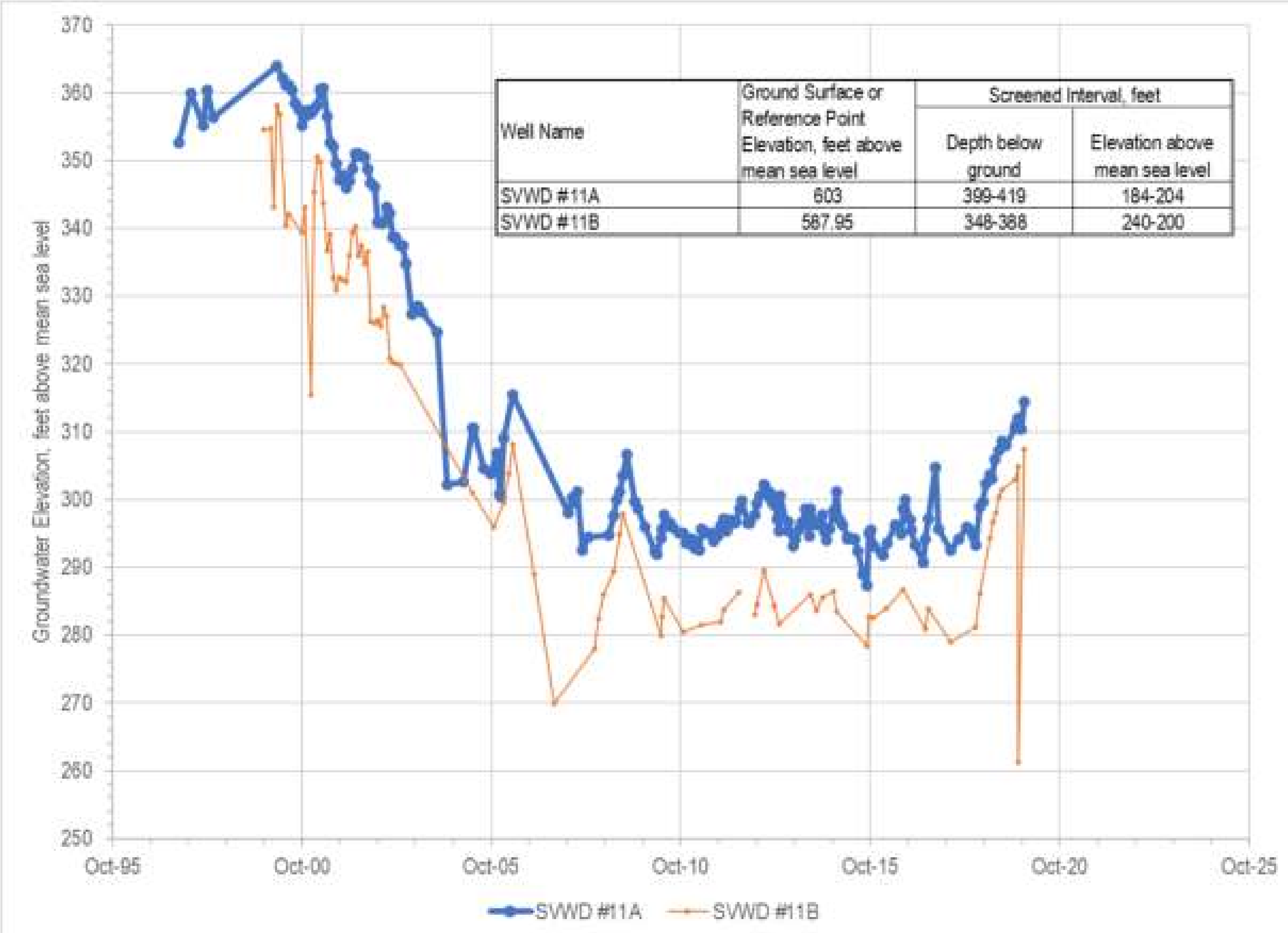


Figure 3-10. Hydrographs Showing Groundwater Elevations in Nearby Wells Relative to Representative Monitoring Point SLVWD Pasatiempo MW-1



Well Name	Ground Surface or Reference Point Elevation, feet above sea level	Screened Interval, feet	
		Depth below ground	Elevation above mean sea level
SVWD #10	511	190-220	291-321
AB303 MW-2	526	705-715, 810-850	(-189) - (-179), (-324) - (-284)
AB303 MW-3A	526	630-680	(-154) - (-104)

Figure 3-11. Hydrographs Showing Nearby Groundwater Elevations in Nearby Wells Relative to Representative Monitoring Point SVWD #10



Well Name	Ground Surface or Reference Point Elevation, feet above mean sea level	Screened Interval, feet	
		Depth below ground	Elevation above mean sea level
SVWD #11A	603	399-419	184-204
SVWD #11B	587.95	348-388	240-200

Figure 3-12. Hydrographs Showing Groundwater Elevation in Nearby Well Relative to Representative Monitoring Point SVWD #11A

3.3.5.2 Reduction of Groundwater in Storage Representative Monitoring Points

The RMPs for reduction in groundwater storage consist of all municipal and private extraction wells where groundwater extraction is measured or estimated. These include metered public water supply and SWS wells and unmetered private uses such as domestic, quarry operations, pond filling, and landscape irrigation. The metered RMP wells for reduction in groundwater storage are summarized in Table 3-4 and shown on Figure 3-2.

3.3.5.3 Degraded Groundwater Quality Representative Monitoring Points

The RMPs used to evaluate groundwater quality compared to degraded groundwater quality SMC are based on the criteria that they are:

- Regularly sampled at least annually
- Representative of the aquifer in which they are screened
- Located in areas where GSP related projects and management actions are likely to influence groundwater conditions

The above criteria were used to narrow the water quality RMPs to the active municipal extraction wells listed in Table 3-15 and shown on Figure 3-13.

Table 3-15. Representative Monitoring Points for Degraded Groundwater Quality

Aquifer	Well Name	Screen Interval (feet below ground)
Santa Margarita	SLVWD Quail Hollow #5A	124-164
	SLVWD Olympia #3	230-300
Monterey	SVWD #9	155-195, 315-355
Lompico	SLVWD Pasatiempo #7	380-440, 495-525
	SVWD #10A	280-380, 400-450
	SVWD #11A	399-419, 459-469, 495-515
	SVWD #11B	348-388, 423-468, 500-515
Lompico/Butano	SVWD #3B	700-720, 880-1,050, 1,180-1,370, 1,400-1,670
	SVWD Orchard Well	705-784, 805-1,063, 1,084-1,455

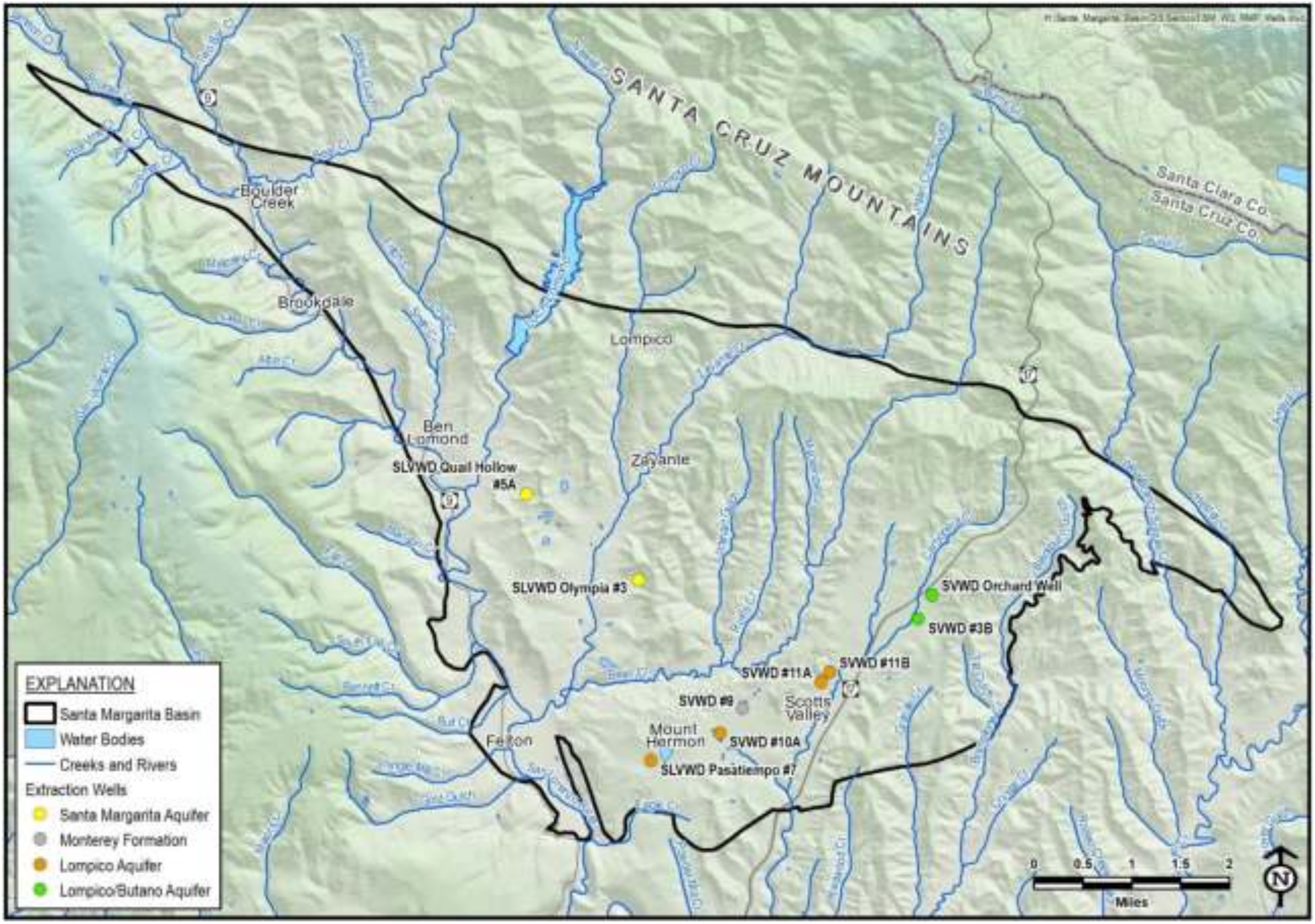


Figure 3-13. Representative Monitoring Points for Groundwater Quality

SLVWD is required to sample their extraction wells less frequent than annually for some COCs (Table 3-6); therefore, a single RMP for each of the 3 clusters of extraction wells in the Quail Hollow, Olympia, and Pasatiempo areas was selected for future increased sampling frequency on an annual basis for the COCs listed in the GSP. SLVWD extraction well water quality RMPs are Quail Hollow #5A, Olympia #3, and Pasatiempo #7. These specific wells are representative of aquifer conditions in nearby extraction wells as they are screened in the same aquifer and show similar groundwater quality trends. The wells selected either had the highest concentration in the well cluster of the COCs identified in Section 2.2.4.4, or if data were similar, had the longest sampling record in the well cluster.

3.3.5.4 Depletion of Interconnected Surface Water Monitoring Representative Monitoring Points

Direct streamflow measurements cannot be used because depletion of surface water by groundwater pumping is a fraction of the other factors influencing streamflow, such as precipitation and runoff, evapotranspiration, diversions, and natural groundwater / surface water interactions creeks. The GSP regulations allow for the use of groundwater elevations as a proxy for assessing the volume or rate of surface water depletion SMC. To use groundwater elevation as a proxy, there must be significant correlation between groundwater elevations and depletion of surface water. This correlation is demonstrated in Section 3.7.2.1.

The only existing shallow monitoring wells in the Basin that can be used for depletion of interconnected surface water RMPs are SLVWD Quail MW-A and SVWD SV4 MW (Figure 3-7). Historically, groundwater levels are measured monthly at SLVWD Quail MW-A and semi-annually at SVWD SV4-MW. SVWD SV4-MW was recently equipped with a datalogger, and SLVWD Quail MW-A will be equipped with a datalogger as part of Proposition 68 grant funds received by the SMGWA. The dataloggers will measure groundwater levels continuously. As a result, SMGWA will have a record of daily groundwater level in these wells.

Two shallow monitoring wells are not enough locations to represent the Basin's major creeks where there is interconnected surface water and groundwater pumping. Additional shallow monitoring wells are needed to monitor and evaluate the effects of groundwater levels on streamflow where it is connected to surface water. The additional monitoring wells are described in more detail in Section 3.3.4.4

3.4 Chronic Lowering of Groundwater Levels Sustainable Management Criteria

Groundwater levels in the Basin fluctuate seasonally and over the long-term. Groundwater level change in the unconfined Santa Margarita aquifer is driven mainly by variations in precipitation, as the aquifer drains quickly during extended dry periods, but is able to fill up during a wet year. The principal confined aquifers in the Basin also respond to changes in climate, but the response is muted in comparison to the unconfined Santa Margarita aquifer.

The primary groundwater condition in the Basin that is considered unsustainable to beneficial users is lowered groundwater levels in 2 of the Basin's principal aquifers, the Lompico and Santa Margarita aquifers in the Mount Hermon / South Scotts Valley area. There is a portion of this area where the entire depth of the Santa Margarita aquifer is dewatered due to groundwater level declines of 30 to 40 feet and where there has been a 150- to 200-foot decline in groundwater levels in the Lompico aquifer. Groundwater levels in both Santa Margarita and Lompico aquifers in the Mount Hermon / South Scotts Valley area started to decline as early as the 1970s when the area underwent extensive development. The groundwater level declines were exacerbated by a 10-year drought starting in 1984. During this drought, the Scotts Valley area experienced an average rainfall deficit of 8.6 inches relative to the long-term average annual rainfall of 41.7 inches. Coinciding with climate-driven reduced natural aquifer recharge, water demand in the Basin peaked further exacerbating groundwater conditions.

Groundwater levels in the Mount Hermon / South Scotts Valley area have stabilized over the past 10 years and even experienced a small amount of recovery due to water use efficiency measures and recycled water use to offset potable demand from the aquifers. The sustainability goal strives to improve groundwater levels in this portion of the Basin and the sustainable management criteria reflect that.

3.4.1 Significant and Unreasonable Chronic Lowering of Groundwater Levels

Significant and unreasonable chronic lowering of groundwater levels occurs if lowered levels materially impair groundwater supply, negatively impact beneficial uses, or cause undue financial burden to a significant number of beneficial users.

In this context, undue financial burden means a cost or financial impact resulting from an action or inaction of the SMGWA or groundwater users in the Basin, that is unwarranted, inappropriate, or excessive and/or rising to a level that is more than necessary, acceptable, or reasonable.

3.4.2 Undesirable Results - Chronic Lowering of Groundwater Levels

3.4.2.1 Criteria for Defining Chronic Lowering of Groundwater Levels Undesirable Results

The description of undesirable results from chronic lowering of groundwater levels is based on a quantitative description of a combination of minimum threshold exceedances that cause significant and unreasonable effects in the Basin.

Criteria considered in developing undesirable results included:

- Knowledge of impacts to groundwater beneficial users during periods when groundwater levels were lowest in the Basin
- How the Basin's aquifers respond to climatic changes
- Some level of flexibility for avoiding undesirable results that gives the SMGWA and its member agencies an opportunity to implement management actions if there are short-term declines in groundwater levels.

When Santa Margarita and Lompico aquifer groundwater levels declined in the Mount Hermon/South Scotts Valley subareas from 1985 through 1994 due to a combination of a 10-year extended drought and increased groundwater use in the area, there were known impacts to human groundwater beneficial users. In the early 1990s, municipal water supply wells screened in the dewatered Santa Margarita aquifer were replaced with wells screened deeper in the Lompico aquifer. Since the South Scotts Valley is supplied municipal water, there were no significant impacts to individual domestic users of groundwater in this portion of the Basin. Chronically lowered groundwater levels have not occurred in any other areas of the Basin.

The County has records that many shallow private wells less than 100 feet in depth outside of the Scotts Valley area were deepened or replaced in response to declining groundwater levels towards the end of the Water Year (WY) 1987-1994 drought. Since that extended drought there have not been many wells deepened or replaced with deeper wells, including during the WY2012-2015 drought.

Lowering of groundwater levels in the Santa Margarita aquifer in years of drought, although not ideal, are not considered significant and unreasonable if levels can recover (either naturally, by managed recharge, or by reducing pumping). It is anticipated that climate change will cause wetter wet years and drier dry years. Multiple consecutive dry years may lead to groundwater levels falling below historical measured lows (i.e., minimum thresholds). Groundwater model simulations under projected climate conditions demonstrate the effects of climate extremes on groundwater levels, including that during wet years, the Santa Margarita aquifer fills up relatively quickly because of its high recharge rate.

The Basin's confined aquifers, Lompico and Butano, together with the Monterey Formation, do not respond as rapidly to changing climatic conditions as the Santa Margarita aquifer.

3.4.2.2 Numerical Description of Undesirable Results

Specific groundwater level conditions that constitute undesirable results for chronic lowering of groundwater levels occur if the groundwater level in any RMP falls below the minimum threshold in 2 or more consecutive non-drought years. If a RMP groundwater level below its minimum threshold is caused by emergency operational issues or extended droughts, it is not considered an undesirable result.

Per DWR's draft Sustainable Management Criteria Best Management Practices (DWR, 2017), chronic lowering of groundwater levels due to prolonged drought will not be considered undesirable results:

> "Undesirable results are one or more of the following effects: Chronic lowering of groundwater levels indicating a significant and unreasonable depletion of supply if continued over the planning and implementation horizon. Overdraft during a period of drought is not sufficient to establish a chronic lowering of groundwater levels if extractions and groundwater recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods".

3.4.2.3 Potential Causes of Undesirable Results

Undesirable results may be caused by unsustainable groundwater use that results in chronic lowering of groundwater levels. Temporary lowering of groundwater levels during extended drought are exempted from this. Undesirable results may occur under the following conditions:

Changes to Basin Pumping. If the location and rates of groundwater pumping change as a result of new high-capacity wells, or projects and management actions implemented to improve sustainability and water supply reliability, these changes could result in localized lowering of groundwater levels and changes in groundwater flow directions. Total Basin extraction more than the sustainable yield is another potential cause of undesirable results for groundwater levels. Total extractions include those for municipal, small water systems, industrial, private domestic and landscaping, and agricultural uses.

Groundwater Recharge. Capture and transfer of stormwater runoff as part of a project that relies on stormwater to recharge groundwater may potentially result in localized lowered groundwater levels due to loss of recharge.

Surface Water Diversions. Diversion of surface water may result in reduced recharge to groundwater in the upper reaches of the Basin's creeks where losing creek conditions occur.

Most creeks in the Basin are currently gaining year-round and surface water diversions are currently small, making this a highly unlikely cause of undesirable results if current groundwater conditions and management practices continue.

3.4.2.4 Effects on Beneficial Users and Land Use

Currently, there are no undesirable results to human beneficial users occurring due to chronic lowering of groundwater levels. As described earlier, deeper wells replaced impacted shallow wells in the 1990's. Those municipal, industrial, agricultural, and domestic users of groundwater have adjusted to the lowered groundwater levels during pre-2012 droughts. Impacts of historical chronic lowering of groundwater levels on environmental groundwater users, such as GDEs and aquatic species is less understood.

If undesirable results from chronic lowering of groundwater levels occur in the future, it will impact beneficial users of groundwater as described in the bullets below. Lowering of groundwater levels will reduce the thickness of saturated aquifer from which wells can pump and may prevent a significant number of water supply wells from pumping the amount of groundwater they have typical used to meet their water needs.

Undesirable results from chronic lowering of groundwater levels can have the following general impacts on beneficial users and land uses:

- **Urban land uses and users**. If groundwater levels fall below municipal supply well pumps, the pump can only be lowered to the point where it reaches the bottom of the well, and then a deeper replacement well needs to be drilled. Lowering the pump or drilling a deeper well in the same location is not a solution as the levels will only continue to drop. Another solution is to move pumping to an unimpacted part of the Basin to meet demands. It is possible that changing extraction to a different groundwater supply source may add stress to those unimpacted parts of the Basin groundwater. Other effects on municipal users from lowered groundwater levels is the increased pumping costs due to greater lift required to bring the water to the surface.

  Lowered groundwater levels in both Santa Margarita and Lompico aquifers result in reduced contributions to streamflow and can impact the City of Santa Cruz, a downstream surface water user, especially in light of their efforts to support enhanced streamflow to protect and restore runs of endangered coho salmon and threatened steelhead trout. One result of the City's commitments to providing instream flows for fisheries is that it is working to develop a supplemental water supply to replace supply dedicated to fisheries. Continued loss of baseflows due to lowered groundwater levels in the Santa Margarita and Lompico aquifers incurs significant costs, borne by the City because it increases the amount of supplemental supply that the City needs to develop so that adequate flows are left in the river to comply with the provisions of the City's Habitat Conservation Plan.

- **Rural residential land uses and users**. Typically, rural residential users have the shallowest wells which makes them more vulnerable to lowered groundwater levels. If groundwater levels decline below the top of well screens or below pump intakes, landowners may lose access to groundwater and be forced to lower their pumps or drill their well deeper. Additionally, when groundwater levels fall below the top of well screens, this has the potential to cause cascading water in the well. Cascading or falling water is water flowing through preferential pathways above the groundwater table that falls into the well. As it pours into the well it introduces air into the water being pumped thereby causing pump cavitation. This condition may increase the cost to pump, cause physical damage to the well and pump, and potentially degrade groundwater quality within the well due to microbial biofouling. Property values may decline if low groundwater levels cause undesirable results that require residential pumping restrictions, deepening of wells, or connection to a public water system. Some small water systems rely on springs and lowered groundwater levels may dry the springs out.
- **Industrial land uses and users**. Industrial use of groundwater in the Basin is limited to process and dust suppression water at 1 remaining sand quarry at Quail Hollow. Chronic lowering of groundwater elevations has the potential to increase pumping costs or reduce access to groundwater for similar reasons listed above for rural residential users.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, chronic lowering of groundwater elevations has the potential to increase irrigation costs or reduce access to groundwater for similar reasons listed above for rural residential users.
- **Ecological land uses and users**. GDEs have the potential to be impacted directly if groundwater depths decrease below the accessible level for GDE vegetation. Surface water bodies connected to groundwater may also incur reductions in baseflow caused by lowering of groundwater levels. Reduced baseflow may negatively impact portions of the lifecycle of aquatic species.

3.4.3 Minimum Thresholds - Chronic Lowering of Groundwater Levels

Section §354.28(c)(1) of the GSP Regulations states that "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."

3.4.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The minimum thresholds and measurable objectives were established based on historical groundwater elevation data collected at RMP wells and projected groundwater levels during the GSP planning and implementation horizon. Appendix 3A includes hydrographs with historical measured and projected groundwater elevations for all RMP wells.

Board discussion on whether historical chronic lowering of groundwater levels during the recent or prior droughts had resulted in diminished supply in the past lead to general agreement that municipal, industrial, agricultural, and domestic users of groundwater adjusted to the lowered groundwater levels during past droughts. However, the SMGWA Board expressed that they did not want groundwater levels to fall below historical low levels as this would cause undue financial burden to some beneficial groundwater users.

3.4.3.2 Chronic Lowering of Groundwater Level Minimum Thresholds

As the SMGWA Board direction on chronic lowering of groundwater levels was that levels should not be allowed to fall below historical low levels, minimum groundwater elevations on record were considered to represent the minimum threshold. The absolute minimum elevation was not used for minimum thresholds because for some RMPs that value appeared anomalous. To treat each well’s data consistently without the need to discard seemingly anomalous data, an average of the 5 lowest measured elevations are used to calculate a minimum elevation to use as a minimum threshold. Using this methodology, minimum thresholds for chronic lowering of groundwater levels are the average of the 5 lowest measured groundwater elevations at each RMP.

Minimum thresholds for each RMP are summarized in Table 3-16. Hydrographs showing minimum thresholds and measurable objectives for each RMP are included in Appendix 3A. Examples from a RMP in the Santa Margarita aquifer and a RMP Lompico aquifer are shown on Figure 3-14 and Figure 3-15, respectively.

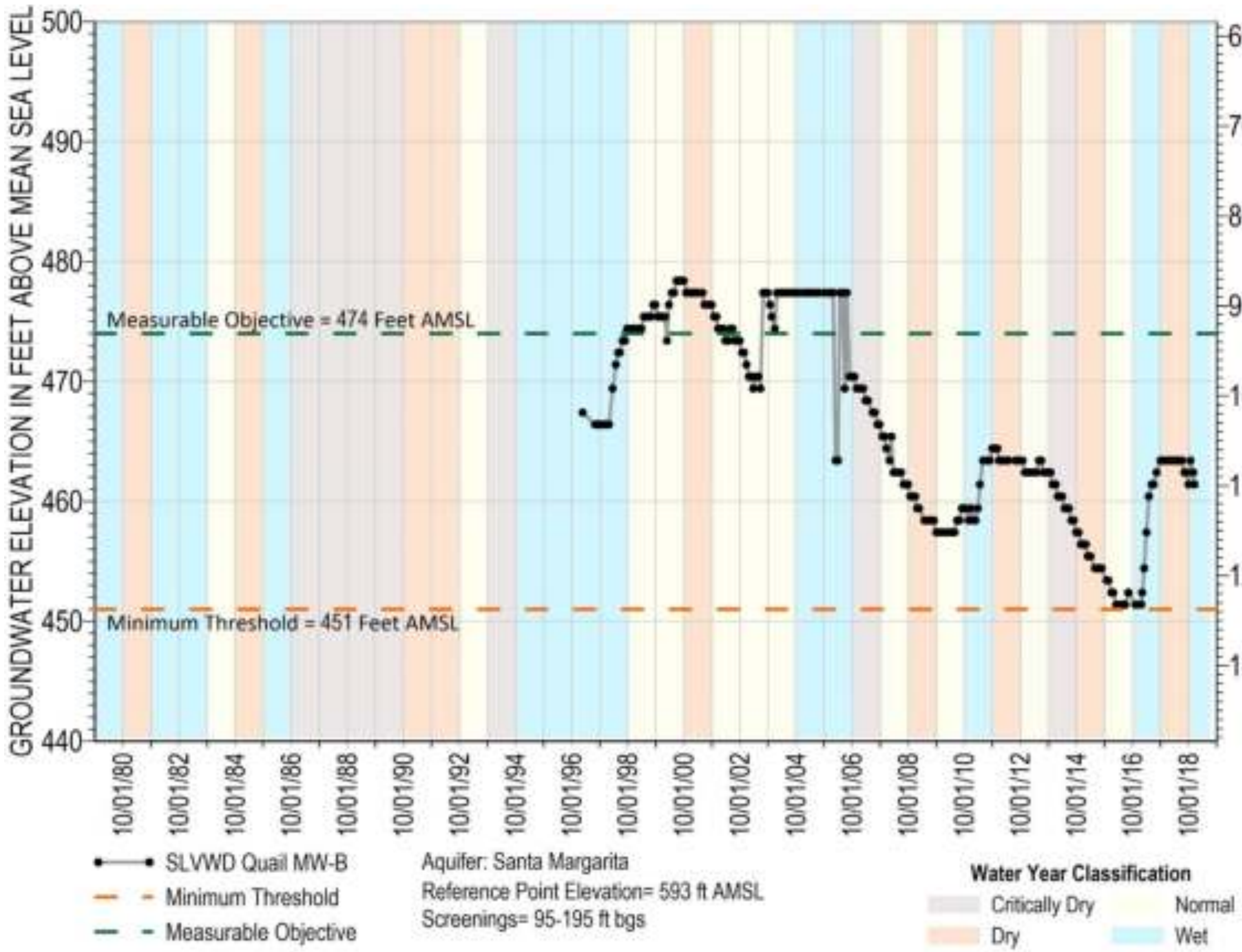


Figure 3-14: Hydrograph for SLVWD Quail MW-B in the Santa Margarita Aquifer Showing Minimum Threshold and Measurable Objective Relative to Measured Groundwater Elevations

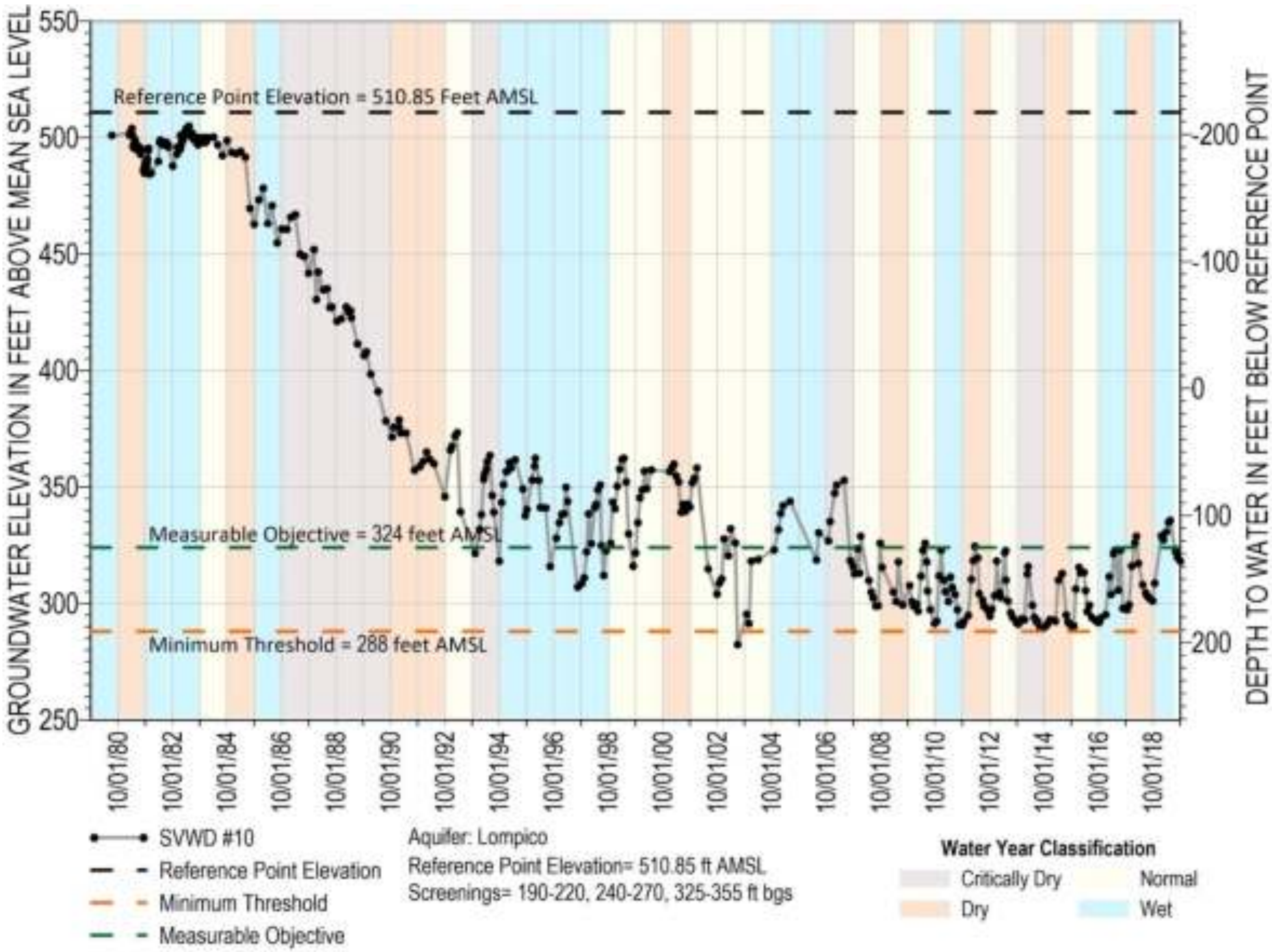


Figure 3-15: Hydrograph for SVWD Well #10 in the Lompico Aquifer Showing Minimum Threshold and Measurable Objective Relative to Measured Groundwater Elevations

Table 3-16. Minimum Thresholds, Measurable Objectives, and Interim Milestones for Chronic Lowering of Groundwater Levels

Aquifer	Well Name	Groundwater Elevation (feet above mean sea level)				
		Minimum Threshold	Interim Milestone #1 (2027)	Interim Milestone #2 (2032)	Interim Milestone #3 (2037)	Measurable Objective
Santa Margarita	SLVWD Quail MW-B	451	474	474	474	474
	SLVWD Olympia #3	304	309	309	309	309
	SLVWD Pasatiempo MW-2	500	516	516	516	516
	SVWD TW-18	462	471	471	471	471
Monterey	SVWD #9	303	342	353	356	360
Lompico	SLVWD Pasatiempo MW-1	336	341	355	359	374
	SVWD #10	288	304	316	318	324
	SVWD #11A	290	301	314	316	319
	SVWD TW-19	314	357	371	373	376
Lompico/Butano	SVWD #15 Monitoring Well	291	310	328	330	333
Butano	SVWD Stonewood Well	839	847	847	847	847
	SVWD Canham Well	427	447	461	463	466

3.4.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Groundwater level minimum thresholds are unique to every RMP. As they are based on historical data, they represent actual achievable conditions that will not conflict other RMP minimum thresholds.

Minimum thresholds for chronic lowering of groundwater level are selected to avoid undesirable results for other sustainability indicators, as described below.

- **Reduction of groundwater in storage**. Minimum thresholds for chronic lowering of groundwater levels do not promote pumping more than the sustainable yield or cause long-term declines of groundwater in storage because they are not lower than historical groundwater elevations. Therefore, minimum thresholds for the chronic lowering of groundwater levels sustainability indicator will not result in an exceedance of the reduction of groundwater in storage minimum threshold.

- **Degraded groundwater quality**. Declines in groundwater elevation may cause wells to draw from different aquifers or hydrogeologic subunits, potentially impacting groundwater quality. Because the minimum threshold is set at the average of 5 lowest historical groundwater elevations, groundwater elevations should not be lower than historical levels. Historical groundwater levels are not believed to have caused degradation of groundwater quality, and thus chronic lowering of groundwater level minimum thresholds should not result in exceedances of groundwater quality minimum thresholds.

- **Depletion of interconnected surface water**. Minimum thresholds for chronic lowering of groundwater levels do not promote additional pumping or lower groundwater elevations adjacent to interconnected surface water than has historically occurred. Therefore, the chronic lowering of groundwater elevations minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface water.

- **Seawater intrusion**. Not applicable.

- **Subsidence**. Not applicable.

3.4.3.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of minimum thresholds for the chronic lowering of groundwater level sustainability indicator on each of the neighboring basins is addressed below.

Santa Cruz Mid-County Basin (critically-overdrafted). There is a relatively impermeable basement high that separates the 2 basins and very limited areas where the Purisima Formation, the largest supply aquifer for Santa Cruz Mid-County Basin, is in direct contact with the principal aquifers of the Santa Margarita Basin. As a result, it is very unlikely that changes in groundwater levels due to projects and management actions in either basin could change hydraulic gradients near the shared basin boundary or affect groundwater level minimum thresholds in the neighboring basin.

Purisima Highlands Subbasin of the Corralitos Basin (very low priority). The Santa Margarita Basin is hydraulically downgradient from the Purisima Highlands Subbasin, but is separated from it by the Zayante-Vergeles fault zone, which acts as a barrier to groundwater flow. Hence, it is unlikely that groundwater elevations in the Santa Margarita Basin can have an influence on groundwater in the Purisima Highlands Subbasin.

West Santa Cruz Terrace Basin (very low priority). The boundary between the Santa Margarita Basin and West Santa Cruz Terrace Basin is located where Tertiary sedimentary rocks that are the principal aquifers in Santa Margarita Basin thin abruptly against basement rocks that are exposed at the surface or are at shallow depth in the subsurface. Groundwater pumping in West Santa Cruz Terrace Basin is mostly from private wells tapping low-yielding Quaternary alluvium and terrace deposits. These Quaternary deposits are not hydrologically connected to similar deposits scattered in small patches in Santa Margarita Basin. The lack of continuity in the Quaternary deposits and thinning of the Santa Margarita Basin aquifers makes it unlikely that groundwater elevations in the Santa Margarita Basin at minimum thresholds would cause chronic lowering of groundwater levels in the West Santa Cruz Terrace Basin.

3.4.3.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

Minimum thresholds for chronic lowering of groundwater levels are set at the average of the 5 lowest historical minimum elevations. Because historical levels have not appeared to cause significant and unreasonable conditions in the past, these levels should continue to support similar beneficial use in the future. The minimum thresholds generally benefit beneficial users and land uses in the Basin as outlined in the bullets below.

- **Urban land uses and users**. Maintaining groundwater elevations at or above historical levels will benefit municipal groundwater pumpers by protecting their ability to pump groundwater from existing municipal wells to meet public water supply demands. The City of Santa Cruz as a user of Basin surface water and implementor of habitat conservation in the San Lorenzo River watershed relies on baseflows to help achieve the Agreed Flows described in Section 2.1.4.2.8. If groundwater levels in the Basin do not fall below historical lows, baseflows should remain within the historical range of flows used to determine the Agreed Flows.

- **Rural residential land uses and users**. Maintaining groundwater elevations at or above historical levels will benefit most domestic users of groundwater by protecting their ability to pump groundwater from domestic wells.
- **Industrial land uses and users**. Maintaining groundwater elevations at or above historical levels should benefit industrial land uses and beneficial users by protecting their ability to pump groundwater from industrial wells.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, maintaining groundwater elevations at or above historical levels will benefit agricultural users and land use by protecting their ability to pump groundwater from irrigation wells.
- **Ecological land uses and users**. Maintaining groundwater elevations at or above historical levels will maintain the very connected nature of groundwater and surface water in the Basin. This will protect GDE habitat used by priority species, and generally benefit ecological land uses and users.

3.4.3.6 Relevant Federal, State, or Local Standards

No federal, state, or currently enforced local standards exist for chronic lowering of groundwater elevations.

3.4.3.7 Method for Quantitative Measurement of Minimum Thresholds

Depth to groundwater will be directly measured at the RMPs identified in Section 3.3.5.1 for comparison to minimum thresholds. The groundwater level data will be collected in accordance with the monitoring protocols outlined in Section 3.3.2.1 and converted to groundwater elevation by subtracting the measured depth to water from the reference point elevation used to take the depth to water measurement. During GSP implementation, individual groundwater level measurements collected manually and by data loggers will be reviewed for quality control and analyzed for minimum threshold exceedances during compilation of GSP annual and 5-year update reports.

3.4.4 Measurable Objectives - Chronic Lowering of Groundwater Levels

3.4.4.1 Measurable Objectives

Measurable objectives are set for each RMPs at groundwater elevations that reflect where the SMGWA would like groundwater elevations to be in 20 years while taking into account realistic project implementation and allowing for operational flexibility. To be consistent with minimum thresholds that are mostly based on seasonal low elevations, measurable objectives are also based on seasonal low elevations. Hydrographs showing measurable objectives for a Santa Margarita aquifer monitoring well and Lompico aquifer monitoring well are shown on Figure 3-14 and Figure 3-15, respectively. Hydrographs for each RMP are included in Appendix 3A.

Measurable objectives are defined as follows:

- The measurable objectives for the Santa Margarita aquifer RMPs are the seasonal low groundwater levels in each well in WY2004.
- RMPs located in the Monterey Formation and the Lompico and Butano aquifers are the average seasonal lows in groundwater elevation measured from 2016 to 2020 plus the projected groundwater elevation increase in seasonal low groundwater elevations simulated to result from implementing a 540 AFY conjunctive use project in the Mount Hermon / South Scotts Valley area.

Measurable objectives are defined differently in the Santa Margarita aquifer than in the underlying aquifers because of the rapid response of its groundwater levels to changes in precipitation. Absent current undesirable results, with no significant projected improvement in levels from potential projects that target the Lompico aquifer (see Section 4), the measurable objectives are based on groundwater levels observed in a typical year. WY2004 was selected because WY2004 and the 5 prior years (4 normal and 1 dry water year) had an average of 41 inches of precipitation per year, which is similar to the average of 41.7 inches for the period 1947-2020 measured at the El Pueblo Yard in Scotts Valley. Hence, the measurable objective for each RMP in the Santa Margarita aquifer is defined as the seasonal low groundwater elevation measured in WY2004.

3.4.4.2 Interim Milestones

Interim milestones in the Santa Margarita aquifer RMPs are all set equivalent to the measurable objective for the aquifer being the seasonal low WY2004 groundwater elevation because projects and management actions are not predicted to increase groundwater elevations significantly.

Interim milestones for the confined aquifers are estimated using the expected benefit (positive change in groundwater elevations) from the conjunctive use simulations compared to the baseline. Expected benefits from 2022-2027, 2028-2032, and 2033-2037 are added the average seasonal low groundwater elevations from 2016-2020. Estimation of interim milestones for the confined aquifers are consistent with the definition of measurable objectives described above that reflects projected rise in groundwater elevations with the implementation of a 540 AFY conjunctive use project. All interim milestones are included in Table 3-16.

3.5 Reduction of Groundwater in Storage Sustainable Management Criteria

Since the 1980s, and even possibly starting in the 1960s, there has been a consistent loss of groundwater stored in the Basin primarily due to overpumping of the Lompico aquifer in the South Scotts Valley area. Individual annual increases of groundwater stored in the Basin correlate with either wet years or normal years if the normal year follows a dry year. Historical normal or drier water year types generally result in groundwater lost from storage. After WY2014, cumulative change in storage appears to level out but it is anticipated that below average rainfall from 2018 through 2021 will continue the trend of declining groundwater in storage.

3.5.1 Significant and Unreasonable Reduction of Groundwater in Storage

Based on SMGWA Board input, a significant and unreasonable reduction of groundwater in storage occurs when there is a long-term decline of groundwater in storage, or the volume of groundwater extracted causes undesirable results for any other sustainability indicator.

3.5.2 Undesirable Results - Reduction of Groundwater in Storage

3.5.2.1 Criteria for Defining Undesirable Results

The reduction in storage sustainability indicator is not measured by a change of groundwater in storage. Rather, per the GSP Regulations, the reduction of groundwater in storage sustainability indicator is measured by "a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results." (§354.28 (c)(2)). This definition intersects with the definition of sustainable yield described in Section 2.2.5.5. As described there, Basin-wide groundwater pumping within the sustainable yield does not constitute proof of sustainability. Sustainability under SGMA is only demonstrated by avoiding undesirable results for all sustainability indicators applicable to the Basin. Therefore, undesirable results for reduction of groundwater in storage is total pumping that causes undesirable results in any other indicator. These total pumping amounts for each aquifer representing undesirable results for the storage indicator are based on predictive model simulations that demonstrate undesirable results for applicable sustainability indicators are avoided.

3.5.2.2 Numerical Description of Undesirable Results

Undesirable results for reduction of groundwater in storage are defined numerically as groundwater extraction volumes that exceed extraction volumes in simulations that avoid undesirable results for applicable sustainability indicators. An undesirable result occurs when this exceedance occurs in one or multiple principal aquifers.

3.5.2.3 Potential Causes of Undesirable Results

Undesirable results for reduction of groundwater in storage may occur due to pumping more than the sustainable yield in one or more of the Basin's principal aquifers. Potentially, increased groundwater extraction may result from urban or agricultural land use expansion or a failure to implement projects and management actions that supplement native groundwater extraction such as conjunctive use or managed aquifer recharge projects. Reduction of groundwater in storage due to extended dry conditions is not considered undesirable if extractions and groundwater recharge are managed as necessary to ensure reductions during a period of drought are offset by increased groundwater levels or storage during other periods.

3.5.2.4 Effects on Beneficial Users and Land Use

Undesirable results of reduced groundwater in storage impacts beneficial users of groundwater by inducing undesirable results for one or more applicable sustainability indicators. Undesirable results can have the following general impacts on beneficial users and land uses:

- **Urban land uses and users**. Continual reduction of groundwater in storage leads to groundwater elevation decline which may reduce well efficiency, increase associated pumping costs, mechanical damage to the well by cavitation, falls below pump intakes or even the bottom of wells. Reduced groundwater in storage decreases contributions to streamflow which may impacts GDEs and surface water users, including the City of Santa Cruz which is a downstream user of surface water.
- **Rural residential land uses and users**. Groundwater elevation declines associated with reduction of groundwater in storage have the potential to reduce or eliminate rural residential access to groundwater. Problems associated with declining groundwater elevations below well screens include reduced pump efficiency, mechanical damage to the well (cavitation), and microbial growth. These problems have cost ramifications for the individual property owner who may need to drill their well deeper, and to the community at large which may see a decline in property value or require connecting to public water service.
- **Industrial land uses and users**. Industrial use of groundwater in the Basin is limited to process and dust suppression water at 1 remaining sand quarry at Quail Hollow. Groundwater elevation declines associated with reduction of groundwater in storage have the potential to increase pumping costs or reduce access to groundwater for similar reasons listed above for rural residential users.
- **Agricultural land uses and users**. Groundwater elevation declines associated with reduction of groundwater in storage have the potential to increase irrigation costs or reduce access to groundwater for similar reasons listed above for rural residential users.

- **Ecological land uses and users**. GDEs have the potential to be impacted directly if groundwater depths fall below the accessible level for GDE vegetation. Surface water bodies connected to groundwater may also incur reductions in baseflow caused by falling groundwater levels expressing reduced groundwater in storage. This may negatively impact portions of aquatic species lifecycles.

3.5.3 Minimum Thresholds - Reduction of Groundwater in Storage

The reduction of storage sustainability indicator is not measured by a change in groundwater in storage. Rather, per the GSP Regulations, the reduction in groundwater in storage sustainability indicator is measured by "a total volume of groundwater that can be withdrawn from the basin without causing conditions that may lead to undesirable results." (§354.28 (c)(2)).

3.5.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

Minimum thresholds and measurable objectives for the reduction of groundwater in storage indicator are established using a simulation from the Basin Model that projects pumping and climate change through WY2072. Minimum thresholds are developed based on pumping in the baseline model simulation (no projects or management actions implemented), while measurable objectives are based on projected pumping that corresponds with implementing a 540 AFY conjunctive use project to reduce November through April pumping by SLVWD and SVWD in an effort to recover groundwater levels in the South Scotts Valley area. The conjunctive use project is described in Sections 4.3.1.2 and 4.3.1.3 and assumptions made in developing the projected model simulation are provided in Appendix 2D.

3.5.3.2 Reduction of Groundwater in Storage Minimum Thresholds

Minimum thresholds for the reduction of groundwater in storage indicator are equivalent to aquifer-specific sustainable yield volumes described in Section 2.2.5.5 on sustainable yield. The minimum thresholds are derived from a projected baseline model simulation incorporating climate change and projected pumping that predicts undesirable results will not occur over the GSP planning and implementation horizon of 50 years. Groundwater pumping volumes from the baseline simulation are used to estimate sustainable yield and represent minimum thresholds. For all aquifers apart from the Santa Margarita aquifer the long-term period from WY2022-2072 produces relatively constant groundwater in storage, therefore the long-term average pumping over this period is used for the minimum threshold calculation. While change of groundwater in storage in the Santa Margarita aquifer is more variable, groundwater pumping in this aquifer produces near zero cumulative groundwater in storage loss from WY2030-2049, therefore this period is used for the minimum threshold calculation. Given that groundwater pumping in the model is not specifically optimized to avoid undesirable results, it is possible that slightly more pumping than the estimated sustainable yield could avoid future undesirable results. A 5 percent buffer to account for this is added to all minimum threshold calculations to allow for pumping optimization during GSP implementation. Reduction of groundwater in storage minimum thresholds and their relationships to historical and current groundwater pumping are summarized in Table 3-17.

Table 3-17. Reduction of Groundwater in Storage Minimum Thresholds by Aquifer Compared to Historical and Current Pumping

Aquifer	Historical Pumping 1985 - 2018	Current Pumping 2010 - 2018	Minimum Threshold	Minimum Threshold Calculation Based On
	(AFY)			
Santa Margarita	1,070	770	850	Average baseline pumping between 2030-2049 plus 5%
Monterey	320	180	140	Average baseline pumping after 2022 plus 5%
Lompico	1,770	1,520	1,290	Average baseline pumping after 2022 plus 5%
Butano	530	480	540	Average baseline pumping after 2022 plus 5%

3.5.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Reduction of groundwater in storage minimum thresholds can influence other sustainability indicators. However, by design (see Section 3.5.2.1 above), minimum thresholds for reduction of groundwater in storage avoid occurrence of undesirable results in other sustainability indicators.

- **Chronic Lowering of Groundwater Levels**. Reduction of groundwater in storage minimum thresholds, by definition, prevent pumping in excess of the sustainable yield that would cause chronic lowering of groundwater level undesirable results. Therefore, the reduction of groundwater in storage minimum thresholds will not result in an exceedance of the chronic lowering of groundwater levels minimum threshold unless the pumping distribution in the Basin changes significantly.
- **Degraded groundwater quality**. Rising or falling groundwater elevations may cause wells to draw from different aquifers or hydrogeologic subunits, potentially impacting groundwater quality. Historical groundwater levels are not believed to have caused degradation of groundwater quality. Because minimum thresholds are set at volumes that avoid undesirable results and should maintain groundwater levels above historical minimums, reduction or groundwater in storage minimum thresholds should not result in exceedances of groundwater quality minimum thresholds.
- **Depletion of interconnected surface water**. Reduction of groundwater in storage minimum thresholds do not promote additional pumping or lowering of groundwater elevations adjacent to interconnected surface water. Therefore, the chronic lowering of

groundwater elevations minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface water.

- **Seawater intrusion**. Not applicable.
- **Subsidence**. Not applicable.

3.5.3.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the minimum thresholds for reduction in groundwater storage on each of the neighboring basins is addressed below.

Santa Cruz Mid-County Basin (critically-overdrafted). There is a relatively impermeable basement high that separates the two basins and very limited areas where the Purisima Formation, the largest supply aquifer for Santa Cruz Mid-County Basin, is in direct contact with the principal aquifers of the Santa Margarita Basin. As a result, it is very unlikely that changes of groundwater in storage due to projects and management actions in either basin could change hydraulic gradients near the shared basin boundary or affect minimum thresholds for the reduction of groundwater in storage in the neighboring basin.

Purisima Highlands Subbasin of the Corralitos Basin (very low priority). The Santa Margarita Basin is hydraulically downgradient from the Purisima Highlands Subbasin, but is separated from it by the Zayante-Vergeles fault zone, which acts as a barrier to groundwater flow. With a flow barrier between the two basins and a minimum threshold based on sustainable yield less than historical pumping, it is highly unlikely Santa Margarita Basin pumping at will have a negative influence on groundwater in storage in the Purisima Highlands Subbasin.

West Santa Cruz Terrace Basin (very low priority). The boundary between the Santa Margarita Basin and West Santa Cruz Terrace Basin is located where Tertiary sedimentary rocks that are the principal aquifers in Santa Margarita Basin thin abruptly against basement rocks that are exposed at the surface or are at shallow depth in the subsurface. Groundwater pumping in West Santa Cruz Terrace Basin is mostly from private wells tapping low-yielding Quaternary alluvium and terrace deposits. These Quaternary deposits are not hydrologically connected to similar deposits scattered in small patches in Santa Margarita Basin. The lack of continuity in the Quaternary deposits and thinning of the Santa Margarita Basin aquifers makes it unlikely that groundwater extraction at minimum thresholds in the Santa Margarita Basin would cause a reduction of groundwater in storage in the West Santa Cruz Terrace Basin.

3.5.3.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

The reduction in groundwater in storage minimum thresholds are set at volumes that avoid undesirable results in the other sustainability indicators, and therefore maintain groundwater elevations above historical lows. Since historical groundwater levels have not appeared to cause undesirable conditions in the Basin, levels no lower than the historical low should continue to support similar beneficial use in the future:

- **Urban land uses and users**. Maintaining available groundwater in storage will benefit municipal groundwater pumpers by protecting their ability to pump groundwater from municipal wells and meet public water supply demands.
- **Rural residential land uses and users**. Maintaining available groundwater in storage will benefit all domestic users of groundwater by protecting their ability to pump groundwater from their wells.
- **Industrial land uses and users**. Maintaining available groundwater in storage will benefit industrial land uses and beneficial users by protecting their ability to pump groundwater from their wells.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, maintaining available groundwater in storage will benefit those beneficial users and land uses by protecting their ability to pump groundwater from irrigation wells.
- **Ecological land uses and users**. Maintaining groundwater in storage above historical low groundwater levels will preserve groundwater's connection to surface water in the Basin thereby protecting GDE habitat used by priority species and generally benefit ecological land uses and users.

3.5.3.6 Relevant Federal, State, or Local Standards

No federal, state, or currently enforced local standards exist for reduction of groundwater in storage.

3.5.3.7 Method for Quantitative Measurement of Minimum Thresholds

Exceedance of minimum thresholds for reduction of groundwater in storage will be quantified using metered and estimated groundwater extractions within the Basin. Municipal and small water systems have metered pumping data, while *de minimis* and non-*de minimis* pumping will be estimated.

3.5.4 Measurable Objectives - Reduction of Groundwater in Storage

Measurable objectives for reduction of groundwater in storage provide quantitative and obtainable goals for volumes of groundwater extracted from each aquifer. Measurable objectives are determined using groundwater pumping projected in a model simulation incorporating a 540 AFY conjunctive use project in the South Scotts Valley area consistent with the calculation of measurable objectives for groundwater levels. Calculations for the measurable objective are consistent with the periods used to calculate minimum thresholds described in 3.5.3.2 above. The measurable objective for the Santa Margarita aquifer uses average conjunctive use simulation pumping from 2030-2049, while the other aquifers use the long-term average from 2022-2072. Table 3-18 summarizes the measurable objectives in comparison to historical and current pumping.

Table 3-18. Reduction of Groundwater in Storage Measurable Objectives by Aquifer Compared to Historical and Current Pumping

Aquifer	Historical Pumping 1985 - 2018	Current Pumping 2010 - 2018	Measurable Objective	Measurable Objective Calculation Based On
	(AFY)			
Santa Margarita	1,070	770	615	Average conjunctive use simulation pumping between 2030-2049
Monterey	320	180	130	Average conjunctive use simulation pumping after 2022
Lompico	1,770	1,520	1,000	Average conjunctive use simulation pumping after 2022
Butano	530	480	380	Average conjunctive use simulation pumping after 2022

3.5.4.1 Interim Milestones

Like the measurable objectives for this indicator, interim milestones are derived from pumping included in the projected conjunctive use model simulation. Simulation of conjunctive use begins in WY2025. Therefore, the interim milestones for reduction of groundwater in storage are equivalent to minimum thresholds prior to 2027 and equivalent to measurable objectives from 2027 onward. Interim milestones are summarized in Table 3-19.

Table 3-19. Reduction of Groundwater in Storage Interim Milestones by Aquifer

Aquifer	Interim Milestone prior to 2027	Interim Milestone from 2027 onward
	(AFY)	
Santa Margarita	850	615
Monterey	140	130
Lompico	1,290	1,000
Butano	540	380

3.6 Degraded Water Quality Sustainable Management Criteria

Groundwater in the Basin is generally of good quality and does not regularly exceed primary drinking water standards. However, both naturally occurring and anthropogenic groundwater quality concerns are present in some aquifers and areas. Municipal water suppliers regularly sample and test both raw and treated water sources per state requirements.

3.6.1 Significant and Unreasonable Degraded Water Quality

Significant and unreasonable water quality conditions occur if projects or management actions in support of SGMA degrade groundwater quality such that it leads to diminished supply, adverse impacts on beneficial uses or undue financial burden for mitigating such negative impacts.

In this context, undue financial burden means a cost or financial impact resulting from an action or inaction of the SMGWA or groundwater users in the Basin, that is unwarranted, inappropriate, or excessive and/or rising to a level that is more than is necessary, acceptable, or reasonable.

3.6.2 Undesirable Results - Degraded Water Quality

3.6.2.1 Criteria for Defining Degraded Water Quality Undesirable Results

There are several criteria for defining undesirable results for degraded groundwater quality:

1. There must be confirmation sampling to prove that a concentration above its minimum threshold is not sampling or laboratory error.
2. Water quality degradation must be caused by SMGWA approved projects or management actions implemented as part of this GSP to achieve and maintain sustainability.

The following are conditions that do not cause undesirable results as defined in this GSP:

1. It is not considered an undesirable result if activities by private individuals or companies mobilize poor quality groundwater or introduce poor quality water or contaminants into the Basin. This is because the undesirable result was not caused by the SMGWA. Although such groundwater quality degradation needs to be addressed, it does not fall under the responsibility of the SMGWA. Per the GSP Regulations, SMGWA is only responsible for its own actions and consequences of implementing the GSP. There are local and state regulatory agencies responsible for enforcing various Acts and policies protecting water resources in the Basin as described in Section 2.1.3.4.6.1 on groundwater contamination cleanup.
2. Naturally elevated concentrations already exceeding minimum thresholds are not considered an undesirable result because it was not caused by the SMGWA member or

cooperating agencies. Examples of elevated naturally occurring chemical constituents in the Basin are iron, manganese, sulfate, and arsenic. These constituents are discussed in more detail in Section 2.2.4.4.3. Although naturally occurring elevated concentrations are undesirable to users of the water and require treatment to make the water either safe for human health or aesthetically acceptable depending on the constituent, those elevated concentrations are not an undesirable result caused by implementation of the GSP.

3. Nitrates introduced into the Santa Margarita aquifer and surface water through wastewater disposal, livestock, fertilizer use, and other sources have been occurring since the lands within the Basin were first developed. County of Santa Cruz Environmental Health is responsible for improving septic tank standards and has been implementing the San Lorenzo Nitrate Management Plan since 1995 to reduce nitrate impacts in the Basin. Since nitrate impacts have been occurring for decades, SMGWA is not responsible for causing them not mitigating them.

3.6.2.2 Numerical Description of Undesirable Results

Undesirable results occur if any of the degraded groundwater quality minimum thresholds are exceeded at RMPs where:

- Minimum thresholds have not been exceeded prior to SMGWA approved project(s) or management action(s)
- An immediate resampling confirms the exceedance
- The exceedance is caused by SMGWA approved project(s) or management action(s)

3.6.2.3 Potential Causes of Undesirable Results

SMGWA approved projects and management activities may potentially degrade groundwater quality under the following conditions:

- **Changes to Basin Pumping.** If the location and rates of groundwater pumping change as a result of projects implemented or management actions taken under the GSP, these changes could alter hydraulic gradients and cause movement of existing poor-quality groundwater towards a supply well at concentrations that exceed minimum thresholds.
- **Groundwater Recharge**. Active groundwater recharge through injection wells or surface spreading could potentially modify groundwater gradients and move existing poor-quality groundwater towards a supply well in concentrations that exceed minimum thresholds. Another potential cause of groundwater degradation from recharge by injecting water into the aquifer is mobilization of metals. Introducing surface water or purified wastewater into an aquifer may change the eH or pH of groundwater in such a way that minerals in the aquifer such as pyrite break down or

trace elements are desorbed from clays, thereby releasing iron, manganese, or arsenic into the groundwater. Pilot testing can help understand geochemical impacts an ASR project may or may not have before a decision can be made on its feasibility.

- **Recharge of Poor-Quality Water.** A SMGWA approved recharge project could introduce poor quality water or contaminants into the Basin. This is highly unlikely because of the state's antidegradation policy that prevents projects from causing degradation of surface water or groundwater.

SMGWA approved projects and management activities may potentially degrade surface water quality under the following conditions:

- **Degraded Groundwater Impacts to Surface Water**: Groundwater in the Basin is highly connected to surface water which means the quality of groundwater influences the quality of surface water. This is evident in the elevated nitrate concentrations in the San Lorenzo River influenced in large part by septic system leaching to groundwater. Users of surface water within the Basin are primarily SLVWD, and to a lesser extent a few private users and small water systems who have water rights. Surface water from the Basin is also used outside of the Basin by the City of Santa Cruz that has appropriative rights to San Lorenzo River water via licenses. These licenses allow the withdrawal of water at the San Lorenzo River Intake in Santa Cruz for delivery to the Graham Hill water treatment plant and the Felton diversion for storage at Loch Lomond Reservoir. Surface water is always treated before being used by the City of Santa Cruz for potable water. If SMGWA approved projects and management activities degrade surface water quality, additional treatment may be needed depending on the chemical constituents and concentrations.
- **Degraded Groundwater Impacts to Soil Vapor**: If SMGWA approved projects or management actions move existing plumes with vapor-forming chemicals, a potential impact on urban land use is formation of soil vapor plumes that may impact health. Vapor intrusion occurs when vapor-forming chemicals in contaminated soils or groundwater migrate into overlying buildings. Vapor-forming chemicals may include VOCs, such as TCE and benzene, select semi-volatile organic compounds, such as naphthalene, elemental mercury, and some polychlorinated biphenyls and pesticides (USEPA, 2020).

3.6.2.4 Effects on Beneficial Users and Land Use

Undesirable results from degradation of groundwater quality can have the following general impacts on beneficial users and land uses:

- **Urban land uses and users**. If municipal supply wells cannot be pumped anymore because of contamination, an alternative water source will need to be used or the groundwater will need to be treated to drinking water standards. New wells or increased pumping in existing wells may change the groundwater pumping regime, which could promote migration of degraded groundwater. If surface water or soil vapor impacts are caused by groundwater degradation, then water or soil vapor treatment may be needed to ensure public safety. With groundwater and surface water closely connected in the Basin, degraded groundwater quality can degrade surface water quality. The only urban user impacted would be the City of Santa Cruz which is a downstream user of surface water. SLVWD surface water sources are outside of and upgradient of the Basin and will not be impacted.

- **Rural residential land uses and users**. Since private well owners do not routinely test groundwater pumped by their wells, there is a strong possibility that they could unknowingly drink groundwater exceeding drinking water standards and experience potential health effects. In addition, not having access to groundwater as a water source because of known undesirable results will significantly devalue properties that have no alternative water source or cannot be connected to a municipal water system. Finally, costly treatment systems may need to be installed depending on the concentration and chemical found in rural water supplies.
- **Industrial land uses and users**. Industrial use of groundwater in the Basin is limited to process and dust suppression water at 1 remaining sand quarry at Quail Hollow. Degraded groundwater quality will have limited negative effect on the use of water used at the quarry. Impacts on groundwater quality by sand mining have a greater potential negative effect than projects or management actions implemented to achieve sustainability.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, degraded groundwater quality has the potential to damage crops. It is unlikely that the agricultural land use will be impacted by degraded water quality caused by SMGWA approved projects or management actions since those land uses are many miles away from the urban settings that have known contaminant plumes.
- **Ecological land uses and users**. Groundwater dependent ecosystems have the potential to be directly impacted if baseflows become contaminated by degraded groundwater enters or is utilized by root zone of GDEs. Each species has differing tolerance to groundwater quality, but in general, groundwater quality degradation may cause nuisance or toxicity for some riparian, aquatic, or terrestrial species.

3.6.3 Minimum Thresholds - Degraded Water Quality

The GSP Regulations allow three options for setting degraded water quality minimum thresholds. Section §354.28(c)(2) of the GSP Regulations states that "The minimum threshold shall be based on the number of supply wells, a volume of water, or a location of an isocontour that exceeds concentrations of constituents determined by the Agency to be of concern for the basin" (CCR, 2016). In this Basin, minimum thresholds are based on specified concentrations of constituents determined to be of concern. This metric is similar to the location of an isocontour approach in the GSP Regulations. Currently available wells monitored annually for COCs are public supply wells.

3.6.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

The primary information used to develop minimum thresholds and measurable objectives are historical groundwater quality data from public supply wells. Other sources of information used to develop minimum thresholds and measurable objectives are state primary and secondary drinking water standards or MCLs, and various guidance documents (DWR, 2017; Moran and Belin, 2019; Community Water Center, 2019).

3.6.3.2 Degraded Water Quality Minimum Thresholds

Minimum thresholds for COCs in degraded groundwater quality RMPs are state drinking water standards, with the exception of nitrate (as N). Using state standards to define minimum thresholds is consistent with the SMGWA defined significant and unreasonable water quality degradation that results in adverse impacts including materially diminished water supplies or undue costs for mitigating such negative impacts. Federal, state, or local regulatory requirements are established after careful scientific study, legal review and procedural steps mandated by law. They are designed to protect public health and welfare, and they provide the clearest indication of the point beyond which there is a real risk of an undesirable result (Moran and Belin, 2019).

Nitrate (as N) concentrations in groundwater are typically less than 5 mg/L. Because nitrate in groundwater influences nitrate concentrations in the San Lorenzo River (described in Section 2.1.2.3), allowing nitrate concentrations in groundwater to increase above 5 mg/L will make it challenging to meet the San Lorenzo River's 0.33 mg/L nitrate total maximum daily load (TMDL) enforced by the Central Coast Regional Water Quality Control Board (RWQCB).

A minimum threshold of 5 mg/L is established for nitrate (as N) because:

1. Concentrations in RMPs are historically below this threshold
2. The groundwater quality goal is to prevent concentrations from worsening and concentrations above 5 mg/L are currently uncommon throughout the Basin
3. Nitrate concentrations in SMGWA approved project source waters close to 10 mg/L would increase the challenge of meeting the nitrate TMDL in the San Lorenzo River. Feasibility for future projects will need to demonstrate the Basin's good quality groundwater will not be degraded above 5 mg/L before the SMGWA can approve its implementation.

Table 3-20 lists the Basin's COCs together with why it is of concern, basis for the minimum threshold, and the minimum threshold value. Appendix 3B includes chemographs for COCs at each RMP showing historical data, minimum thresholds, and measurable objectives.

Table 3-20. Minimum Thresholds for Groundwater Quality Constituents of Concern

Constituent of Concern	Reason for Concern	Minimum Threshold Based On	Minimum Threshold (mg/L)
Total dissolved solids	basic health of basin	Upper recommended limit of State secondary MCL used county-wide	1,000
Chloride	basic health of basin	State secondary MCL	250
Iron	naturally elevated	State secondary MCL	0.30
Manganese	naturally elevated	State secondary MCL	0.05
Arsenic	naturally elevated	State primary MCL	0.01
Nitrate as Nitrogen	septic systems	Consideration of the State TMDL for San Lorenzo River	5
Methyl-tert-butyl-ether (MTBE)	Introduced into groundwater by leaking gasoline tanks	State primary MCL	0.013
Chlorobenzene		State primary MCL	0.07
Trichloroethylene (TCE)	Introduced into groundwater by Watkins-Johnson and Scotts Valley Dry Cleaners	State primary MCL	0.005
Tetrachloroethylene (PCE)		State primary MCL	0.005
1,2-Dichloroethylene (1,2-DCE)		State primary MCL	0.07

MCL = maximum contaminant level

Each future SMGWA approved project implemented as part of the GSP will have a set of COC that apply to monitoring and extraction wells included in their use permits granted by the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW). For example, projects injecting purified recycled water into the Basin are classified as groundwater replenishment reuse projects and permits from SWRCB DDW are required. A compendium of groundwater replenishment reuse regulations (GRRR) (Title 22, Division 4, Chapter 3) was issued by the SWRCB in 2014 (SWRCB, 2018). Specific monitoring wells and a list of chemical constituents to monitor are part of specific permit conditions. The GRRR Section 60320.200 (c) requires at least four quarters of background groundwater quality data to characterize groundwater quality in each aquifer that will be receiving recycled water before injection of purified recycled water starts. Constituents of concern for implemented projects will be added to the list of COC for this GSP, and some of the monitoring wells specified in the permit will be added as RMPs.

For Aquifer Storage & Recovery (ASR) projects, the SWRCB has adopted general waste discharge requirements for ASR projects that inject water of drinking water quality into groundwater (Order No. 2012-0010-DWQ or ASR General Order). The ASR General Order provides a consistent statewide regulatory framework for authorizing both pilot ASR testing and permanent ASR projects. Oversight of these regulations is through the Regional Water Quality

Control Board (RWQCB) and obtaining coverage under the General ASR Order requires the preparation and submission of a Notice of Intent (NOI) application package. The NOI includes a technical report that, amongst other things, identifies and describes target aquifers, delineates the Areas of Hydrologic Influence, identifies all land uses within the delineated Areas of Hydrologic Influence, identifies known areas of contamination within the Areas of Hydrologic Influence, identifies project-specific constituents of concern, and groundwater degradation assessment.

3.6.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

SGMA regulations do not require projects or management actions to improve existing groundwater quality, although the GSA may undertake such a goal. Since the Basin's groundwater quality is generally below minimum thresholds, the SMGWA's objective is to keep it at current concentrations and will not be taking any actions to improve it. Keeping groundwater quality at current concentrations, therefore, poses no threat to other sustainability indicators. However, preventing migration of poor-quality groundwater may limit projects or management actions needed to achieve minimum thresholds for other sustainability indicators.

- **Chronic lowering of groundwater levels**. Degraded groundwater quality minimum thresholds could influence groundwater level minimum thresholds by limiting the types of water that can be used for recharge to increase groundwater levels if groundwater levels started to approach minimum thresholds.
- **Change in groundwater storage**. Degraded groundwater quality minimum thresholds do not promote pumping in excess of the sustainable yield that is needed to ensure change in groundwater storage does not cause undesirable results. Therefore, the degraded groundwater quality minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.
- **Seawater intrusion**. Not applicable.
- **Subsidence**. Not applicable.
- **Depletion of interconnected surface water**. Degraded groundwater quality minimum thresholds do not promote additional pumping or lower groundwater elevations adjacent to interconnected surface water. Therefore, the degraded groundwater quality minimum thresholds will not result in a significant or unreasonable depletion of interconnected surface water.

Minimum thresholds for specific COCs are the same for each RMP throughout the Basin, thus there is no conflict between individual RMP minimum thresholds.

3.6.3.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the minimum thresholds for degraded groundwater quality on each of the neighboring basins is addressed below.

Santa Cruz Mid-County Basin (critically overdrafted). Limited groundwater flows from the Santa Cruz Mid-County Basin into the Santa Margarita Basin. Groundwater quality in the vicinity of the basins' boundary is generally good except for naturally occurring elevated iron, manganese, and occasionally arsenic. No GSP projects or management actions, for either basin, that might change hydraulic gradients or directions are likely in the vicinity of the basins' shared boundary. The Santa Cruz Mid-County Basin's minimum thresholds for groundwater quality are drinking water standards and therefore, it is unlikely that the degraded groundwater quality minimum thresholds established for the Basin will prevent the Santa Cruz Mid-County Basin from achieving sustainability. Even though the Santa Cruz Mid-County Basin's minimum threshold for nitrate (as N) of 10 mg/L is higher than the Santa Margarita Basin's minimum threshold of 5 mg/L, the lack of connection between the Santa Cruz Mid-County Basin's primary aquifer (Purisima Formation) and the Santa Margarita Basin's primary aquifers (Santa Margarita, Lompico and Butano aquifers) will not prevent the Santa Margarita Basin from achieving its nitrate (as N) minimum threshold.

Purisima Highlands Subbasin of the Corralitos Basin (very low priority). The Santa Margarita Basin is hydraulically downgradient from the Purisima Highlands Subbasin, but is separated from it by the Zayante-Vergeles fault zone, which acts as a barrier to groundwater flow. Furthermore, with minimum thresholds in the Santa Margarita Basin set at drinking water standards, groundwater quality at those concentrations or better will remain safe for Purisima Highlands Subbasin beneficial users.

West Santa Cruz Terrace Basin (very low priority). The boundary between the Santa Margarita Basin and West Santa Cruz Terrace Basin is located where Tertiary sedimentary rocks that are the principal aquifers in Santa Margarita Basin thin abruptly against basement rocks that are exposed at the surface or are at shallow depth in the subsurface. Groundwater pumping in West Santa Cruz Terrace Basin is mostly from private wells tapping low-yielding Quaternary alluvium and terrace deposits. These Quaternary deposits are not hydrologically connected to similar deposits scattered in small patches in Santa Margarita Basin. Even if the sediments in the two basins were highly connected, groundwater quality at drinking water standards would not adversely impact rural residential or GDE groundwater users in the West Santa Cruz Terrace Basin.

3.6.3.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

In general, groundwater quality concentrations at or less than the minimum thresholds will not impact beneficial users and land uses in the Basin. The selected minimum thresholds generally benefit beneficial users and land uses in the Basin:

- **Urban land uses and users**. The degraded groundwater quality minimum thresholds benefit the urban water users in the Basin. Preventing groundwater for drinking water supply from exceeding state drinking water standards ensures an adequate supply of groundwater for municipal use.
- **Rural residential land uses and users**. The degraded groundwater quality minimum thresholds benefit domestic water users in the Basin. Ensuring constituents of concern in water supply wells remain below state drinking water standard to protect groundwater for domestic use.
- **Industrial land uses and users.** The degraded groundwater quality minimum thresholds generally benefit industrial water users in the Basin. Ensuring constituents of concern in water supply wells remain below state drinking water standard is more protective than is needed for industrial use.
- **Agricultural land uses and users.** The degraded groundwater quality minimum thresholds generally benefit the limited agricultural water use in the Basin by preventing impacts to crop health from degraded groundwater.
- **Ecological land uses and users**. Although the groundwater quality minimum thresholds do not directly benefit ecological uses, it can be inferred that the degraded groundwater quality minimum thresholds generally benefit the environmental water uses in the Basin. Preventing poor-quality groundwater from migrating to GDEs and surface water bodies will limit ecosystem impacts.

3.6.3.6 Relevant Federal, State, or Local Standards

The degraded groundwater quality minimum thresholds are defined as the state drinking water standards with the exception of the nitrate minimum threshold, which is less than the state drinking water standard.

3.6.3.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater quality in RMPs will be directly measured by collecting and testing groundwater samples in accordance with the monitoring protocols outlined in Section 3.3.2. Chemical concentrations reported by the laboratory will be used to compare chemical COC concentrations in relation to their respective minimum thresholds. Should a minimum threshold be exceeded, follow-up sampling and analysis will be conducted to confirm that exceedances are not due to sample collection or laboratory errors.

3.6.4 Measurable Objectives - Degraded Water Quality

3.6.4.1 Measurable Objectives

All measurable objectives set for degraded groundwater quality strive to keep groundwater quality at current concentrations. Measurable objectives for each RMP are the average concentration between January 2010 and December 2019 concentrations for each COC. The measurable objectives for RMPs are shown in Table 3-21 and included on chemographs in Appendix 3B.

3.6.4.2 Interim Milestones

Groundwater quality in the Basin is currently above minimum thresholds for all RMPs with no changes in quality expected from projects and management actions implemented to achieve sustainability. Since the measurable objectives effectively represent current conditions, interim milestones are set at the same concentration as measurable objectives (see Table 3-21).

Table 3-21. Minimum Thresholds and Measurable Objectives for Degradation of Groundwater Quality

Aquifer Unit	Well Name	Total Dissolved Solids	Chloride	Iron	Manganese	Arsenic	Nitrate as Nitrogen	Methyl-tert-butyl-ether (MTBE)	Chlorobenzene	Trichloroethylene (TCE)	Tetrachloroethylene (PCE)	1,2-Dichloroethylene (1,2-DCE)
All units in mg/L	**Minimum Threshold**	1,000	250	0.3	0.05	0.01	5	0.013	0.07	0.005	0.005	0.07
Santa Margarita	SLVWD Quail Hollow #5A	123	8.00	0.020	0.003	0.002	2.13	0.003	0.001	0.0005	0.0005	0.0005
	SLVWD Olympia #3	573	8.85	0.502	0.157	0.002	0.400	0.003	0.001	0.0005	0.0005	0.0005
Monterey	SVWD Well #9	839	44.7	0.082	0.015	0.002	0.400	0.003	0.001	0.0008	0.0005	0.0005
Lompico	SLVWD Pasatiempo #7	143	7.40	0.539	0.099	0.002	0.330	0.003	0.001	0.0005	0.0005	0.0005
	SVWD #10A	290	30.6	1.51	0.099	0.002	0.390	0.003	0.001	0.0005	0.0005	0.0005
	SVWD #11A	525	27.1	0.459	0.112	0.003	0.400	0.003	0.001	0.0005	0.0005	0.0005
	SVWD #11B	367	21.3	0.826	0.077	0.009	0.400	0.003	0.001	0.0005	0.0005	0.0005
Lompico/ Butano	SVWD #3B	563	31.6	0.380	0.042	0.002	0.400	0.003	0.001	0.0005	0.0005	0.0005
	SVWD Orchard Well	450	26.3	0.063	0.004	0.002	0.400	0.003	0.001	0.0005	0.0005	0.0005

3.7 Depletion of Interconnected Surface Water Sustainable Management Criteria

Stream gauging, accretion studies, groundwater level monitoring, stream and GDE field reconnaissance, and groundwater modeling have all been used to show that surface water is connected to groundwater throughout most of the Basin. As discussed in Section 2.2.4.6, during the dry season from late May through October, almost all the water flowing in the Basin's streams and creeks is derived from groundwater. In the historical groundwater model simulation, there is about 2.5 times more groundwater discharge to creeks than creek recharge of groundwater. The result of net groundwater discharge to surface water is widespread gaining stream conditions that contribute to more surface water flowing out of the Basin than flowing into the Basin.

The depletion of interconnected surface water SMC is developed using groundwater levels as a proxy as discussed in Section 3.7.2.1 below. Recognizing that the Basin does not have enough shallow wells to monitor and evaluate the effects of groundwater extractions on streamflow depletion in interconnected surface waters, up to 5 new shallow monitoring wells will be installed in 2022 to complete the monitoring network. This section details the SMC for the 2 existing monitoring wells near creeks that will be used as RMP. SMC will be defined for new monitoring wells once several years of groundwater level data have been collected and a relationship between groundwater levels, groundwater extractions, rainfall, and other factors can be established. Any new RMPs and SMC developed with input from and approved by the SMGWA Board will be included in future updates to the GSP.

3.7.1 Significant and Unreasonable Depletion of Interconnected Surface Water

Significant and unreasonable depletion of interconnected surface water occurs if groundwater use, or projects or management actions in support of SGMA adversely impact the sustainability of groundwater dependent ecosystems or selected priority species or cause undue financial burden to beneficial users of surface water.

In this context, undue financial burden means a cost or financial impact resulting from an action or inaction of the SMGWA or groundwater users in the Basin, that is unwarranted, inappropriate, or excessive and/or rising to a level that is more than is necessary, acceptable, or reasonable.

3.7.2 Undesirable Results - Depletion of Interconnected Surface Water

3.7.2.1 Groundwater Elevation as a Proxy for Depletion of Interconnected Surface Water Minimum Thresholds

The metric for depletion of interconnected surface water is a volume or rate of surface water depletion. Limited data collected to date does not allow for measurement or estimation of a volume or rate of historical depletion of interconnected surface water due specifically from groundwater extractions. Data limitations include streamflow gauges not paired with shallow monitoring wells and having to rely on estimates of extraction for unmetered groundwater usage by *de minimis* pumpers and some non-*de minimis* pumpers. Although there have been multiple accretion studies to understand where groundwater and surface water are interconnected, and what the groundwater contributions are to baseflow (as described in Section 2.2.4.6), there have been no studies conducted in the Basin to understand the effects of groundwater use on streamflow or the GDEs that rely on streamflow for supporting flora and fauna.

Even though streamflow depletion from groundwater extractions cannot be directly measured at a streamflow gauge because it is only one component of many other components that make up streamflow, changes in groundwater contributions to streamflow can be simulated with a groundwater model. Sensitivity runs using the calibrated Basin model to simulate groundwater conditions and water budget with and without groundwater pumping and associated return flows shows, on average over the WY1985-2018 historical model period, there is around 1,000 AFY (approximately 1.4 cfs) of year-round surface water depletion due to groundwater extraction (Figure 3-16). The negative values on Figure 3-16 indicate the volume of pumping and return flows removed from the model in the "without pumping" simulation, while the positive values for discharge to creeks indicate the increase in discharge in response to pumping being removed.

Analysis of the model simulated water budget for the Bean Creek watershed reveals that on average from WY1985 through 2018 groundwater extractions reduce groundwater contributions to Bean Creek during low flow periods by approximately 0.5 cfs (Figure 3-17). The amount of groundwater contribution in the low flow months is highly dependent on rainfall depicted as water year type on Figure 3-17.

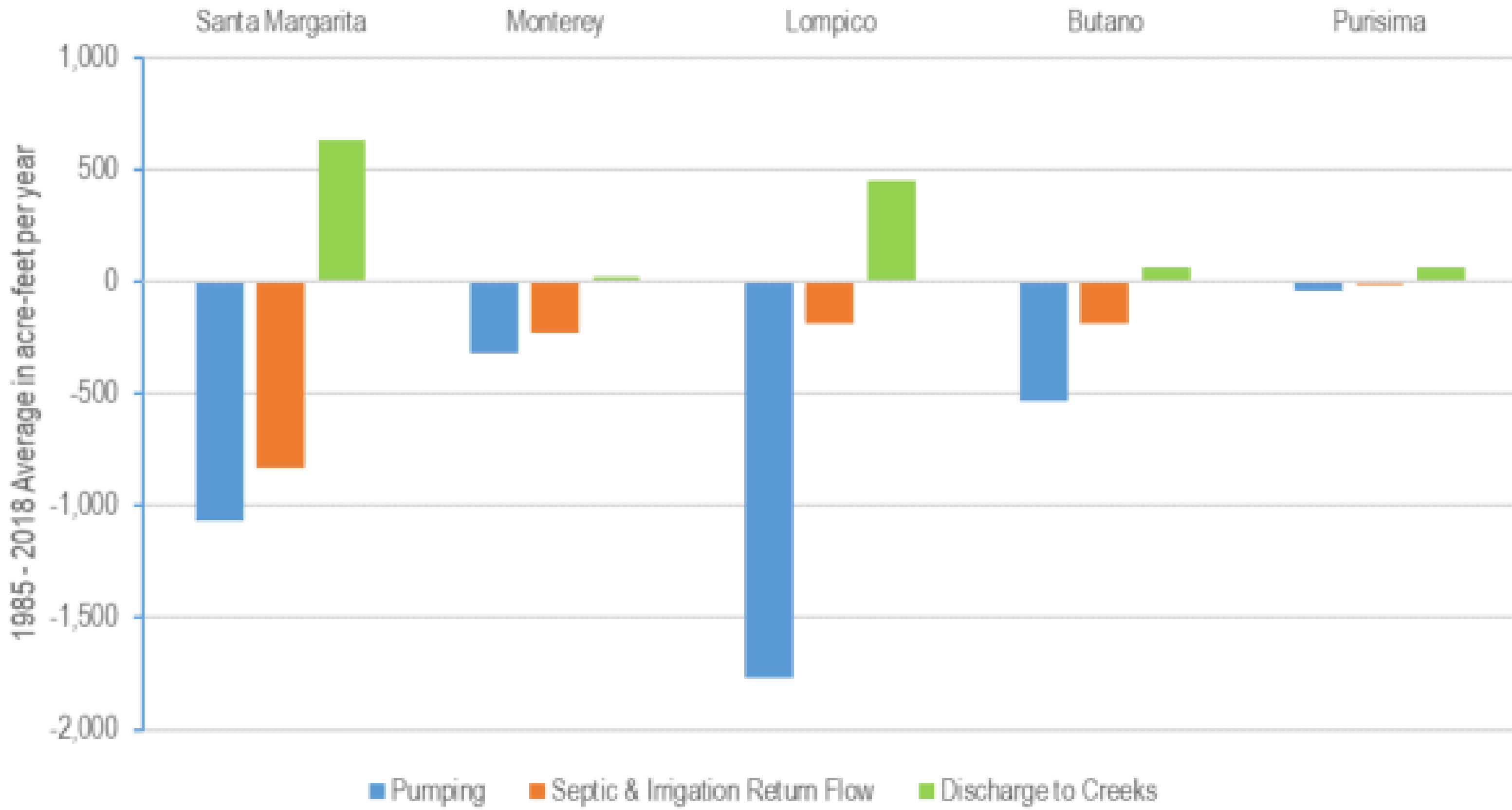


Figure 3-16. Model Simulated Effects of Groundwater Extractions on Groundwater Discharge to Creeks (Difference between Simulations Without Pumping and With Pumping)

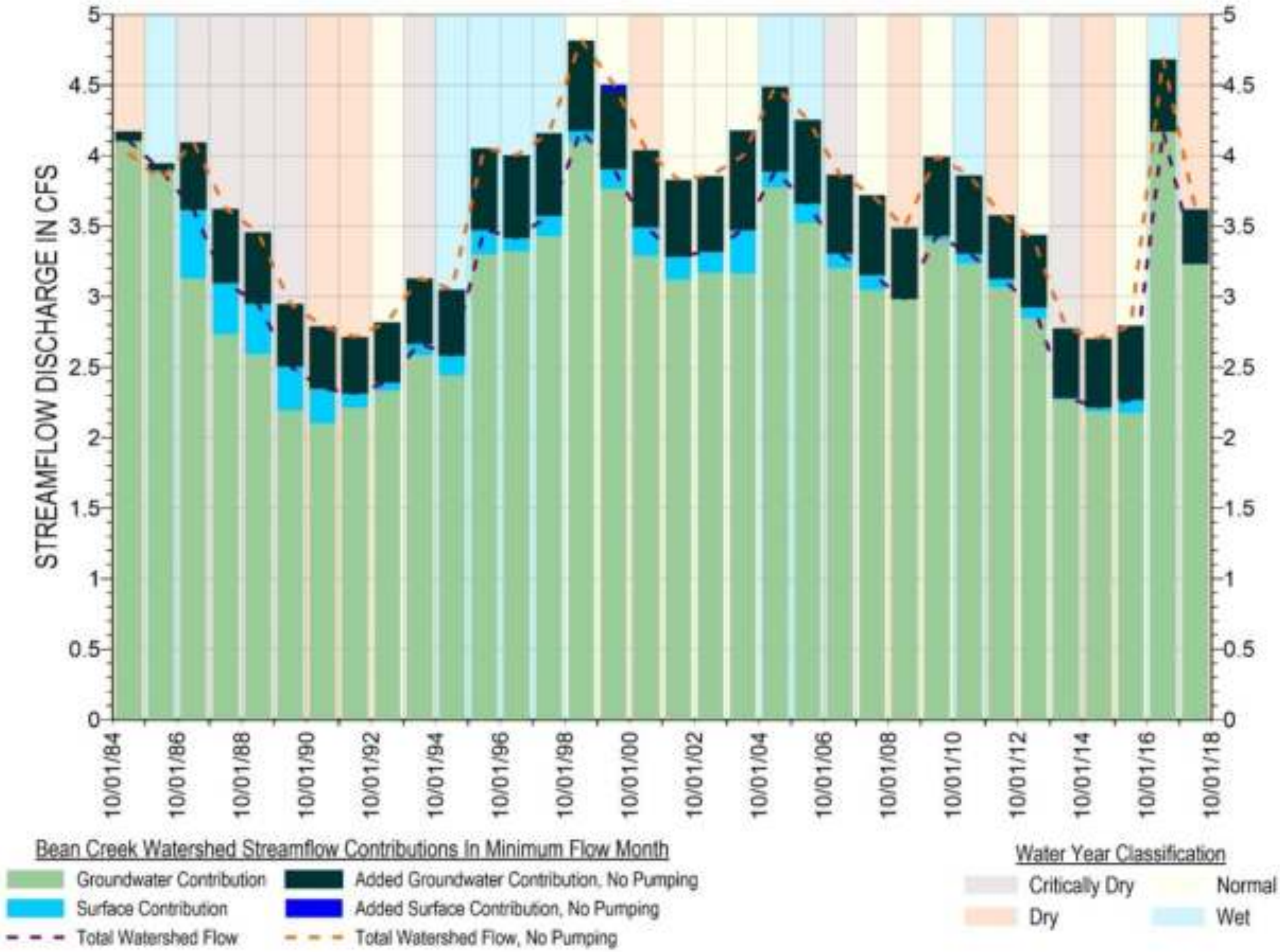


Figure 3-17. Model Simulated Effects of Groundwater Extractions on Groundwater Discharge to Bean Creek in Minimum Flow Month

There are only 2 monitoring wells from the existing monitoring network adjacent to creeks and screened in the aquifer connected to the creek that can be used as RMPs for the depletion of interconnected surface water. Each of these wells has some limitations:

- SLVWD's Quail MW-A is screened in the Santa Margarita aquifer and is closer to an unnamed non-perennial tributary of Zayante Creek than Zayante Creek. This well is included as an RMP even though its location is not ideal because it more likely represents flow in the unnamed tributary rather than Zayante Creek.

- SVWD's SV4-MW is screened in the Santa Margarita aquifer and is located south of Bean Creek in an area of known groundwater contribution to baseflows. This location is more suitable for an RMP however, it only has semi-annual historical groundwater level measurements which is not a suitable frequency for monitoring interconnected surface water. To improve data from this well, it was recently equipped with a pressure transducer to monitor groundwater levels continuously.

In 2022, up to 5 shallow monitoring wells in areas with groundwater extraction and interconnected surface water will be installed, as described in Section 3.3.4.1.3. These additional shallow wells are needed to better understand the relationship between groundwater conditions and baseflow in creeks, to improve the simulation of groundwater and surface water interactions in the groundwater model, and to add to the depletion of interconnected surface water RMP network. Some of the new shallow wells will be paired with nearby streamflow gauges. Streamflow and groundwater level data from the new monitoring wells along with more frequent groundwater levels from the 2 RMPs will be used to establish a relationship between streamflow, nearby groundwater use, and other relevant components of streamflow. Until those relationships can be established and because of no other direct means to estimate depletions of interconnected surface water in streamflow records, groundwater levels in the 2 RMPs will be used in the interim to monitor groundwater levels adjacent to creeks. This approach is justified because both RMPs have had groundwater elevations well above adjacent streambed elevations over their respective periods of record (greater than 24 years). If groundwater elevations connected to creeks are kept at or above historical elevations, there will be no more depletion of surface water than experienced over the past 24 years. These historical groundwater levels are not thought to have caused significant and unreasonable impacts to groundwater dependent ecosystems or selected priority species or cause undue financial burden to beneficial users of surface water.

3.7.2.1.1 Correlation between Groundwater Elevation and Streamflow Depletion in SLVWD Quail MW-A

Model simulated streamflow adjacent to SLVWD Quail MW-A for "with pumping" and "without pumping" simulations are used to evaluate the relationship between measured groundwater elevation and baseflow in the adjacent unnamed tributary to Zayante Creek (Figure 3-7). The results plotted on Figure 3-18 and Figure 3-19 show data from September of every year of the calibrated model period (WY1985 – 2018). Data from September represent baseflow during the driest time of year.

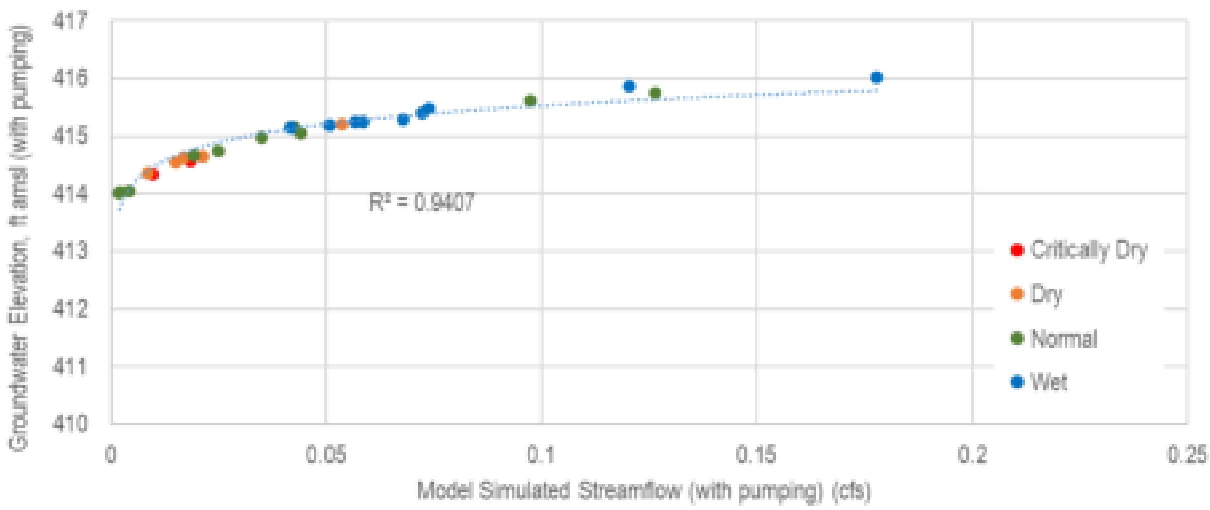


Figure 3-18. SLVWD Quail MW-A September Model Simulated Streamflow Compared to Groundwater Elevations

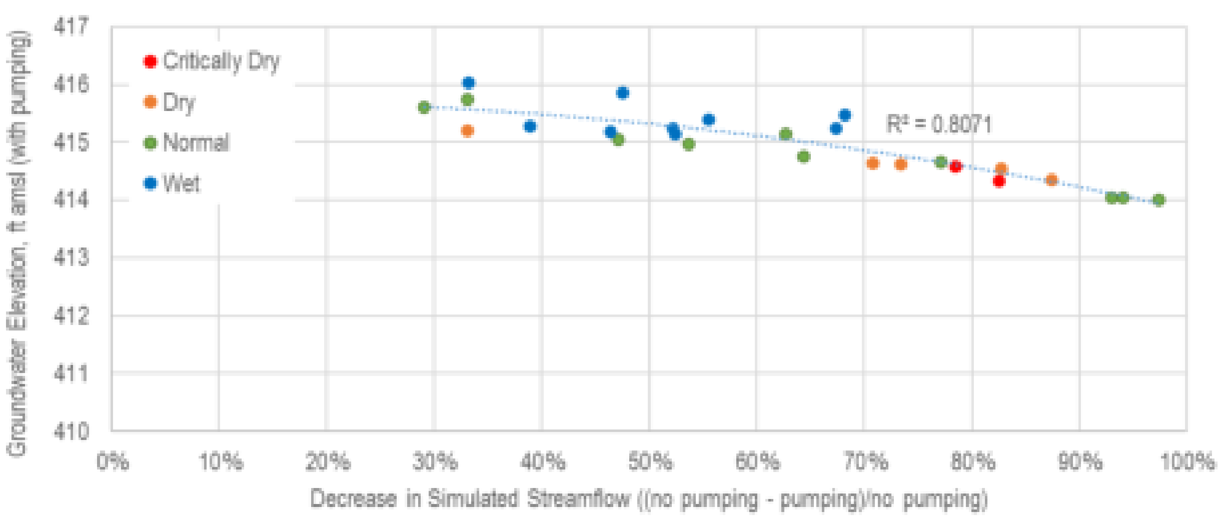


Figure 3-19. SLVWD Quail MW-A September Simulated Streamflow Depletion Compared to Groundwater Elevation

Figure 3-18 shows the relationship between simulated streamflow and measured groundwater elevations during historical Septembers with pumping. There are 8 dry and critically dry years during the interval WY1985-2018 for which there is no simulated streamflow in the unnamed tributary in September and measured groundwater elevations are lower than 414 feet above mean sea level (amsl). Those points are not included on the chart. Figure 3-18 shows a strong relationship between September streamflow and groundwater levels at SLVWD Quail MW-A. The relationship indicates with wetter years there is more groundwater recharge and higher groundwater levels leading to greater groundwater discharge to creeks.

Figure 3-19 shows simulated streamflow depletion compared to historical measured groundwater elevations. Simulated streamflow depletion is calculated as the difference between baseflow with and without pumping. Years with no baseflow are not included. Figure 3-19 shows a good correlation between simulated streamflow depletion in the unnamed tributary from pumping compared to measured groundwater elevation. Streamflow depletion at this location is sensitive to changes in groundwater elevation, with 50% reduction in streamflow occurring from a 1-foot decline in groundwater level.

3.7.2.1.2 Correlation between Groundwater Elevation and Streamflow Depletion in SVWD SV4-MW

The results of the same analysis performed on simulated streamflow and measured groundwater level data for SLVWD Quail MW-A above is shown on Figure 3-20 and Figure 3-21 for SVWD SV4-MW just south of Bean Creek. Well location is shown on Figure 3-7.

Figure 3-20 shows the relationship between simulated streamflow in Bean Creek close to the monitoring well and measured groundwater elevations in the monitoring well during historical Septembers with pumping. The relationship between streamflow and groundwater levels at this location is not as good as at SLVWD Quail MW-A, likely because of other factors that influence streamflow, one of which may be the discharge of treated water from the Watkins Johnson Superfund site remediation efforts from October 1986 to July 2016 (described in Section 2.1.3.4.6.1).

Figure 3-21 shows simulated streamflow depletion compared to historical groundwater elevations. Streamflow depletion is calculated as the difference between baseflow with and without pumping. Unlike at SLVWD Quail MW-A, at this monitoring well there is not a good long-term relationship between simulated streamflow depletion from pumping compared to groundwater elevations potentially because of the effects of discharge of treated water from the Watkins Johnson Superfund site. Since discharges from the Watkins Johnson Superfund site have now stopped, groundwater levels monitored in SVWD SV4-MW over the next 5 years will be used to determine whether the relationship between groundwater elevations and modeled surface water depletions is improved and the groundwater elevations can be more confidently used as a proxy for surface water depletion.

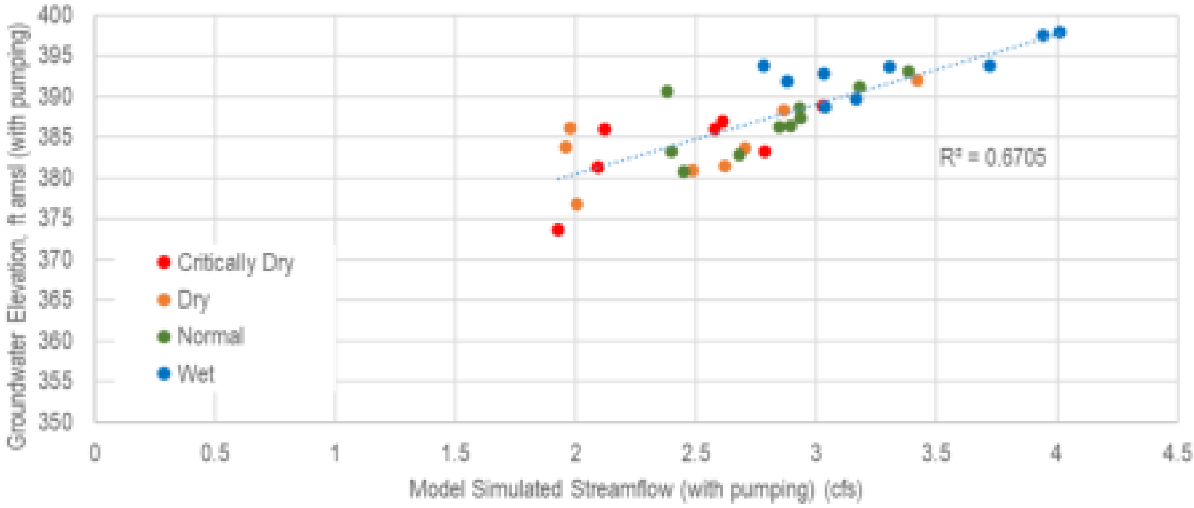


Figure 3-20. SVWD SV4-MW September Model Simulated Streamflow Compared to Groundwater Elevations

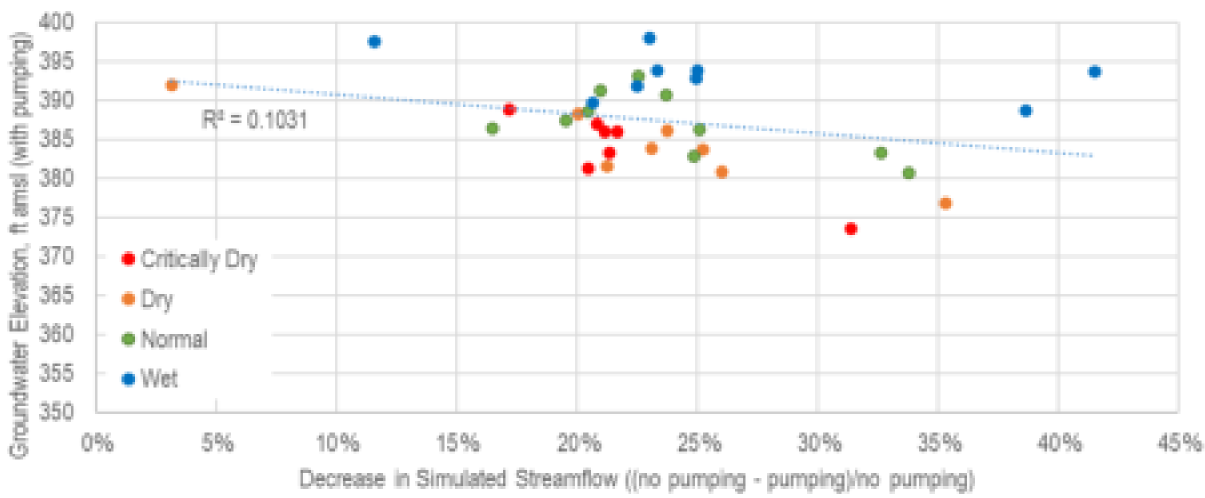


Figure 3-21. SVWD SV4-MW September Simulated Streamflow Depletion Compared to Groundwater Elevation

3.7.2.1.3 Future Evaluation of Depletion of Interconnected Surface Water from Groundwater Extraction

Development of this GSP relies on best available data and science. Until there are data collected that can inform specific studies to quantify groundwater extraction's impact on surface water, the data currently available to the SMGWA are being used to monitor groundwater's contribution to surface water. The SGMA regulations allow for the use of groundwater elevations as a proxy for volume or rate of surface water depletion. To use a groundwater elevation proxy there must be significant correlation between groundwater elevations and the sustainability indicator for which groundwater elevation measurements are to serve as a proxy.

Correlation based on the data from the 2 monitoring wells collected to date is not sufficient to establish that correlation. With a total of 8 monitoring wells collecting daily data near creeks plus stream gauging data, it is anticipated that by the first GSP 5-year update in 2027, there will sufficient data to better quantify depletions from groundwater extraction and establish whether groundwater elevations as a proxy are still applicable or not. Supplementing field measurements, there will be some component of analysis of depletion of surface water that relies on model simulation since depletion of surface water by groundwater extraction is only one component of streamflow and is not directly measurable in streamflow.

3.7.2.2 Criteria for Defining Depletion of Interconnected Surface Water Undesirable Results

The depletion of interconnected surface water undesirable result is defined using groundwater elevation as a proxy. Per the GSP Regulations, the description of undesirable results was based on a quantitative description of the combination of minimum threshold exceedances that cause significant and unreasonable effects in the Basin.

Criteria that were considered by the SMGWA Board in defining undesirable results include avoiding conditions worse than historical conditions. Having recently had water infrastructure destroyed by wildfires, the Board believes that emergency operational issues or extended droughts are not cause for undesirable results. Fortunately, the Santa Margarita aquifer that contributes the majority of the Basin's baseflow quickly recharges in above-average water years, thereby naturally recovering after drought years and does not have a long-term effect on baseflow.

3.7.2.3 Numerical Description of Undesirable Results

Groundwater level conditions that constitute undesirable results for depletion of interconnected surface water occur if the groundwater level in any RMP falls below the minimum threshold in 2 or more consecutive non-drought years. If a RMP groundwater level below its minimum threshold is caused by emergency operational issues or extended droughts, it is not considered an undesirable result.

3.7.2.4 Potential Causes of Undesirable Results

Surface water flow is more strongly correlated with precipitation than groundwater extraction. However, undesirable results for depletion of interconnected surface water in the context of the GSP must be related to the extraction of groundwater or other project and management actions implemented for groundwater sustainability, and not due to lack of precipitation during periods of prolonged drought. Undesirable results may occur in the future to GDEs if groundwater pumping near creeks causes declines in shallow groundwater levels and baseflow to creeks, or if increased diversion of runoff results in reduced recharge in the aquifers, particular the Santa Margarita aquifer.

3.7.2.5 Effects on Beneficial Users and Land Use

Undesirable results from depletion of surface water can have the following general impacts on beneficial users and land uses:

- **Urban land uses and users**. If municipal supply wells cannot be pumped due to depletion of interconnected surface water, an alternative water source will need to be used. This will likely add stress on municipal water systems which will result in installation of new wells or increased pumping in wells distal from the impact area, which increases the potential for further depletions of interconnected surface water in other portions of the Basin. Depletion of interconnected surface water may reduce the availability of surface water for the City of Santa Cruz which is a downstream user of surface water that can only divert when there are flows greater than the Agreed Flows described in Section 2.1.2.8.
- **Rural residential land uses and users**. Depletion of interconnected surface water may limit the amount of available groundwater for residential groundwater supply due to reduced recharge from streams. Property values may decline if lowering of groundwater levels causes undesirable results that require residential pumping restrictions, deepening of wells, or connection to a public water system.
- **Industrial land uses and users**. Industrial use of groundwater in the Basin is limited to process and dust suppression water at 1 remaining sand quarry at Quail Hollow. Depletion of interconnected surface water has the potential to reduce access to groundwater for similar reasons listed above for rural residential users.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, depletion of interconnected surface water may reduce access to groundwater for similar reasons listed above for rural residential users.
- **Ecological land uses and users**. GDEs have the potential to be impacted directly if the depth to groundwater exceeds depths accessed by the roots of groundwater dependent vegetation. Surface water bodies connected to groundwater may also incur reductions in baseflow. Under late summer low flow conditions, there is a direct relationship between streamflow and the amount of suitable GDE habitat. Reduction of flow directly reduces the amount of suitable rearing habitat for steelhead, by reducing the amount of wetted area, stream depth, flow velocity, cover, and dissolved oxygen. Reduced flow can also result in increased water temperature. In extreme conditions, dewatering of stream reaches eliminates the ability of fish to move to more suitable areas and can cause mortality. In even more extreme conditions, lowering of groundwater levels below the root zone of riparian vegetation can result in the loss of vegetation, impacting terrestrial GDE habitat.

3.7.3 Minimum Thresholds - Depletion of Interconnected Surface Water

3.7.3.1 Information and Methodology Used to Establish Minimum Thresholds and Measurable Objectives

Information used to establish the depletion of interconnected surface water minimum thresholds and measurable objectives include:

- Definitions of significant and unreasonable conditions and desired groundwater elevations discussed during Surface Water TAG and SMGWA Board meetings
- Depths, locations, and logged lithology of existing monitoring wells throughout the Basin
- Historical groundwater elevation data from monitoring wells
- Streamflow and stream stage data collected by the USGS, SLVWD, and County of Santa Cruz
- Input from the Surface Water TAG (described in Section 3.2.2)
- Past hydrologic reports and accretion studies

Since groundwater level is used as a proxy to define the minimum thresholds for the depletion of interconnected surface water, the approach for this sustainability indicator is consistent with the approach for defining minimum thresholds for chronic lowering of groundwater levels, described in Section 3.4.3.1.

Consistent with the approach used for chronic lowering of groundwater level minimum threshold, historical data from the 2 existing surface water depletion RMPs, SLVWD Quail MW-A and SVWD SV4-MW, is used to develop surface water depletion minimum thresholds. These RMPs are both screened in the Santa Margarita aquifer in locations close to interconnected creeks. Historical groundwater level records at SLVWD Quail MW-A have been consistent; the absolute minimum is less than 1 ft lower than the average of the 5 lowest measurements. However, at monitoring well SVWD SV4-MW there is more variation in measured groundwater levels. The absolute minimum, recorded in 2009, is approximately 12 feet lower than the average of the 5 lowest measurements. This point was the only measurement over a 7-year span and was approximately 11 feet lower than any other recorded point. The average of the 5 lowest groundwater levels is approximately 1 foot higher than the second lowest recorded groundwater level in 1999. As more data are collected, the validity of this outlying measurement at SVWD SV4-MW will be assessed. The surface water depletion RMP network will be refined with new data and monitoring wells during the GSP 5-year update.

3.7.3.2 Depletion of Interconnected Surface Water Minimum Thresholds

Minimum thresholds for depletion of interconnected surface water RMPs are summarized in Table 3-22. Hydrographs showing historical groundwater elevation data compared to the minimum threshold and streambed elevation are provided on Figure 3-22 and Figure 3-23.

Table 3-22. Minimum Thresholds, Measurable Objectives, and Interim Milestones for Depletion of Interconnected Surface Water

	Groundwater Elevation (Feet MSL)				
Well Name	Minimum Threshold	Interim Milestone #1 (2027)	Interim Milestone #2 (2032)	Interim Milestone #3 (2037)	Measurable Objective
SLVWD Quail MW-A	413	416	416	416	416
SVWD SV4-MW	381	387	387	387	387

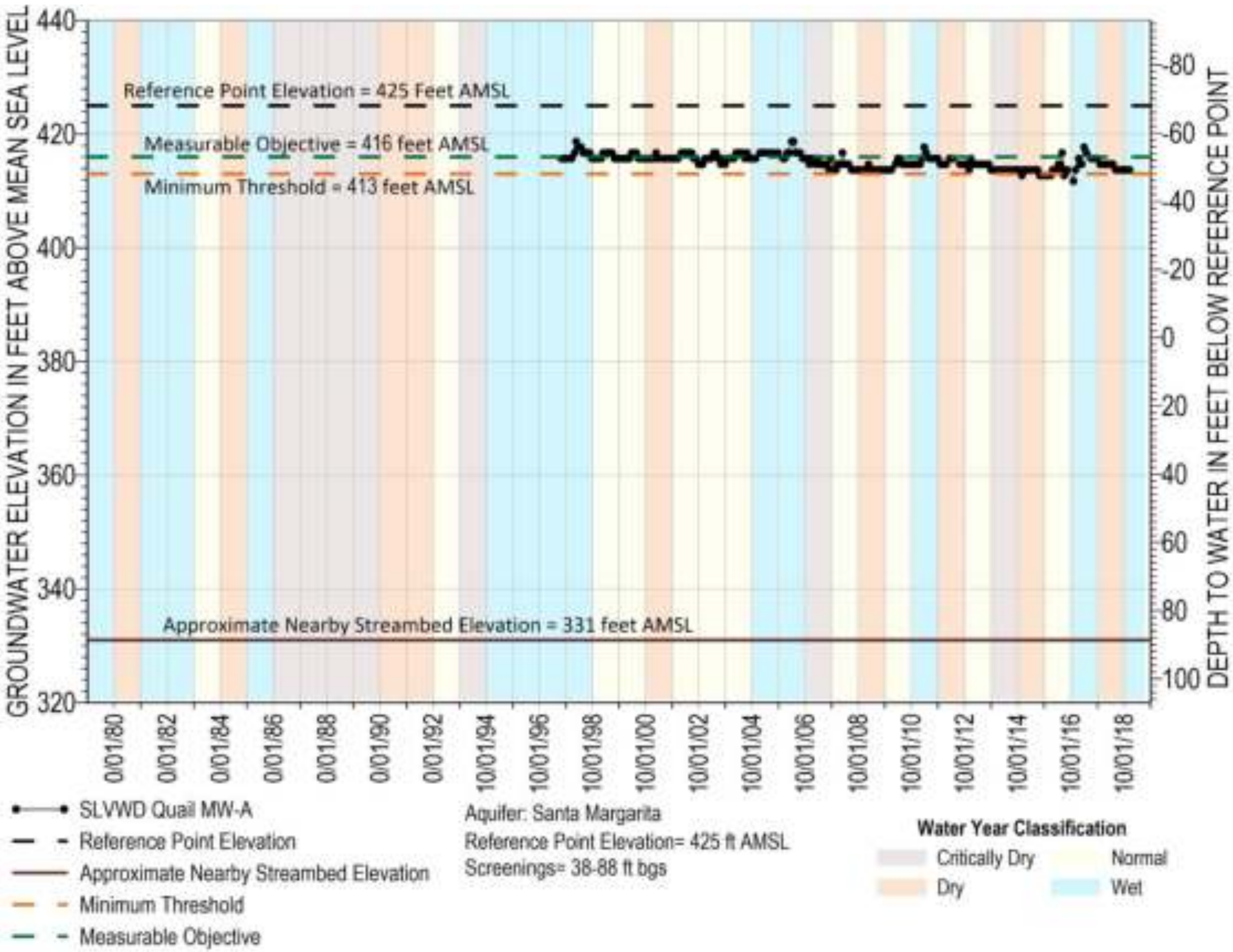


Figure 3-22: Hydrograph for SLVWD Quail MW-A in the Santa Margarita Aquifer Showing Minimum Threshold and Measurable Objective Relative to Measured Groundwater and Streambed Elevations

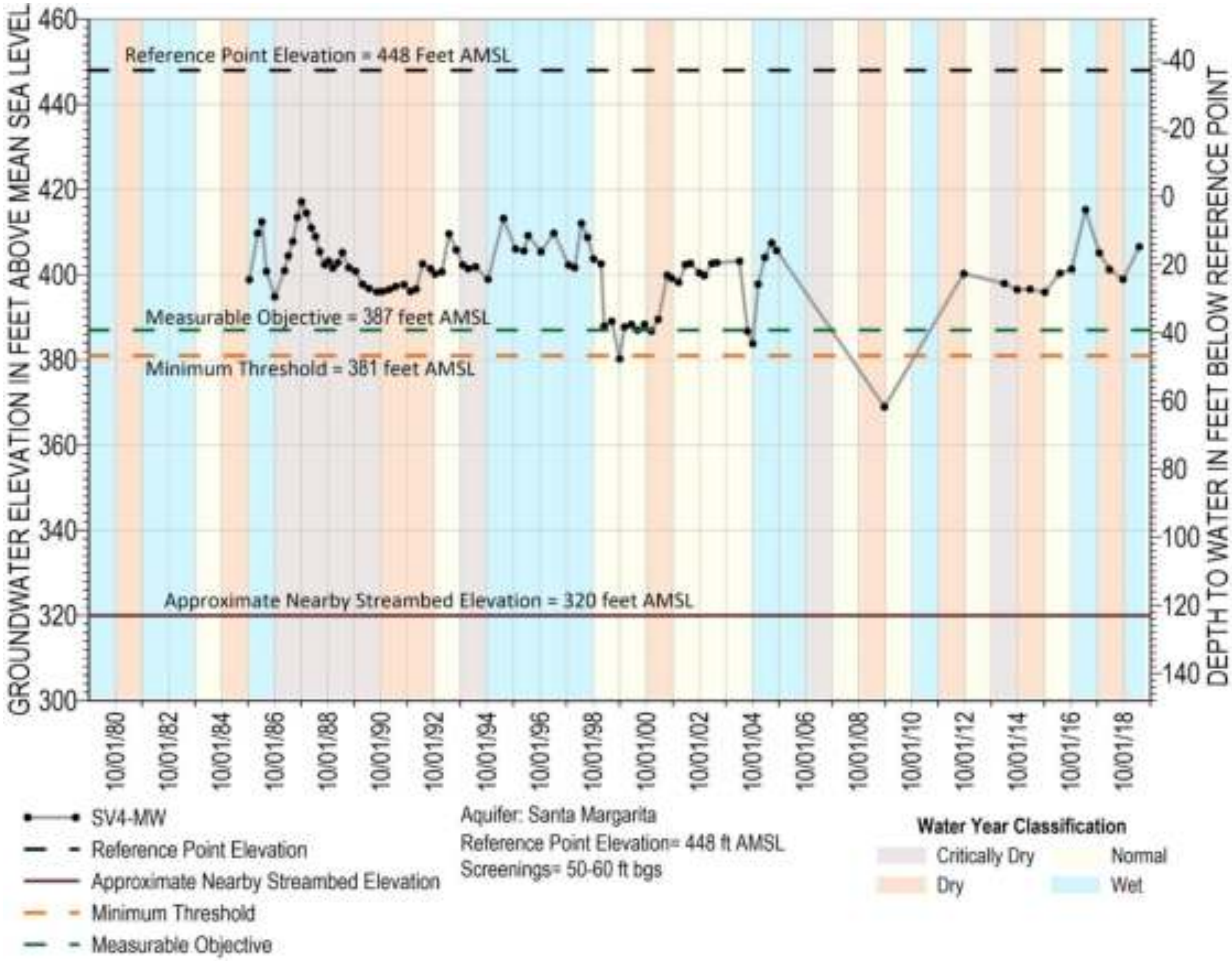


Figure 3-23: Hydrograph for SLWD SV4-MW in the Santa Margarita Aquifer Showing Minimum Threshold and Measurable Objective Relative to Measured Groundwater and Streambed Elevations

3.7.3.3 Relationship between Individual Minimum Thresholds and Relationship to Other Sustainability Indicators

Since the groundwater elevations are based on historical conditions and are considered an achievable condition, the individual minimum thresholds at RMPs do not conflict with each other.

The surface water depletion minimum thresholds have the potential to influence other sustainability indicators. The groundwater level minimum thresholds are selected to avoid undesirable results for other sustainability indicators, as described below:

- **Chronic lowering of groundwater levels**. Groundwater levels are used as a proxy for monitoring the depletion of interconnected surface water minimum thresholds. The methodology for establishing minimum thresholds for both sustainability indicators are the same. If groundwater levels for chronic lowering of groundwater level RMPs are lower than their minimum thresholds, groundwater levels for streamflow depletion are also likely to be lower than their minimum thresholds.
- **Reduction of groundwater in storage**. Minimum thresholds for depletion of interconnected surface water do not promote pumping in excess of the sustainable yield that is needed to ensure change of groundwater in storage does not cause undesirable results. Therefore, the minimum threshold for depletion of interconnected surface water minimum thresholds will not result in an exceedance of the groundwater storage minimum threshold.
- **Degraded groundwater quality**. Minimum thresholds for depletion of interconnected surface water are set just above the historical minimum groundwater elevation. Since historical groundwater levels are not thought to cause existing degradation of groundwater quality, depletion of interconnected surface water minimum thresholds should not result in exceedances of groundwater quality minimum thresholds.
- **Seawater intrusion**. Not applicable.
- **Subsidence**. Not applicable.

3.7.3.4 Effect of Minimum Thresholds on Neighboring Basins

The anticipated effect of the depletion of interconnected surface water minimum thresholds on each of the neighboring basins is addressed below.

Santa Cruz Mid-County Basin (critically-overdrafted). The Santa Margarita Basin is upstream of the Santa Cruz Mid-County Basin. The San Lorenzo River does not run through the Santa Cruz Mid-County Basin, but the West Branch of Soquel Creek and Carbonera Creek do. Only a very small portion of the West Branch of Soquel Creek runs through the Santa Margarita Basin and Carbonera Creek is largely disconnected from groundwater (Figure 2-70). By maintaining groundwater levels above historical levels in areas near interconnected streams, this GSP does not prevent the Santa Cruz Mid-County Basin from meeting their respective surface water depletion minimum thresholds which are based on groundwater elevations slightly higher than historical lows. Groundwater flow between the Santa Cruz Mid-County Basin and the Santa Margarita Basin is limited, and there are no GSP projects or management actions planned for either basin that might change hydraulic gradients near the basins' shared boundary. The lack of connection between the Santa Cruz Mid-County Basin's primary aquifer (Purisima Formation) and the Santa Margarita Basin's primary aquifers (Santa Margarita, Lompico and Butano aquifers) further reduces the likelihood of either basin affecting depletion of interconnected surface water minimum thresholds in the neighboring basin.

Purisima Highlands Subbasin of the Corralitos Basin (very low priority). The Purisima Highlands Subbasin is hydraulically upgradient from the Santa Margarita Basin and separated by the Zayante-Vergeles fault zone which acts as a barrier to groundwater flow. This hydrogeologic disconnect provides little opportunity for depletion of interconnected surface water in the Santa Margarita Basin to influence groundwater in the Purisima Highlands Subbasin.

West Santa Cruz Terrace Basin (very low priority). Most private domestic wells in the West Santa Cruz Terrace Basin pump from low yielding Quaternary alluvium and terrace deposits (DWR, 2003). These deposits are not principal aquifers in the Santa Margarita Basin nor are they hydraulically downgradient of the Santa Margarita Basin. Therefore, it is unlikely that the depletion of interconnected surface water minimum thresholds in the Santa Margarita Basin would influence the West Santa Cruz Terrace Basin.

3.7.3.5 Effects of Minimum Thresholds on Beneficial Users and Land Uses

The minimum thresholds for depletion of interconnected surface water measured using groundwater levels as a proxy assumes that maintaining groundwater levels at or above historical low levels in the Basin, will maintain historical levels of surface water depletion. Maintaining surface water depletion at levels greater than historical conditions will provide a benefit to beneficial users and land uses that rely on interconnected surface water. The following specifically describes how minimum thresholds will benefit land and beneficial water use in the Basin:

- **Urban land uses and users**. Municipal groundwater pumpers will still be able to meet their typical water demands if surface water interconnection with groundwater remains similar to historical levels. The City of Santa Cruz as a user of Basin surface water and implementor of habitat conservation in the San Lorenzo River watershed relies on baseflows to help achieve the Agreed Flows described in Section 2.1.2.8. If groundwater levels adjacent to creeks are no lower than historical levels, baseflows should remain within the historical range of flows used to determine the Agreed Flows.

- **Rural residential land uses and users**. Maintaining surface water interconnection with groundwater at or above historical levels will protect residential beneficial users of groundwater by keeping groundwater levels at or above historical low levels. This protects their ability to pump from domestic wells in the vicinity of creeks.
- **Industrial land uses and users**. Maintaining surface water interconnection with groundwater should benefit industrial land uses and beneficial users by supporting similar groundwater pumping to historical levels.
- **Agricultural land uses and users**. For the very limited agriculture in the Basin, maintaining interconnection of surface water and groundwater at historical levels should not impact irrigation water supply.
- **Ecological land uses and users**. The main benefit of the surface water depletion minimum thresholds is to GDEs for priority species. Meeting minimum thresholds for depletion of surface water allows for continuing gaining surface water in the vicinity of the RMPs. Based on historical conditions, these groundwater levels are considered sufficient to support GDEs for priority species.

3.7.3.6 Relevant Federal, State, or Local Standards

No explicit federal, state, or local standards exist for depletion of interconnected surface water. However, both the Central Coast RWQCB and state and federal endangered species provisions call for the protection and restoration of conditions necessary for steelhead and coho salmon habitat in San Lorenzo River. These provisions were considered in development of the surface water depletion minimum thresholds.

3.7.3.7 Method for Quantitative Measurement of Minimum Thresholds

Groundwater elevations will be measured in RMPs used to monitor surface water depletion as a proxy. Groundwater level monitoring will be conducted in accordance with the monitoring protocol outlined in Section 3.3.2.1.

In addition to the direct measurement of groundwater levels, GDE monitoring described in Section 3.3.1.5.1 will be compared to proxy groundwater levels in an effort to correlate vegetation vigor with groundwater levels.

3.7.4 Measurable Objectives - Depletion of Interconnected Surface Water

3.7.4.1 Measurable Objectives

Measurable objectives are established to define an achievable average groundwater level in the depletion of interconnected surface water RMPs. The measurable objectives for the Santa Margarita aquifer surface water depletion RMPs are the seasonal low groundwater levels in each RMP from the fall of WY 2004.

Measurable objectives are based on groundwater levels that occurred in a historical average year. The average year selected is WY2004 because WY2004 and the 5 prior years cumulatively average 41 inches per year, which is similar to the average precipitation of 41.7 inches between 1947 and 2020 measured at the El Pueblo Yard in Scotts Valley. The prior 5 years comprise 4 normal and 1 dry water year.

Measurable objectives for depletion of interconnected surface water RMPs are summarized in Table 3-22 and hydrographs showing historical groundwater elevation data compared to the measurable objective are provided in Appendix 3A.

3.7.4.2 Interim Milestones

Recent groundwater levels are close to the measurable objective at both depletion of interconnected surface water RMPs. Because the 540 AFY expanded conjunctive use project used to develop the measurable objectives targets the Lompico aquifer, the RMPs in the Santa Margarita aquifer are predicted to have very small increases in groundwater levels. Interim milestones are therefore set at the same elevations as measurable objectives shown in Table 3-22.

3.8 References

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SANTA MARGARITA
Groundwater Agency

Public Review Draft

Section 4. Projects and Management Actions

Santa Margarita Basin
Groundwater Sustainability Plan

July 23, 2021

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Acronyms & Abbreviations

AACE............Association for the Advancement of Cost Engineering
AF ....acre-feet
AFY...............acre-feet per year
ASR...............aquifer storage and recovery
AWPF ....Advanced Water Purification Facility
AWTF ....advanced wastewater
CEQA............California Environmental Quality Act
cfs..................cubic feet per second
DPR...............direct potable reuse
DWR ....California Department of Water Resources
EIR ....Environmental Impact Report
GSA...............Groundwater Sustainability Agency
GSP ....Groundwater Sustainability Plan
IPR ....indirect potable reuse
IRWM ....Integrated Regional Water Management
JPA................Joint Powers Agreement
LID................low impact development
MGD ....million gallons per day
MGY ....million gallons per year
MHA ....Mount Hermon Association
MOA ....Memorandum of Agreement
O&M.............operations and maintenance
RMP ....representative monitoring point
SCWD...........Santa Cruz Water Department
SGMA ....Sustainable Groundwater Management Act
SLVWD ....San Lorenzo Valley Water District
SMC ....sustainability management criteria
SMGWA ....Santa Margarita Groundwater Agency
SqCWD..........Soquel Creek Water District
SVWD...........Scotts Valley Water District
SWRCB..........State Water Resources Control Board
UWMP ....Urban Water Management Plan
WTP ....Water Treatment Plant
WWTF ....Wastewater Treatment Facility

4 PROJECTS AND MANAGEMENT ACTIONS

This chapter describes a range of potential projects and management actions that will allow the Santa Margarita Basin (Basin) to attain sustainability in accordance with §354.42 and §354.44 of the Sustainable Groundwater Management Act (SGMA) regulations.

As a Joint Powers Authority, the Santa Margarita Groundwater Agency (SMGWA) is comprised of 3 member agencies: San Lorenzo Valley Water District (SLVWD), Scotts Valley Water District (SVWD), and County of Santa Cruz (County). The SMGWA Board consists of representatives from the 3 member agencies and from other public agencies and private groups that rely directly or indirectly on groundwater from the Basin: City of Scotts Valley, City of Santa Cruz, Mount Hermon Association, and private well owners. Projects and management actions presented herein may provide benefits to just a single agency, to multiple agencies, and/or other groundwater or surface water users within the Basin. The term *cooperating agencies* is used throughout this section to represent the diverse water supply and land use planning agencies, organizations, and other operations that have a role in developing or implementing projects and/or management actions within the Basin. It includes SMGWA member agencies, other public agencies, and private parties.

Projects and management actions discussed in this section are in varying stages of development. They are proposed to achieve one or more of the following outcomes:

- Achieve groundwater sustainability in the Basin by meeting sustainable management criteria by 2042
- Meet the water supply goals of the cooperating agencies
- Provide a framework for future collaboration and cost sharing for cooperating agencies

Groundwater is a primary source of drinking water for residents and businesses within the Basin. Groundwater supports important creek baseflows for municipal agencies and aquatic species throughout the year, but most importantly, in the summer and fall. The City of Santa Cruz indirectly uses groundwater from the Basin because the surface water it diverts from the San Lorenzo River for municipal use partially comprises baseflows supported by Basin groundwater discharge to creeks.

Projects introduced within this section focus on achieving high return on investment using existing supply and infrastructure resources within the Basin, transferring surface water sources from outside the Basin, or recharging the Basin with purified wastewater. Several projects have the benefit of creating supplemental supply to improve water supply reliability for the City of Santa Cruz, SLVWD, and SVWD. Some projects benefit areas pumped by *de minimis* groundwater users.

The primary groundwater condition in the Santa Margarita Basin that projects and management actions aim to improve is lowered groundwater levels in one of the Basin's primary aquifers. The affected aquifer is the Lompico aquifer, in particular in the Mount Hermon / South Scotts Valley area where there has been a 150 to 200-foot historical decline in groundwater levels as described in Section 2.2.4.1. The long-term decline has been halted by successful water use efficiency programs and supplying recycled water for non-potable uses. Increasing groundwater levels to meet the SMGWA's sustainability goal will require additional projects and management actions to achieve sustainability under the assumed future climate conditions.

Projects and management actions are presented in 3 groups that provide distinction of the general status of projects and management actions representing a range of scale, cost, and state of planning and implementation, and timeframe which they may be implemented.

Group 1 - Baseline Projects and Management Actions: Activities in Group 1 are considered existing commitments by cooperating agencies. These include projects and management actions that are currently being implemented and are expected to continue to be implemented, as needed, to assist in achieving the sustainability goal throughout the GSP implementation period. Group 1 projects and management actions are incorporated into baseline conditions in the groundwater model used to evaluate projected groundwater conditions. Group 1 projects and management actions, by themselves, are not sufficient to achieve groundwater sustainability.

Group 2 - Projects and Management Actions in Planning Process: Projects in Group 2 are considered the Basin's best options for reaching sustainability. Many Group 2 projects require detailed feasibility and environmental review. Continuation of Group 1 projects along with the select Group 2 projects is anticipated to bring the Basin into sustainability. It is anticipated that the continuation of Group 1 projects along with a subset of Group 2 projects should allow the Basin to reach sustainability. If this combination is not able to meet the SMGWA's sustainability goals, additional Group 2 projects and even Group 3 projects may be implemented.

Group 2 projects are further organized into tiers based on their source of water:

- Tier 1 – Projects that rely on existing water sources within the Basin
- Tier 2 – Projects that rely on water from existing surface water sources outside the Basin
- Tier 3 – Projects that rely on purified wastewater

Group 3 - Projects and Management Actions Requiring Future Evaluation: If groundwater model projections and assumptions of future supply availability change or if Group 2 projects do not end up having the expected results further projects and/or actions will be required to achieve sustainability. Similarly, if Group 2 projects fail to become feasible either due to costs, environmental requirements, or any other reason, SMGWA may need to look to additional projects. In either case, appropriate projects may be chosen from those listed under Group 3. As work continues on water supply and resource management efforts, it may be prudent to incorporate additional projects into future GSP updates.

4.1 How Projects will be Accomplished

Projects and management actions included in Sections 4.2 through 4.6 provide a framework for achieving goals stated previously, however project feasibility must be completed and necessary cooperation agreements negotiated before any of the projects and management actions proceed with design, permitting, water rights, environmental review, and ultimately implementation. Costs for implementing projects are in addition to the costs for operation of the SMGWA as described in the GSP's implementation plan in Section 5. The SMGWA's first implementation activity in Section 5 is to evaluate its membership and funding structure. A 5-year GSP implementation budget is also included in Section 5 for operation of the SMGWA, including monitoring and required reporting.

Group 2 and 3 projects are not developed enough for cooperating agencies to fully commit to any projects prior to submission of the GSP to DWR in January 2022. Project implementation will ultimately be led by cooperating agencies working in coordination with one another for projects with multi-stakeholder benefits.

Through project feasibility analysis, cooperating agencies will need to demonstrate to the SMGWA that their projects meet SMGWA's groundwater sustainability goals, water supply goals of the individual cooperating agencies without causing undesirable effects to other groundwater beneficial uses or users.

Feasibility and analysis of projects will require additional information, technical and financial analysis, modeling, and potentially, pilot scale testing. Findings and results of such feasibility and analysis will be provided to the SMGWA Board for final evaluation and approval. SMGWA Board involvement in project evaluation is likely limited to determining if projects interfere with achieving the Basin's sustainability goals or have negative impacts on other GSP--related projects or management actions. Cooperating agencies are encouraged to coordinate with one another on projects to ensure multi-stakeholder benefits, thereby decreasing the likelihood of project interference. The process described herein is shown in Figure 4-1.

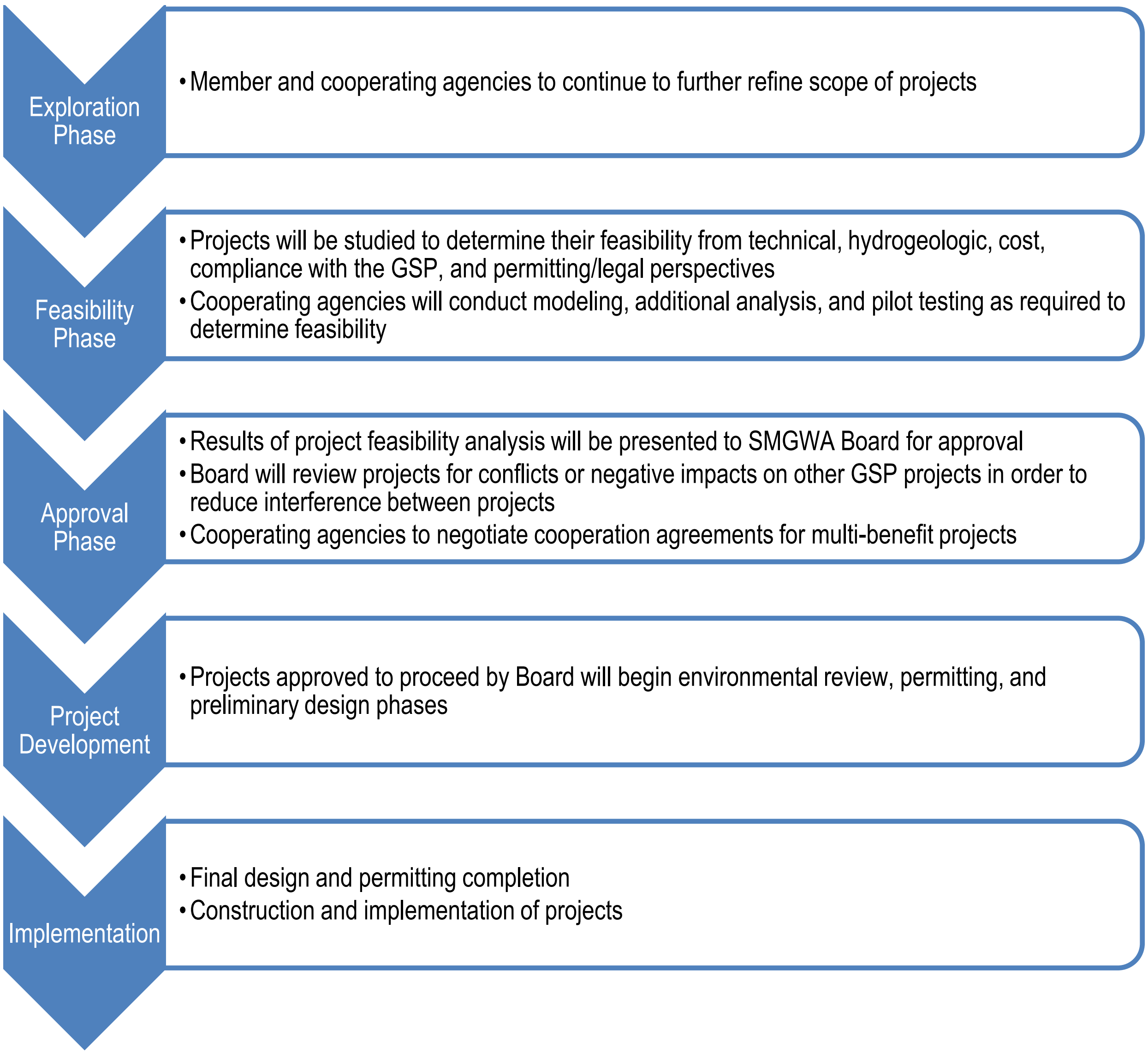

Figure 4-1. Project Feasibility Process

Aside from feasibility and analysis, each SMGWA member and cooperating agency will be responsible for permitting and other specific implementation oversite for its own projects. Inclusion in this GSP does not forego any obligations under local, state, or federal regulatory programs.

Most of the projects presented within Groups 2 and 3 are conceptual and still within the development phase as shown in Figure 4-1. Very few projects within these groupings have had any sort of feasibility analysis performed. For those where feasibility analysis has been performed, additional analysis is likely needed to update project scopes, benefits, limitations, and costs.

4.2 Baseline Projects and Management Actions (Group 1)

Projects and management actions in Group 1 are considered existing commitments by cooperating agencies and are currently being implemented. These baseline projects and management actions are expected to continue, as needed, throughout the GSP implementation period. As mentioned previously, these projects and management actions alone do not achieve basin sustainability on their own.

4.2.1 Existing Water Use Efficiency

SLVWD and SVWD are already implementing a number of water use efficiency and conservation activities. These successful programs have been in place for some time and have contributed to significant demand reduction. These programs are regularly updated to continue to incentivize conservation and promote efficient use of water. The programs are supported by extensive public outreach and education measures.

SLVWD, SVWD, the County, and City of Santa Cruz are members of the Water Conservation Coalition of Santa Cruz County, which serves as a regional information source for countywide water reduction measures, rebates, and resources. The Water Conservation Coalition provides water saving tips, information on countywide rebate programs, and educational materials (e.g., drought-tolerant plants suitable for local conditions). The organization works collaboratively to produce press releases, newspaper ads, radio ads, and informational booths at local events.

SLVWD, SVWD, the County, and the City of Santa Cruz have adopted water waste ordinances (incorporating State of California Executive Order B-37-16), which allow agencies to address incidents of water waste by investigating, recommending corrective action, providing follow-up documentation of resolution, and administering penalties, fines, and water service disconnection commensurate with the excessiveness of the action.

SLVWD promotes public awareness and education through a variety of water use efficiency programs. SLVWD provides information to customers regarding the water supply sources, the San Lorenzo River watershed, and the public's role in conserving water and protecting shared resources. The SLVWD website provides seasonal water use efficiency tips, informs customers when the drought contingency plan is in effect, posts restrictions or prohibitions for outdoor water use, provides rebate and landscape waterwise assistance and provides contacts for other partner organizations supporting water conservation. As mentioned previously SLVWD is part of the Water Conservation Coalition of Santa Cruz County.

SVWD, like SLVWD, also promotes public awareness and education through a variety of water efficiency programs. SVWD established the Think Twice Water Use Efficiency program which prescribes a set of activities to support SVWD's long-term sustainable water supply planning efforts. The program outlines a multi-pronged approach that increases awareness about indoor and outdoor water use efficiencies, promotes water efficient behaviors, and continuously reduces water waste. A key Think Twice program component is education and outreach. SVWD promotes public awareness and education of SVWD water supply sources, the San Lorenzo River watershed, and the public's role in conserving water and protecting shared resources. The SVWD website provides water use efficiency tips, informs customers when the drought contingency plan is in effect, posts restrictions or prohibitions for outdoor water use, provides rebate and landscape waterwise assistance and provides contacts for other resources that support water conservation. As mentioned previously, SVWD is part of the Water Conservation Coalition of Santa Cruz County.

Although the City of Santa Cruz is not in the Basin, it does divert water from the San Lorenzo River in the Basin. Consequently, conservation measures implemented by the city lessen the need for surface water diversions in the Basin. The City of Santa Cruz actively values and promotes public awareness and education about its water resources and the importance of water conservation. In 2017, the City of Santa Cruz initiated a Water Conservation Master Plan to define the next generation of water conservation activities and serve as a road map to help the community achieve maximum, practical water use efficiency. The City of Santa Cruz disseminates information to the general public in different forms including media, workshops and community events, billing and customer service, and school education programs. In addition to education and outreach the City of Santa Cruz implements the following conservation programs: metering infrastructure improvements to monitor water losses, large landscape budget-based water rates, residential leak assistance, high efficiency plumbing fixture rebates, turf removal and lawn rebates, sprinkler nozzle rebates, gray water retrofits and rain barrels, and overall system water loss reductions.

These management actions will continue to evolve with technological advances and future legislative requirements. Existing water use efficiency activities lower water demand and consequently reduce groundwater pumping and surface water diversions. Depending on where pumping and diversion reductions occur, groundwater levels may increase, and surface water depletions may be reduced.

There is currently no plan to end these successful water use efficiency activities. SVWD's peak water usage was in 2003 and they have since reduced consumption by 45% (data from 1995 to 2020 water years, WSC & M&A, 2021). SLVWD's peak water usage was in 2002 and they have since reduced consumption by 26% (data from 1995 to 2020 water years, WSC & M&A, 2021). City of Santa Cruz's peak water usage was in 2000 and they have since reduced consumption by 45% (data from 1951 to 2015 water years, City of Santa Cruz, 2016). Costs of conservation and demand management programs are built into respective agency's budgets and are not anticipated to be passed on to the SMGWA. As existing water use efficiency activities within the Basin continue to evolve over time, any significant changes will be publicly noticed as necessary by each implementing agency's governing bodies. Existing California state law gives water districts the authority to implement water conservation programs. Local land use jurisdictions have police powers to develop similar permitting programs to conserve water. SGMA grants the SMGWA legal authority to pass regulations necessary to achieve sustainability. Cooperating agencies are committed to successful implementation of their conservation programs.

4.2.2 SVWD Low-Impact Development

SVWD has implemented 3 low impact development (LID) projects, largely with grant funds that apply stormwater best management practices – such as infiltration basins, vegetated swales, bio-retention and/or tree box filters – to retain and infiltrate stormwater that is currently being diverted into the storm drain system. SVWD has installed monitoring equipment to assess the performance of the facilities. The total amount of stormwater captured at the three LID facilities in the SVWD service area in 2019 was 40.38 acre-feet (AF) and in 2020 was 19.42 AF (Montgomery & Associates, 2021). The location of the LID facilities is described in Section 2.1.3.4.6.3 and shown on Figure 2-7. The 3 LID projects are:

- Transit Center LID: SVWD obtained grant funding through a Santa Cruz County Proposition 84 grant from the State Water Resources Control Board (SWRCB) for the planning, design, and construction of a LID retrofit at the Scotts Valley Transit Center site. The design included construction of a vegetated swale, a below-ground infiltration basin, and pervious pavement. Construction began in October 2016 and was completed in May 2017. In 2020, SVWD recorded a total of 1.5 AF of infiltrated stormwater at this location (Montgomery & Associates, 2021).
- Woodside Homeowner's Association LID: As part of the Proposition 84 grant match, SVWD worked with a local developer to install a stormwater recharge facility at the Woodside Homeowner's Association along Scotts Valley Drive. This facility includes a large below-ground infiltration basin. Stormwater is routed from the development to the basin where it can percolate down into the groundwater. Initial hydrology reports estimate recharge on the order of 20 to 40 acre-feet per year (AFY) (Ruggeri, Jensen, and Azar, 2010). In 2020, SVWD recorded, a total of 14.97 AF of infiltrated stormwater at this location (Montgomery & Associates, 2021).
- Scotts Valley Library LID: An earlier grant-funded project installed a below-ground infiltration basin at the Scotts Valley Library. In 2020 SVWD recorded, a total of 2.94 AF of infiltrated stormwater at this location (Montgomery & Associates, 2021).

In addition to the 3 LID projects described above, SVWD was part of the Strategic and Technical Resources Advisory Groups for Ecology Action's regional sponsorship of the Proposition 84 LID Incentives Grant. SVWD staff provided input on rating criteria for the landscape certification program and the structure of grant reporting. Through 2018, 32 SVWD customers were awarded grant incentives for making stormwater management improvements to their properties, with strategies such as rainwater harvesting, lawn and hardscape removal, and stormwater retention methods, such as swales and rain gardens. According to SVWD staff records, the program provided 31,733 square-feet of permeable recharge area.

The infiltrated stormwater recharges the shallow aquifers in a manner similar to natural processes. The infiltration helps augment groundwater levels and sustains groundwater contributions to stream baseflow that supports local fishery habitats. In the case of the existing LID facilities, all 3 overlie percolate stormwater into the Santa Margarita Sandstone in areas where the underlying Monterey Formation restricts recharge of that water into the Lompico aquifer beneath the Monterey Formation. Because of this geological sequence there is limited potential of the LID facilities recharging the Lompico aquifer which has the greatest need for recovery and is the source of most of SVWD's water supply. A complicating factor in implementing LID projects in the Scotts Valley area is that there is no centralized stormwater collection system. This limits the ability to do large scale projects to direct groundwater augmentation to the most beneficial areas. Costs of existing projects have been offset by grant funding. SVWD will continue to evaluate additional LID projects in the future and look for opportunities to gain additional funding as needed.

4.2.3 SLVWD Conjunctive Use

SLVWD owns, operates, and maintains 2 permitted water systems: San Lorenzo Valley System (comprising 2 connected distribution systems: North System and South System) and Felton System (Figure 2-3), which supply separate areas from independent water sources. A conjunctive use program is already implemented in the North System, as this water system relies on surface water when available and groundwater when surface water diversion is not possible.

The North System is approximately 57 square miles and includes the unincorporated communities of Boulder Creek, Brookdale, and Ben Lomond. The North System is supplied by both stream diversions and groundwater wells. Six active points of diversion are located on Peavine, Foremen, Clear, and Sweetwater creeks. Two active groundwater wells draw from the Santa Margarita aquifer in each of the Quail Hollow and Olympia areas. On average, the North System obtains 56% of its water supply from stream diversions and 44% from groundwater pumping (Exponent, 2019).

Conjunctive use in this sense refers to the optimized, sustainable use of multiple water sources throughout repeated climatic cycles under physical, legal, and environmental constraints. As practiced in the North System, conjunctive use requires water production from stream diversions whenever possible. This allows a significant portion of unused and recharging groundwater to remain essentially stored for use during dry periods. The conjunctive use of these sources has met annual production demands since 1984, without a substantial decline in groundwater levels.

This successful conjunctive use program has allowed SLVWD to optimize the use of surface water and groundwater in the North System by utilizing stream flows while they are high and groundwater during low flow times. The resulting impacts are reduced groundwater pumping, increased groundwater levels around the wells that are resting, and increased creek baseflow.

The existing conjunctive use program uses operational changes to increase surface diversions when there is enough flow available that results in reduced groundwater pumping. The conjunctive use program can only be operated when there is available surface water. When surface water is not available due to sustained drought, groundwater pumping will increase. SLVWD currently has no plan to end the conjunctive use strategy it has been applying toward its 2 water sources, and instead has plans to expand the diversions in the North System to offset additional groundwater pumping (see Section 4.3.1.2). Costs of implementing additional diversions are built into ongoing SLVWD budgetary commitments and are not anticipated to be passed on to the SMGWA.

4.2.4 SVWD Recycled Water Program

The Recycled Water Program is a cooperative effort between SVWD and the City of Scotts Valley. Recycled water has been used by SVWD since 2002 in lieu of groundwater for non-potable uses. This augments the water supply and helps to meet water use efficiency goals. Recycled water is produced at the City of Scotts Valley Tertiary Treatment Plant, where it undergoes treatment including nitrate removal, ultra-violet disinfection, and chlorination. Recycled water is then distributed by SVWD to customers through a dedicated recycled water system. Recycled water is mostly used for landscape irrigation and dust control to a lesser extent.

The following specific recycled water programs are implemented by SVWD:

- The City of Scotts Valley has an order mandating use of recycled water for irrigation for new construction when permissible and economically feasible.
- Recycled Water Fill Station was activated in 2016-2018 and 2021 to offer free recycled water to District customers and City residents for permitted uses.
- In 2016, the City of Scotts Valley and Pasatiempo Golf Club, located outside of the Basin, reached an agreement for the City of Scotts Valley to provide treated wastewater to the golf course for irrigation. This allows Pasatiempo Golf Club to reduce its reliance on potable water from the City of Santa Cruz during peak-use months when irrigation demand is high. In support of this regional effort, SVWD released 10% of its total recycled water allocation in exchange for compensation that can be applied toward funding future projects. SVWD did not have a current identified use for the amount of recycled water that it supplied to the golf course.

Recycled water use within the Basin represents an equivalent reduction in groundwater pumping. Groundwater not pumped from the basin is assumed to be available for future beneficial use. Therefore, recycled water use results in a reduction in groundwater pumping and an increase in groundwater levels in the Basin.

SVWD continues using recycled water use in lieu of groundwater pumping and is exploring options to maximizing the beneficial use of recycled water in the future (see Section 4.6.7). Costs of operating the recycled water system are built into SVWD and City of Scotts Valley budgets and are not anticipated to be passed on to the SMGWA.

4.3 Projects and Management Actions Using Existing Water Sources Within the Basin (Group 2, Tier 1)

4.3.1 Project Descriptions, Objectives, and Circumstances for Implementation

Group 2 projects represent current thinking regarding the Basin's best option for reaching sustainability. Projects and management actions presented in this section have been designated under Group 2, Tier 1 and comprise projects that rely on existing water sources within the Basin, often cases within each agencies' own systems. Tier 1 projects and management actions also include expansion of some of the baseline, Group 1 projects presented in the previous section. These projects and management actions describe strategies for additional water use efficiency and conjunctive use of existing water sources in the Basin. Some of the potential projects in Tier 1 are the result of work and ideas emanating from a 2017 Memorandum of Agreement (MOA) between SLVWD, SVWD, City of Santa Cruz, and County of Santa Cruz (City of Santa Cruz *et al.*, 2017) to explore and evaluate potential projects for the conjunctive use of surface and groundwater resources in the Basin and San Lorenzo River watershed.

The following subsections provide detailed project descriptions followed by a summary of objectives and discussion of circumstances for implementation.

4.3.1.1 SLVWD and SVWD Additional Water Use Efficiency

Project Description

As discussed in Section 4.2.1, SLVWD and SVWD have a long history of implementing successful water use efficiency activities resulting in significant demand reduction. Further expansion of these programs will allow SLVWD and SVWD to reach more customers and expand the awareness. This management action establishes a set of activities to support the SLVWD and SVWD's long-term sustainable water supply planning efforts. The management action outlines a multi-pronged approach that increases awareness about indoor and outdoor water use efficiencies, promotes water efficient behaviors, and continuously reduces water waste.

The program components include additional education and outreach measures such as free house calls to provide consultation and devices for efficient water use, continued participation in countywide conservation coalition activities, continued public speaking and local media placements, irrigation scheduling guidelines, commercial kitchen pre-rinse spray valve project repeating in 5 years (2023), and community outreach at Scotts Valley and Felton Farmers Market and other events. SLVWD and SVWD will continue to provide rebates on a variety of activities and equipment and free devices, which enhance water use efficiencies. Both SLVWD and SVWD will continue implementation and enforcement of the water waste policies (SLVWD Ordinance 106 and SVWD P500-15-1). In addition, SVWD will evaluate feasibility and effectiveness of a program that sets water targets for landscape customers.

While education and outreach programs increase awareness and efficiency on the customer side, both SLWVD and SVWD will look to continue to increase efficiencies within their respective distribution systems through improvements to the metering infrastructure, evaluation and remediation of non-revenue water, and system pressure reduction. New metering infrastructures allow for increased accuracy, leak detection, and customer involvement and awareness. In 2016, SLVWD began deployment of new meters in its Lompico service area, and a multi-year system wide meter change out program that has upgraded 27% of meters system wide at the time of writing this GSP. In 2016, SVWD began system-wide deployment of Advanced Metering Infrastructure and achieved 100% completion in spring 2021.

As part of regular capital improvements, SLVWD is planning to begin replacement of older storage tanks and pipelines. Many of these facilities are parts of older distribution systems that have been acquired by SLVWD. Several storage tanks within SLVWD are made of redwood and known sources of water loss. Systemically addressing water losses increases overall efficiency and reduces non-revenue loss thereby decreasing consumption and groundwater pumping.

Project Objectives

Management actions to reduce water demand have been implemented at various times depending on the agency and are continued to this day. Benefits from already implemented water use efficiency programs have resulted in overall reduction of pumping and halting the long-term decline in Lompico aquifer and Monterey Formation groundwater levels in the Scotts Valley area. Expected project benefits from expanding water use efficiency projects include further reductions in groundwater pumping that results in increased groundwater levels, and the ancillary benefits such as increased groundwater storage and reduction in surface water depletion. Additional water use efficiency on its own is not expected to increase groundwater levels to meet measurable objectives for chronic lowering of groundwater levels and depletion of interconnected surface water, but it is expected to contribute to keeping water demand flat while population increases slightly.

Circumstances for Implementation

Majority of water use efficiency measures are already in place and covered in existing budgets of the respective agencies. Since existing water use efficiency programs are well received and successful, expansion of these programs where viable is not expected to face any significant setbacks.

4.3.1.2 SLVWD Existing Infrastructure Expanded Conjunctive Use (Phase 1)

Project Description

As discussed in Section 4.2.3, SLVWD has been practicing conjunctive use in their North System for decades, however, SLVWD has an opportunity to expand conjunctive use in their South System. Expanding conjunctive use will allow SLVWD to optimize use of currently available treated surface water sources in their North System and Felton System by using existing system interties and potential capacity enhancements to offset groundwater pumping in their South System where lowered groundwater levels have occurred. The South System is supplied groundwater pumped from the Lompico aquifer by SLVWD's Pasatiempo wellfield. SLVWD would achieve reductions in groundwater pumping in this area by substituting Pasatiempo pumping with excess surface water from the North System and/or Felton System. In very wet years when there is more surface water available than needed to meet SLVWD's South System and SVWD demands, the Santa Margarita aquifer will benefit by resting SLVWD's Quail Hollow and Olympia wellfields in the North System. This project is the first of 2 phases to increase surface water use in an effort to reduce groundwater pumping in areas with depressed groundwater levels. A second phase requiring additional infrastructure is described in Section 4.3.1.3.

Estimated available excess surface water from the North System is approximately 99 AFY and the Felton System may have up to 128 AFY. Available excess surface water is based primarily on runoff simulated to occur in response to the future climate projection developed for the GSP. The following constraints are taken into account in the analysis of availability:

- Minimum Fall Creek winter (November 1 through March 31) bypass flow of 0.75 cubic feet per minute (cfs) for dry years, and 1.5 cfs for otherwise. Dry years are defined based on cumulative flow volume in the San Lorenzo River at Big Trees from the beginning of the water year, and it should be noted that the administrative definition of dry year used to constrain Felton System diversions differs from the definition of dry year used for the GSP.
- SLVWD' permitted appropriative right to divert at a maximum total diversion rate of 1.7 cfs from Fall and Bull Creeks, and Bennett spring, with a maximum total annual diversion volume of 1,059 AF.

- Diversions from streams serving SLVWD's Felton System are permitted only if streamflow in the San Lorenzo River at Big Trees is at least 20 cfs.

Details on the climate projection and water availability analysis is described in the groundwater model report included as Appendix 2D. Excess surface water in the North and Felton Systems would be transferred to the South System in lieu of pumping groundwater from the Pasatiempo wellfield during the winter/springs months. This would allow the unpumped groundwater to remain stored for use during dry periods. On average, an estimated 227 AFY of excess surface water from SLVWD's North and Felton Systems is potentially available for expanded conjunctive use (Appendix 2D).

In general, availability of excess surface water is constrained by a number of factors, including drinking water treatment capacity, water rights place of use restrictions, required minimum fish flows, and availability of adequate surface water supplies to serve SLVWD customers in the North System. SLVWD's Fall Creek diversion that supplies the Felton System is currently limited by the water right place of use to the town of Felton.

SLVWD has been studying expanded conjunctive use for a number of years. Currently, SLVWD is completing a California Environmental Quality Act (CEQA) analysis and a final Conjunctive Use Plan, which has been funded with grant funds. The following supporting studies have been completed:

- Fisheries Resource Considerations for the San Lorenzo River Watershed Conjunctive Use Plan (Podlech, 2019)
- Water Availability Assessment for San Lorenzo River Watershed Conjunctive Use Plan (Exponent, 2019)

Project Objectives

The project objective is to use existing infrastructure to expand conjunctive use to passively recharge groundwater in SLVWD's Quail Hollow, Olympia, and Pasatiempo wellfield areas by resting those wells when excess North and Felton Systems surface water is available while also increasing stream baseflows. Groundwater stored by in-lieu recharge can be pumped in years when surface water flows are less available. As a result of expanding conjunctive use in the Basin, it is expected that there will be increased groundwater levels, increased stored groundwater, and increased baseflows.

Circumstances for Implementation

SLVWD's expanded conjunctive use project is already in the early planning stages and is likely to be implemented in the next year or two. As presented in Section 4.3.8, it is the lowest capital cost of the projects and management actions included in this GSP to implement assuming future excess surface water is available.

4.3.1.3 SLVWD and SVWD Inter-District Conjunctive Use with Loch Lomond (Phase 2)

As a second phase to the expanded conjunctive use project presented in Section 4.3.1.2, the Inter-District Conjunctive Use project with Loch Lomond would provide an additional 313 AF of treated surface water from Loch Lomond each year to offset wet season demand in SLVWD's South System and, once that need is satisfied, in SVWD's service area. Combined with Phase 1, there would be on average 540 AFY to offset all or almost all wet season groundwater demand in these particular areas. Through this demand offset SLVWD and SVWD could recover groundwater resources by reducing or eliminating pumping during the wet part of the year. Water transfers through existing and to be constructed system interties will allow the transfer and purchase of surface water from City of Santa Cruz to SLVWD and SVWD.

SLVWD has entitlements to a portion of Loch Lomond yield. In 1958, SLVWD sold 2,500 acres encompassing a portion of the Newell Creek watershed to the City of Santa Cruz with the agreement that SLVWD would be entitled to purchase 500 AFY, which was12.5% of the annual safe yield from a future Newell Creek reservoir planned by the City of Santa Cruz. In 1960, the City completed the Newell Creek Dam which created Loch Lomond Reservoir. The reservoir has a drainage area of 8.3 square miles and a reservoir capacity of approximately 9,000 AF. The City of Santa Cruz's appropriative right allows a maximum direct diversion of 3,200 AFY and a maximum use of 5,600 AFY.

SLVWD began receiving a portion of the reservoir yield in 1963. In 1965 SLVWD constructed the Glen Arbor Treatment Plant for treating its Loch Lomond deliveries. Toward the end of the 1976-77 drought, the City of Santa Cruz stipulated that SLVWD was not entitled to an allocation of 500 AFY, merely 12.5% of the safe yield. This decision, based on a reduction to the estimated annual safe from the Newell Creek Reservoir, reduced SLVWD's contractual allocation. This determination led to several years of water disputes between the City of Santa Cruz and SLVWD. In June 1977, SLVWD filed a Complaint for Declaratory Relief, which requested the Court to make a judicial determination of the respective parties' duties and rights. In June 1980, a court order fixed the estimated annual safe yield from Newell Creek Reservoir at reduced quantity, which resulted in a reduction to SLVWD's contractual allocation. SLVWD can currently purchase up to 313 AFY. Since implementation of the Surface Water Treatment Rule, SLVWD has not had the means to adequately treat diversions from Loch Lomond. For that reason, SLVWD has not exercised its contractual allotment of 313 AFY of raw Loch Lomond water. In 2010, the City of Santa Cruz and SLVWD discussed an option that would allow SLVWD to purchase up to 313 AFY (102 MGY) of treated City of Santa Cruz water. During the discussion, however, the City indicated that the treated water allocation would be reduced or interruptible during declared water-shortage emergencies. This was unacceptable to SLVWD, so the discussion did not lead to an agreement.

SLVWD commissioned a study to evaluate the feasibility and cost of utilizing its allotment of Loch Lomond (SPH Associates Consulting Engineers, 2010). The 2010 study presented costs of a project to upgrade the Kirby WTP and interconnect the Felton and San Lorenzo North and South Systems at a cost of approximately $6.4 million. This cost estimate is now outdated and would need to be updated, and the project scope and assumptions revisited.

An alternative would be purchasing treated water from the City of Santa Cruz. This would require conveyance lines, upgrades to the Graham Hill WTP, a booster pump from the Graham Hill WTP, and additional interties to route treated water to SLVWD's South System and SVWD. In previous discussions, the City of Santa Cruz indicated that the availability of treated water sales would carry drought restrictions. During drought is exactly when SLVWD would most need the water. Upgrading the Kirby WTP, on the other hand, would allow SLVWD unrestricted use of its Loch Lomond entitlement during all seasons and water quality conditions.

Project Objectives

The project objective is to use both existing and new infrastructure to expand conjunctive use beyond Phase 1 to passively recharge groundwater in SLVWD's Quail Hollow, Olympia, and Pasatiempo wellfield areas and in Scotts Valley where SVWD's extraction wells are located by resting those wells when Loch Lomond and excess North and Felton System surface water is available. Groundwater stored by in-lieu recharge can pumped in years when surface water flows are less available. As a result of expanding conjunctive use in the Basin, it is expected that there will be increased groundwater levels, increased stored groundwater, and increased baseflows.

Circumstances for Implementation

Adding the Loch Lomond component (Phase 2) to the Expanded Conjunctive Use project (Phase 1) is currently a conceptual project. Apart from the constraints outlined for the Phase 1 project above, the major factor constraining use of Loch Lomond water is adequate water treatment. Additionally, a study will be required to determine if there are water quality issues from mixing surface and groundwater across interties between SLVWD and SVWD.

It is expected that Phase 1 (227 AFY of in-lieu recharge) will not be able to achieve the increases in groundwater levels required to reach measurable objectives for chronic lowering of groundwater levels on its own. Sustainable management criteria developed for this GSP are based on the model results of combined 313 AFY of Loch Lomond and 227 AFY of North System and Felton System surface water being used in lieu of groundwater pumping in the winter and spring months (totaling an average of 540 AFY). Work to complete Phase 2 will likely follow completion of Phase 1.

4.3.1.4 SLVWD Olympia Groundwater Replenishment

Project Description

The Olympia groundwater replenishment project is a potential aquifer replenishment project in SLVWD's North System. Injection wells at the Olympia wellfield would be used to replenish the Santa Margarita aquifer with treated surface water from available winter flows. The winter surface water flows available for replenishment would be those greater than ongoing operations, water rights, and fish flows.

Since Olympia area Santa Margarita aquifer is a major contributor to baseflow in Zayante Creek, the project could only provide for operational storage for one season rather than as a drought reserve. It is unknown currently what the losses to baseflow would be as groundwater modeling of the project has not been undertaken.

Replenishment of the Santa Margarita aquifer in this area may be needed in the future if groundwater extraction in the area caused significant and unreasonable surface water depletions or chronic lowering of groundwater levels. Currently, there is some slight long-term declines in groundwater levels in the Olympia area.

Similar to the projects presented in the previous Sections 4.3.1.2 and 4.3.1.3, replenishing the Olympia wellfield area would be sourced by excess surface water in the North System and Felton System. If the Expanded Conjunctive Use project (Phase 1) and Inter-District Conjunctive Use project with Loch Lomond (Phase 2) are implemented and all available excess surface water is used by those projects, the Olympia Groundwater Replenishment project would not have source water. It is therefore considered an alternative project that would only be needed if groundwater extraction in the area caused significant and unreasonable surface water depletions or chronic lowering of groundwater levels.

Use of excess surface water for replenishment would directly recharge groundwater and increase groundwater levels instead of indirect or in-lieu passive recharge from conjunctive use presented in the 2 previous projects (see Sections 4.3.1.2 and 4.3.1.3). In addition to increasing groundwater storage in the Santa Margarita aquifer through direct recharge, a portion of the replenished water will discharge to creeks as baseflow.

Project Objectives

The objectives of this project are to replenish the Santa Margarita aquifer in the Olympia area if significant and unreasonable chronic lowering of groundwater levels or depletion of interconnected undesirable results occur.

Circumstances for Implementation

The Olympia Groundwater Replenishment project is an alternative use of excess surface water described for the conjunctive use projects in Sections 4.3.1.2 and 4.3.1.3. It would use similar water sources as the conjunctive use projects. Technical feasibility of the project is still largely unknown and further study is required.

4.3.2 Public Noticing

Public notice for all aspects of the conjunctive use and replenishment projects will be carried out by member agencies prior to the start of the project. Public noticing is anticipated to occur through compliance with CEQA for any facilities or plans associated with the project.

Projects will be approved through regular member agency public board or council meetings in which public discussions or comments will occur. Future notification of the public for any additional pilot testing or long-term implementation will be carried out prior to initiation of any project.

4.3.3 Overdraft Mitigation and Management Actions

The water budget described in Section 2.2.5 identifies there have been historical losses of groundwater in storage in the Basin and those losses will continue in the future without projects and management actions. The historical declines in groundwater levels in the Mount Hermon / south Scotts Valley started to lessen in the mid-2000s due to water use efficiency efforts by SLVWD and SVWD as well as elimination of pumping by Hansen Quarry to the point that groundwater levels are no longer declining.

While the stabilization of groundwater levels in recent years is promising, cooperating agencies will need to implement projects that recharge the areas of the Basin that have lowered groundwater levels. Projects and management actions presented within this section offer existing sources of water to offset groundwater pumping to raise groundwater levels through increased water use efficiency (reducing demand), conjunctive use (in-lieu recharge), or through replenishment (direct recharge). If existing sources and groundwater pumping are managed prudently, groundwater levels will increase resulting in basin sustainability.

4.3.4 Permitting and Regulatory Process

No permitting is required for water use efficiency and public education programs. However, the conjunctive use and the Olympia replenishment projects will require compliance with CEQA. An Initial Study – Mitigated Negative Declaration is currently being prepared for the expanded conjunctive use project with Loch Lomond water. Upon completion of the CEQA process, the SMGWA member and cooperating agency boards must take actions to certify the CEQA work and approve projects. No new water rights are being requested as part of any of the projects presented under this section, however, change of water rights place of use will be needed for excess surface water available from the Fall Creek diversion in the Felton System.

4.3.5 Timetable for Implementation

Additional water use efficiency programs are expected to start being implemented in 2022. Of the conjunctive use and replenishment projects relying on similar water sources, expanded conjunctive use (Phase 1) and addition of Loch Lomond water (Phase 2) are those most likely to be implemented first.

SLVWD is in the planning stage for Phase 1 of expanded conjunctive use and is currently preparing CEQA documentation for routine use of existing emergency interties which would be required as part of both the conjunctive use and replenishment projects (SLVWD, 2020). As such, the expanded conjunctive use and replenishment projects are not included in SLVWD's or SVWD's most recent capital improvement plans or fiscal planning budgets. It is anticipated that expanded conjunctive use (Phase 1) will be fully implemented within the next 5 years, while planning, environmental documentation, and construction of the infrastructure required to access Loch Lomond water will be completed before 2032.

4.3.6 Expected Benefits

While Basin groundwater levels have stabilized in the last few decades, it is anticipated that further water use efficiency efforts will not be able to increase groundwater levels on their own. Additional conjunctive use and/or groundwater replenishment will help increase Basin groundwater levels in areas where wells are rested. Current projections indicate that the combined projects of expanded conjunctive use (Phase 1) and addition of Loch Lomond water (Phase 2) will meet the sustainable management criteria described in Section 3. The severity of climate change over the next 20 years will determine whether supplemental projects are needed to achieve groundwater sustainability.

The Basin groundwater model described in Appendix 2D was used to simulate groundwater conditions in the Basin in response to implementing the combined projects of expanded conjunctive use (Phase 1) and addition of Loch Lomond water (Phase 2) for a total of 540 AFY in-lieu recharge in the areas where SLVWD and SVWD extract groundwater. The Basin groundwater budget and groundwater levels for the project simulation are compared against a baseline "no project" simulation. Both the project and baseline simulations account for projected climate change described in Appendix 2D. It is important to note that the simulations used to evaluate benefits are based on an assumed climate projection that will not reflect the year-to-year climate that transpires. The climate projection was selected to allow for a drier future to conservatively guide sustainability planning. Actual projects and management actions benefits will be understood by monitoring groundwater responses to their implementation. Recognizing the impossibility of predicting future climate and how much groundwater is pumped and where it is pumped, some of the smaller volumes in the water budgets are smaller than the noise or statistical uncertainty of those simulated volumes.

Table 4-1 compares baseline “no project” conditions to 540 AFY Phase 1 and 2 conjunctive use water budgets. An average 510 AFY reduction in pumping due to conjunctive use has the following benefits:

- 100 AFY more groundwater is left in storage
- 400 AFY more net groundwater discharge to creeks as baseflow

The baseline and conjunctive use simulations both have cumulative losses of groundwater in storage (Table 4-1). This is predominantly because the climate change projection in those simulations has 940 AFY less precipitation than WY2010 through WY2018 average precipitation. Storage losses are mostly in the Santa Margarita aquifer which is the most vulnerable to drought because it is directly recharged by rainfall and loses much of its recharge to creeks (Table 4-2).

Table 4-1. Baseline and 540 AFY Conjunctive Use Project Groundwater Budget

Water Budget Components Average Total for Water Budget Period in parenthesis (AF)		Projected Baseline 2020-2072		540 AFY Conjunctive Use 2020-2072	
		Annual Average (AF)	Percent of Total Inflow or Outflow	Annual Average (AF)	Percent of Total Inflow or Outflow
Inflows	**Precipitation Recharge**	12,100	56%	12,100	56%
	Subsurface Inflow	100	<1%	100	<1%
	Return flows (System Losses, Septic Systems, Quarry, Irrigation)	1,200	6%	1,100	5%
	Streambed Recharge	8,400	39%	8,300	38%
	Total Inflow	***21,800***		***21,600***	
Outflows	**Groundwater Pumping**	2,800	12%	2,300	10%
	Subsurface Outflow	100	1%	100	1%
	Discharge to Creeks	19,400	87%	19,700	89%
	Total Outflow	***22,300***		***22,100***	
Storage	**Average Annual Change in Storage**	-500	-	-400	-
	Cumulative Change in Storage	-24,000	-	-19,700	-

*Small discrepancies between total inflow and outflow may occur due to rounding

Table 4-2. 540 AFY Conjunctive Use Project Groundwater Budget by Aquifer

Water Budget Components Average Total for Water Budget Period in parenthesis (AF)		540 AFY Conjunctive Use 2020-2072			
		Santa Margarita Aquifer	Monterey Formation	Lompico Aquifer	Butano Aquifer
Inflows	**Precipitation Recharge**	5,700	1,300	900	3,600
	Subsurface Inflow	0	0	0	100
	Return flows (System Losses, Septic Systems, Quarry, Irrigation)	500	200	200	200
	Streambed Recharge	1,600	800	400	3,300
	Flow from Other Aquifers	0	300	1,600	600
	Inflow Totals	***7,800***	***2,600***	***3,000***	***7,700***
Outflows	**Groundwater Pumping**	700	100	1,000	400
	Subsurface Outflow	0	0	0	100
	Discharge to Creeks	6,300	2,120	1,400	6,900
	Flow to Other Aquifers	1,100	400	600	400
	Outflow Totals	***8,000***	***2,600***	***3,000***	***7,800***
Storage	**Average Annual Change in Storage**	-200	0	0	-100
	Cumulative Change in Storage	-9,600	-2,400	-2,700	-4,500

*Small discrepancies between total inflow and outflow may occur due to rounding

The groundwater model is used to simulate benefits to groundwater levels from the expanded conjunctive use project (magenta line on Figure 4-2 through Figure 4-5) in the areas where SLWVD and SVWD extraction wells are rested during the wet season months. In the Olympia wellfield area (Figure 4-2) extracting from the Santa Margarita aquifer, there is little increase in groundwater levels because the simulation assumes that to improve groundwater levels in the Lompico aquifer, excess surface water is used to first offset SLVWD Pasatiempo pumping, followed by SVWD pumping. Any remaining surface water is used to offset SLVWD pumping from its Olympia and Quail Hollow wellfields, which only occurs in a few very wet years. The projected baseline and expanded conjunctive use lines on Figure 4-2 are very similar and as a result the baseline is obscured.

Figure 4-3 and Figure 4-4 show simulated groundwater levels for Lompico aquifer wells in the vicinity of SLVWD and SVWD extraction wells that are rested in the wet season months. A conjunctive use project of 540 AFY is simulated to recover groundwater levels around the Pasatiempo wellfield (Figure 4-3) by an average of 25 feet and in south Scotts Valley (Figure 4-4) by an average of 20 feet. Monitoring well SVWD #15 screened in both the Lompico and Butano aquifers is simulated to have a benefit of around 50 feet of groundwater level recovery (Figure 4-5).

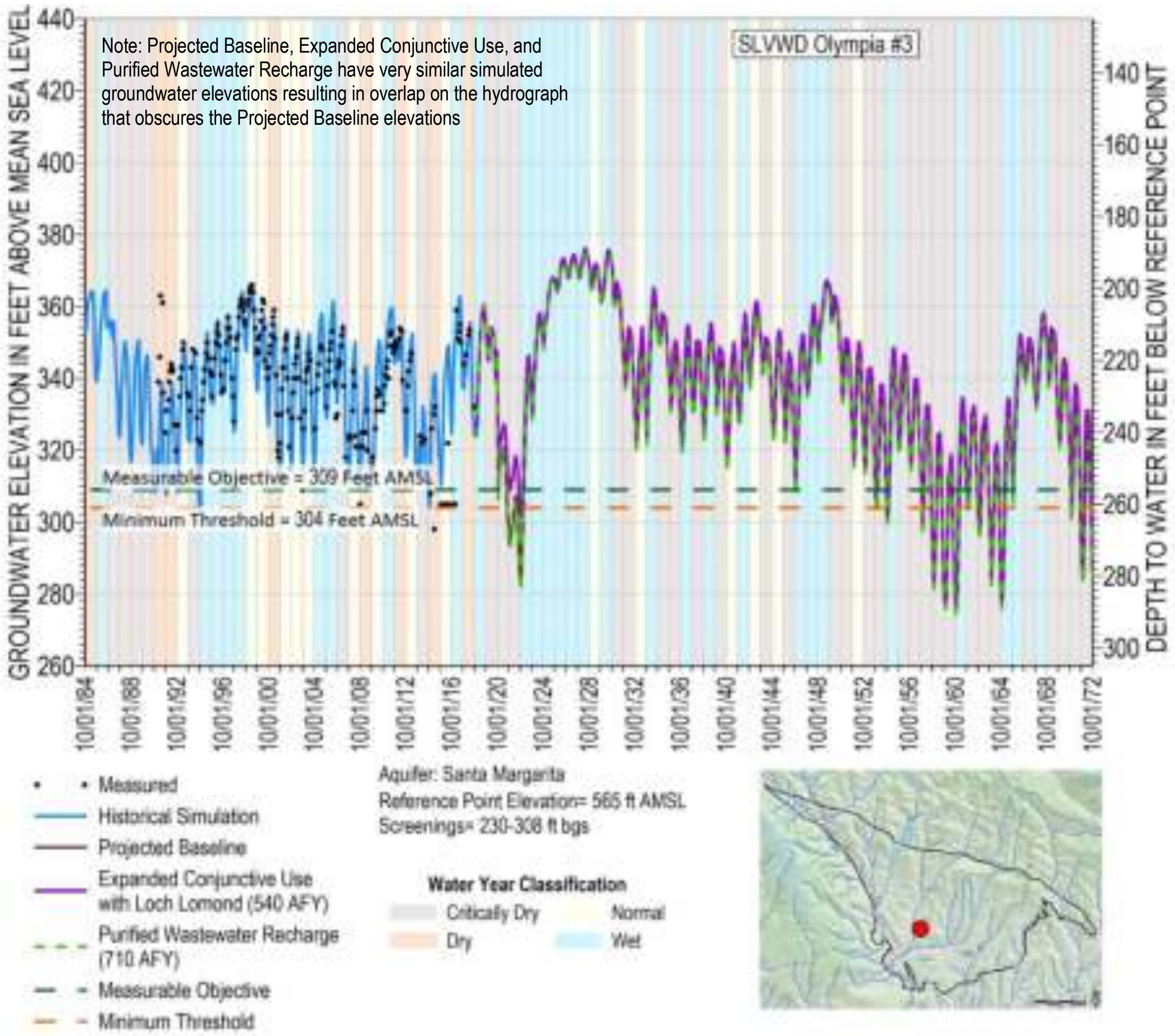

Figure 4-2. SLVWD Olympia #3 Simulated Groundwater Levels (Santa Margarita Aquifer)

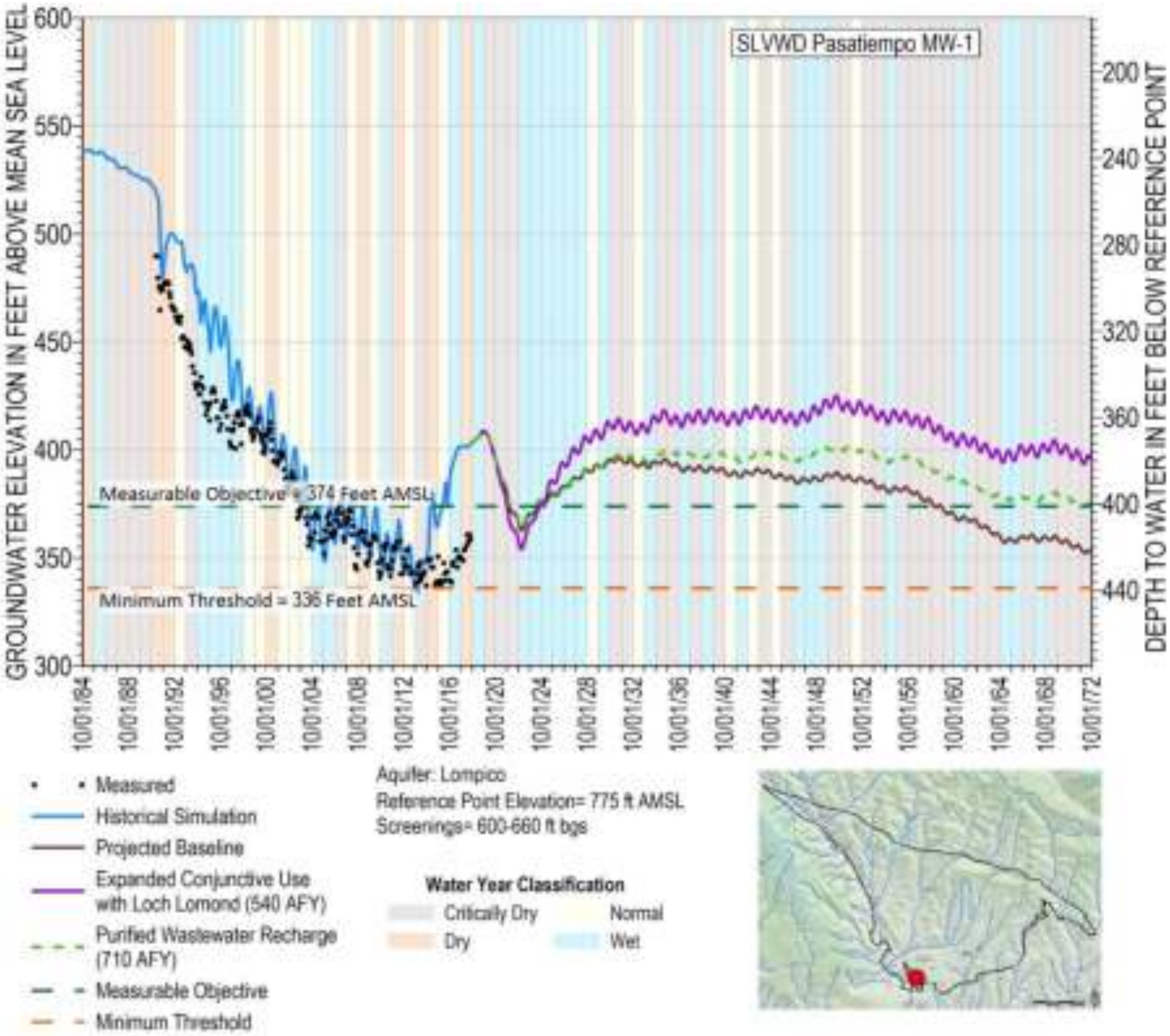

Figure 4-3. SLVWD Pasatiempo MW-1 Simulated Groundwater Levels (Lompico Aquifer)

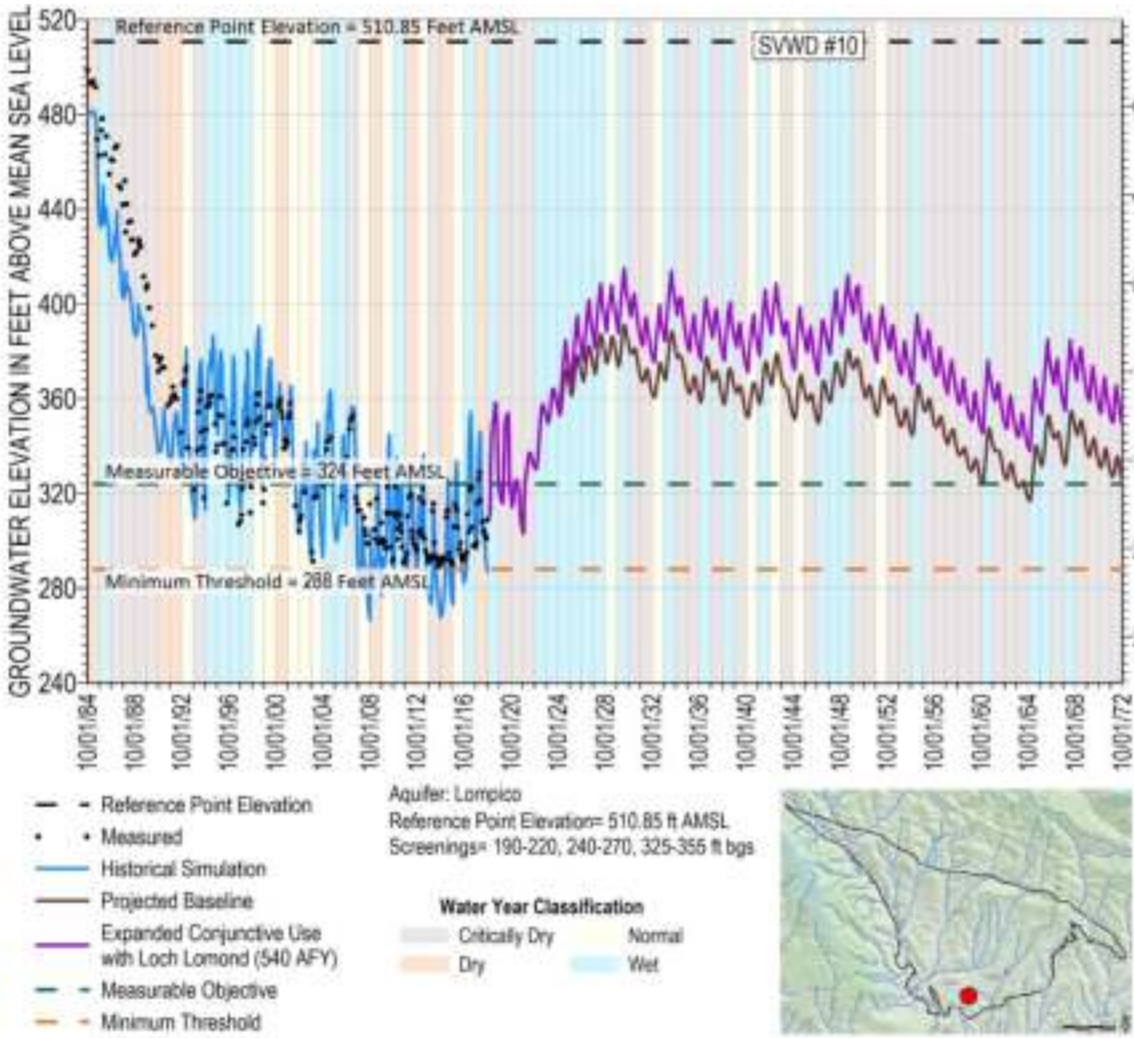

Figure 4-4. SVWD #10 Simulated Groundwater Levels (Lompico Aquifer)

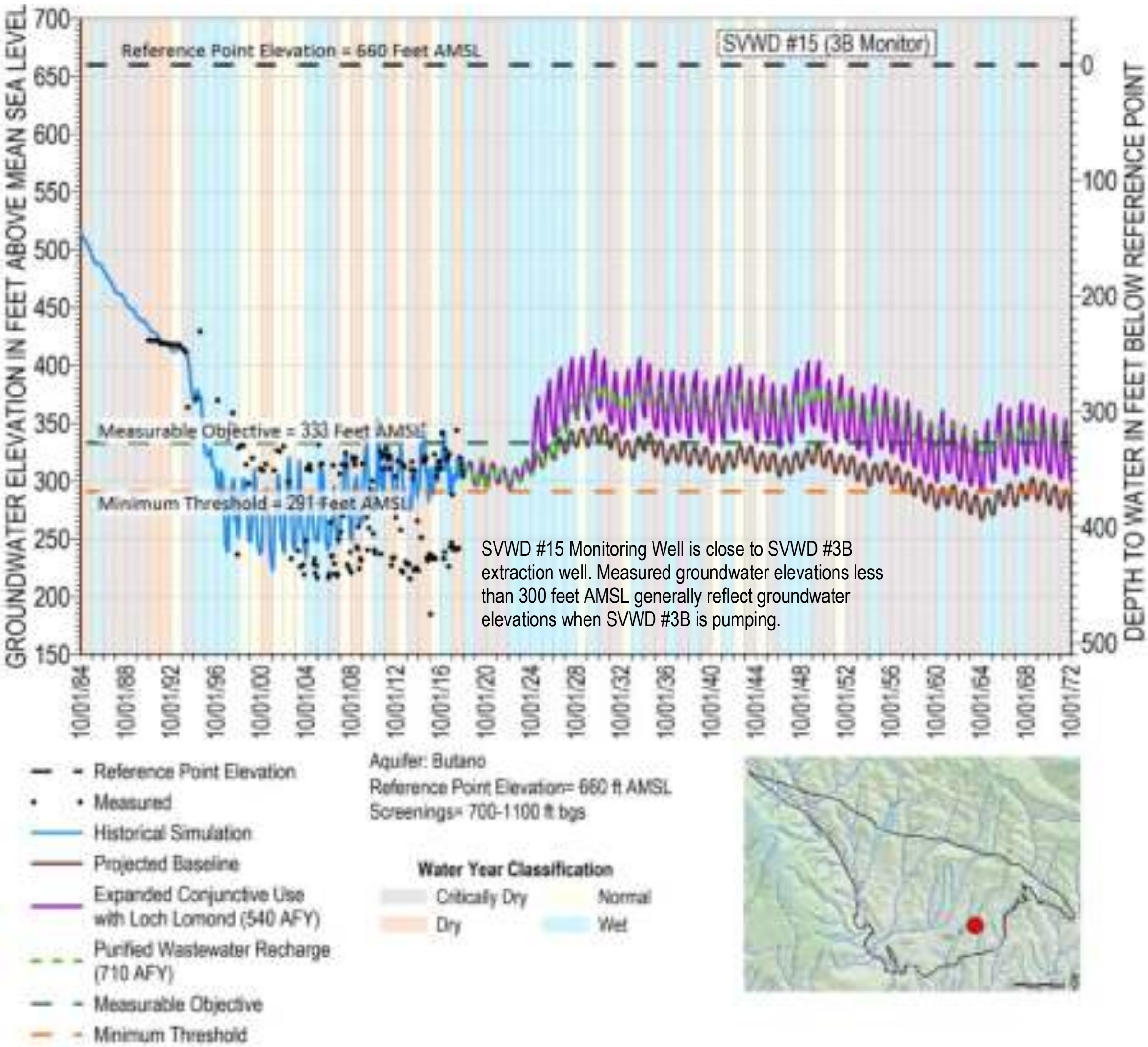

Figure 4-5. SVWD #15 Monitor Simulated Groundwater Levels (Butano Aquifer)

4.3.7 Legal Authority

California state law gives water districts the authority to take actions necessary to supply sufficient water for present or future beneficial use. Land use jurisdictions have police powers to develop similar programs. The SGMA grants SMGWA legal authority to adopt rules, regulations, ordinances, and resolutions necessary to achieve sustainability. Water use efficiency and conjunctive use projects make use of preserving existing water resources already within each member agency's system to which each agency already has access. Water transfers and purchases between agencies will comply with all legal requirements.

4.3.8 Estimated Costs and Funding Plan

Projects and management actions within this section will utilize a significant amount of existing infrastructure and in the case of additional water use efficiency will expand currently implemented programs. Additional infrastructure such as pipelines, pump stations, interties, injection wells and treatment capacity expansions will be required as part of the expanded conjunctive use with Loch Lomond and groundwater replenishment projects. Costs associated with these projects will be funded through a combination of increased operating revenue and outside funding sources. SLVWD has already received Proposition 50 grant funds for CEQA permitting required to expand conjunctive use within their system. Potential outside funding sources include Integrated Regional Water Management Grant Programs (IRWM), Sustainable Groundwater Management Grant Program, State Revolving Fund low interest loans, USDA grants and/or low interest loans, or USBR Drought Resiliency and/or Title XVI Recycled Water grants.

A summary of estimated costs is included in Table 4-3. Other project related costs presented below include engineering, permitting, land acquisition, environmental, special studies, legal, water rights, and other indirect costs. Cost estimates were prepared to Advancement of Cost Engineering (AACE) Estimate Class 5 intended for conceptual and planning level uses.

Table 4-3. Group 2, Tier 1 Estimated Project Costs

Project	Capital Construction Cost	Other Project Related Cost	Total Capital Cost	Annual O&M Costs
SLVWD and SVWD Additional Water Use Efficiency	$0.9 M	$1.0 M	$1.9 M	$0.9 M
SLVWD Existing Infrastructure Expanded Conjunctive Use (Phase 1)	$0.5 M	$2.8 M	$3.3 M	$0.2 M
SLVWD and SVWD Inter-District Conjunctive Use with Loch Lomond (Phase 2)	$25.1 M	$26.7 M	$51.7 M	$2.0 M
SLVWD Olympia Groundwater Replenishment	$12.0 M	$12.8 M	$24.8 M	$2.0 M

4.3.9 Management of Groundwater Extractions and Recharge

The Additional Water Use Efficiency activities and Expanded Conjunctive Use with Loch Lomond projects target to reduce groundwater pumping by SLVWD and SVWD. Reductions in groundwater pumping allow aquifers to passively recharge around the extraction wells being pumped less. Reduced pumping will contribute to increased groundwater levels and groundwater in storage. Increased groundwater extractions in dry years when surface water is less available will need to be managed such that minimum thresholds are not exceeded. Management actions are described in the 2020 Water Shortage Contingency Plan included in SVWD and SLVWD's joint 2020 Urban Water Management Plan (UWMP). These actions are developed to address supply shortages that take into account groundwater levels approaching minimum thresholds and extraction averages compared to projected long-term average baseline pumping (WSC and M&A, 2021).

The GSP monitoring network will be used to track groundwater levels, groundwater extraction, and groundwater quality by cooperating agencies to evaluate pumping impacts, measures of sustainability, and effects of implemented GSP projects and management actions on beneficial groundwater users and uses.

4.4 Projects and Management Actions Using Surface Water Sources Outside the Basin (Group 2, Tier 2)

4.4.1 Project Descriptions, Objectives, and Circumstances for Implementation

Projects and management actions presented in this section are designated as Group 2, Tier 2 and comprise projects that rely on surface water sources outside of the Basin. The following subsections provide a detailed project description followed by a summary of objectives and discussion of any circumstances for implementation for Tier 2 projects.

4.4.1.1 Transfer for Inter-District Conjunctive Use

Project Description

Similar to the expanded conjunctive use projects presented in Sections 4.3.1.2 and 4.3.1.3, this is a conjunctive use project, but it relies on treated surface water from outside of the Basin to offset some or all SLVWD and SVWD groundwater pumping during the wet season months. Treated source water would be provided by the City of Santa Cruz from its San Lorenzo River and North Coast sources when excess water is available.

A majority of the City of Santa Cruz water system relies on local surface water supplies, which include the North Coast sources, the San Lorenzo River, and Loch Lomond. The North Coast sources consist of surface diversions from three coastal streams and a natural spring. The San Lorenzo River is the City's largest source of water supply through their primary surface water diversion, Tait Diversion, and is supplemented by shallow, auxiliary wells located directly across the river. The City of Santa Cruz's Felton Diversion is a secondary diversion on the San Lorenzo River within the Basin. The diversion is an inflatable dam and intake structure about 6 miles upstream from the Tait Diversion. Water is pumped from this diversion to Loch Lomond to augment storage in the reservoir during dry years when natural inflow from Newell Creek, which feeds Loch Lomond, is low.

Project Objectives

The City of Santa Cruz Transfer for Inter-District Conjunctive Use project has the primary objective of helping recover groundwater levels in the Lompico aquifer in the Scotts Valley area. It would allow for passive groundwater recharge in the areas where the SLVWD and SVWD extract groundwater by using treated surface water supply from City of Santa Cruz in lieu of groundwater pumping. Conjunctive use projects have the potential to increase groundwater levels and create additional groundwater in storage if adequate amounts of treated surface water are available.

Circumstances for Implementation

The City of Santa Cruz Transfer for Inter-District Conjunctive Use is currently a conceptual project. In general, availability of excess surface water is constrained by a number of factors, including drinking water treatment capacity, water rights place of use restrictions, required minimum fish flows, and availability of adequate surface water supplies to serve SLVWD's and SVWD's demands. Some of the City of Santa Cruz's surface water is currently limited by water right place of use restrictions and the City has prepared a draft EIR evaluating the potential for significant environmental impacts from improved flexibility for operation of the City's water system while enhancing stream flows for local anadromous fisheries. The draft EIR public review period is from June 10 to July 26, 2021. To improve operational flexibility of the water system, the City of Santa Cruz is proposing water rights modifications to its existing rights, permits, and licenses to expand the authorized place of use, to better utilize existing diversions, and to extend the City's time to put water to full beneficial use. A purchase water agreement would need to be established between inter-SMGB agencies (i.e., SLVWD and SVWD) and the City of Santa Cruz.

If a conjunctive use project using sources from within the Basin is implemented, it is unlikely a conjunctive use project using water from outside of the Basin would also be implemented (and vice versa) because there is not enough wet season demand for both conjunctive use projects at the same time.

4.4.1.2 Aquifer Storage & Recovery Project in Scotts Valley Area of the Basin

Over the past few years, the City of Santa Cruz has explored the possibility of an aquifer storage and recovery (ASR) project in the Basin. The potential project would use treated surface water from the City of Santa Cruz's San Lorenzo River and North Coast sources to create an underground reservoir in the Basin for drought supply. The project would be located in the area of Scotts Valley where there are lowered Lompico aquifer groundwater levels and the most storage capacity.

The City of Santa Cruz has used the Basin groundwater model to simulate some preliminary ASR options for different ASR configurations and operations. However, its ASR feasibility study in the Basin has generally been deferred while this GSP is developed to ensure an ASR project is designed and operated in a manner that does not prevent the Basin from achieving sustainability. The City of Santa Cruz is also evaluating and pilot testing ASR in the neighboring Santa Cruz Mid-County Basin.

Project Objectives

The potential ASR project is a drought storage project for the City of Santa Cruz because it has limited water storage options. The objective is to store treated surface water in the Lompico aquifer for use in drought years. For the SMGWA to support a storage project such as this, there must be benefits to the Basin that would likely need to include a reduction in depletion of interconnected surface water and increased groundwater levels. To achieve this, the project will need to leave an agreed amount of water in the aquifer to provide a benefit to the Basin.

The ASR project feasibility study will need to include an evaluation of potential adverse impacts, such as property damage from high groundwater levels, reduction in groundwater baseflows to creeks, and groundwater levels falling below minimum thresholds when the City of Santa Cruz needs to use their drought storage.

Circumstances for Implementation

The potential ASR project is a drought storage project for the City of Santa Cruz, however, for it to be supported by the SMGWA it needs to operate within the GSP's sustainable management criteria. If a feasibility study shows an ASR project to be technically feasible, it will also need to demonstrate that it has benefits to groundwater beneficial users and uses, such as groundwater dependent ecosystems, municipal users, and private domestic users.

4.4.2 Public Noticing

Public notice for all aspects of an ASR project will be carried out by the City of Santa Cruz prior to the start of the project. Public noticing is anticipated to occur through compliance with CEQA for any facilities or plans associated with the project.

Projects will be approved through regular member agency public board or council meetings in which public discussions or comments will occur. Future notification of the public for pilot testing or long-term implementation will be done prior to initiation of the project.

4.4.3 Overdraft Mitigation and Management Actions

An ASR project will not permanently stop overdraft of the Basin on its own. It is not designed for that purpose, although if combined with another potential project(s) included in this GSP it may cumulatively increase groundwater in storage.

4.4.4 Permitting and Regulatory Process

The conjunctive use and ASR projects presented under this section will require an EIR to be developed in compliance with CEQA. Upon completion of the CEQA process, the cooperating agencies' boards and/or councils shall take actions to certify the CEQA work and approve projects. At this early stage of planning, it is unknown if any modifications to existing water rights would be required for these projects, or if a storage supplement could be filed through an administrative process.

4.4.5 Timetable for Implementation

The ASR project is only in the preliminary planning stages. Key next steps are to fully determine project feasibility and Basin benefits. The ASR project will continue to be evaluated over the next year or two.

The Transfer for Inter-District Conjunctive Use project is purely conceptual at this stage with no plan to conduct a feasibility study. If Phase 2 of the Expanded Conjunctive Use project is completed with treated Loch Lomond water being treated by the City of Santa Cruz and piped back up to south Scotts Valley in lieu of pumping groundwater by SLVWD and SVWD, the infrastructure will then be in place to supply the treated water needed for both ASR and transfer of surface water to the Basin for inter-district conjunctive use.

4.4.6 Expected Benefits

The transfer of treated surface water from outside the Basin for inter-district conjunctive use will have similar benefits as described in Section 4.3.6, if the volume transferred averages at least 540 AFY over the long-term. Benefit will be proportional to the volume of water available for conjunctive use and resulting in-lieu recharge.

Expected benefits from ASR are temporary increased groundwater levels and groundwater in storage. The benefits are temporary until a drought period when the stored water is needed and groundwater levels and storage decline until more drought storage can be injected into the aquifer. How the ASR project can be configured and operated so it does not negatively impact the Basin is still being evaluated. To provide a benefit to the Basin, the project will need to leave an agreed amount of water in the aquifer to improve groundwater levels and groundwater discharge to creeks.

4.4.7 Legal Authority

California state law gives water districts the authority to take actions necessary to supply sufficient water for present or future beneficial use. Land use jurisdictions have police powers to develop similar programs. The SGMA grants SMGWA legal authority to adopt rules, regulations, ordinances, and resolutions necessary to achieve sustainability. Water use efficiency and conjunctive use projects make use of preserving existing water resources already within each member agency's system to which each agency already has access. Water transfers and purchases between agencies will comply with all legal requirements.

4.4.8 Estimated Costs and Funding Plan

Projects included in this section will require additional new infrastructure such as pipelines, interties, pump stations and treatment capacity expansions and costs associated with these would be funded through a combination of increased operating and outside funding sources. Potential outside funding sources could include IRWM Grant Programs, Sustainable Groundwater Management Grant Program, State Revolving Fund low interest loans, USDA grants and/or low interest loans, or USBR Drought Resiliency and/or Title XVI Recycled Water grants.

A summary of estimated costs is presented in Table 4-4. Other project related costs presented below include engineering, permitting, land acquisition, environmental, special studies, legal, water rights, and other in-direct costs. Cost estimates were prepared to AACE Estimate Class 5, intended for conceptual and planning level uses.

Table 4-4. Group 2, Tier 2 Estimated Project Costs

Project	Capital Construction Cost	Other Project Related Cost	Total Capital Cost	Annual O&M Costs
Inter-District Transfer for Conjunctive Use	$15 M	$16 M	$31 M	$2.5 M
Aquifer Storage & Recovery Project in Scotts Valley Area of the Basin	$25 M	$26.6 M	$51.6 M	$2.5 M

4.4.9 Management of Groundwater Extractions and Recharge

The Transfer for Inter-District Conjunctive Use project intends to reduce groundwater pumping by SLVWD and SVWD. Reductions in groundwater pumping allow aquifers to passively recharge around the extraction wells being pumped less. Reduced pumping will contribute to increased groundwater levels and groundwater in storage. Increased groundwater extractions in dry years when surface water is less available will need to be managed such that minimum thresholds are not exceeded. Management actions are described in the 2020 Water Shortage Contingency Plan included in SVWD and SLVWD's joint 2020 Urban Water Management Plan (UWMP). These actions are developed to address supply shortages that take into account groundwater levels approaching minimum thresholds and extraction averages in comparison with projected long-term average baseline pumping (WSC et al., 2021).

The ASR project will need to be designed to operate such that it does not draw groundwater levels down below minimum thresholds for extended periods of time without the means to recharge the aquifers again before significant and unreasonable conditions occur.

The GSP monitoring network will be used to track groundwater levels, groundwater extraction, and groundwater quality by cooperating agencies to evaluate pumping impacts, measures of sustainability, and effects of implemented GSP projects and management actions on beneficial groundwater users and uses.

4.5 Projects and Management Actions Using Purified Wastewater Sources (Group 2, Tier 3)

4.5.1 Project Descriptions, Objectives, and Circumstances for Implementation

Projects and management actions presented in this section have been designated under Group 2, Tier 3 and represent projects that obtain their source water from purified wastewater supplies. The following subsections provide a detailed project description followed by a summary of objectives and discussion of any circumstances for implementation.

4.5.1.1 Purified Wastewater Recharge in Scotts Valley Area of the Basin (710 – 1,500 AFY Treated at Existing Facility Outside of the Basin)

A purified wastewater recharge project in the Scotts Valley area would use advanced water purification technology to treat existing secondary-treated effluent source water from the City of Santa Cruz Wastewater Treatment Facility (WWTF). Advanced treated wastewater would be injected into the Lompico aquifer in the Scotts Valley area. The project could use the expanded capacity of Soquel Creek Water District's (SqCWD) Chanticleer Advanced Water Purification Facility (AWPF) that is scheduled to begin construction in 2021 as part of the Pure Water Soquel project.

SVWD is in the process of assessing the feasibility and benefit to the Basin of using purified wastewater to replenish the Lompico aquifer. In 2020, SVWD performed an alternatives analysis to assess alternative purified wastewater projects ranging between 250 to 2,600 AFY (Kennedy/Jenks, 2020). Modeling performed in preparation of this GSP shows 710 AFY of replenishment would be enough to raise groundwater levels in the Lompico aquifer by 20 to 80 feet (see Section 4.5.6 for results) and meet measurable objectives. Preliminary modeling results indicate that if the expanded conjunctive use project with Loch Lomond (Phase 1 and 2) is not implemented, recharge of purified wastewater in excess of 710 AFY will create drought storage that can be used while still meeting measurable objectives.

To generate 710 AFY of purified wastewater, Pure Water Soquel Chanticleer AWPF would require a partial expansion, while full expansion of the Pure Water Soquel Chanticleer AWPF would generate 1,500 AFY of purified wastewater. In both the 710 and 1,500 AFY alternatives, secondary-treated effluent would be conveyed to the Chanticleer AWPF via planned infrastructure as part of the Pure Water Soquel project. Secondary-treated effluent would be treated using micro-filtration, reverse osmosis, and ultraviolet light and advanced oxidation process. Purified wastewater would be conveyed to the SVWD's El Pueblo yard for final conditioning and injected into wells near El Pueblo yard to recharge the Lompico aquifer. Brine is intended to be discharged via the Santa Cruz outfall.

A purified wastewater project is a high-cost option, but with regional participation it could provide greater water availability as well as the benefit of shared infrastructure and costs.

Project Objectives

The 710 AFY alternative's objective is to recharge the Lompico aquifer in the Scotts Valley area to increase groundwater levels and groundwater discharge to creeks. For alternatives recharging more than 710 AFY, the excess water recharged may be used as drought supply.

Circumstances for Implementation

The expanded conjunctive use with Loch Lomond (Phase 1 and 2) projects are a cheaper option for raising groundwater levels in the Lompico aquifer than a purified wastewater recharge project. However, the advantage of using purified wastewater is that it is a drought resilient source, while conjunctive use is reliant on having excess surface water. With concerns that changing climate is altering the timing and intensity of rainfall events that impact surface water runoff, conjunctive use may not solely provide the benefits needed to achieve sustainability.

As a backup option for achieving sustainability, and as a source of drought supply storage that can have multi-agency benefits, purified wastewater recharge is a potential project that the cooperating agencies are now considering.

Technical feasibility of the project is still largely unknown and further investigation is required. Several key factors that will determine feasibility are:

- Public perception related to perceived public health issues associated with using purified wastewater as a source
- Groundwater modeling required to assess available capacity in the groundwater basin and ability to meet regulatory travel times
- Pilot testing of Lompico aquifer injection capacity
- Water quality testing is required to assess potential impacts to the Basin and to meet regulatory and GSP requirements
- Dependability on other agencies to supply the source wastewater and treatment at the Chanticleer AWPF (i.e., City of Santa Cruz and SqCWD)
- Concept for Pure Water Soquel expansion capacity was initially intended for the Santa Cruz Mid-County Basin and not for the Santa Margarita Basin
- Complex multi-agency partnerships and institutional agreements would be required (i.e., cost sharing, operational agreements, etc.)
- Lack of conveyance network with other agencies to sell excess recharged water and considerable capital and operations and maintenance (O&M) cost for treatment of purified water and conveyance to Scotts Valley

4.5.1.2 Purified Wastewater Recharge in Scotts Valley Area of the Basin (3,500 AFY Treated at New Facility inside the Basin)

Similar to the purified wastewater recharge project presented in the previous subsection, this larger project utilizes advanced water purification technology to treat existing secondary-treated effluent source water from the City of Santa Cruz WWTF for injection into the Lompico aquifer. The difference between this 3,500 AFY project and the previous project with a 710 to 1,500 AFY capacity is that this project requires a new AWPF site in or near Scotts Valley. A project of this capacity would need to be a regional project with separate infrastructure from that used by Pure Water Soquel. Cooperating agencies are still in early discussions amongst themselves to determine if this project has potential regional support before assessing its feasibility.

Under this project 4 million gallons per day (MGD) of secondary-treated effluent would be conveyed to a new Scotts Valley based-AWPF via new conveyance infrastructure. Secondary-treated effluent would be put through a rigorous advance treatment using technology that meets regulatory requirements and industry best practices for similar sites throughout California. Purified wastewater would be conveyed and injected into injection wells near SVWD's El Pueblo yard and at several other suitable location in Scotts Valley. Brine discharge will need new infrastructure to connect to the Santa Cruz outfall.

Project Objectives

The 3,500 AFY purified wastewater recharge alternative's objective is to recharge the Lompico aquifer through active injection in the Scotts Valley area to increase groundwater levels, groundwater in storage, and groundwater discharge to creeks. Recharged purified wastewater in excess of 710 AFY may be used by multiple cooperating agencies as drought supply.

Circumstances for Implementation

A project of this size and cost can only be implemented if there is regional multi-agency benefit to the cooperating agencies. Longer drought periods and the threat of wildfires are considerations that need to be weighed against the costs and benefits of a drought resilient supply. This is a long-range project that needs to be studied together with the lesser capacity alternatives described in Section 4.5.1.1. The different project sizes will have different cost-benefits and operational strategies to maximize storage potential and control loses to creeks that may dictate which project size is the most beneficial to the Basin and its users.

4.5.1.3 Purified Wastewater Augmentation at Loch Lomond

This project involves augmenting Loch Lomond storage with purified wastewater. Advanced treatment would occur via an AWTF located at or near City of Santa Cruz WWTF employing full advanced treatment technology that meets regulatory requirements and industry best practices. The project would convey purified wastewater from the AWFT to Loch Lomond where it would be blended with raw water in the reservoir, a source of municipal drinking water supply for the City of Santa Cruz. Brine discharge would be via connection to the existing City of Santa Cruz ocean outfall. Other infrastructure would include a pump station near the treatment facility, conveyance pipelines and diffuser discharge facility at Loch Lomond (Kennedy/Jenks, 2018).

The available supply for a surface water augmentation project would depend on the amount of secondary effluent available for reuse, the dilution ratio and the retention time in the reservoir needed to meet regulation. Monthly wastewater flows are generally their lowest during summer months thereby limiting the size of the surface water augmentation project. This also happens to correspond with the time in which there is more available capacity in Loch Lomond. The ability to augment Loch Lomond may be limited to when there is available capacity in the reservoir to accept advanced treated flows. Reservoir augmentation would take place about half of each year and be sized to produce 3.2 MGD of advanced treated water when the reservoir is being drawn down to meet demands. Production would scale down in the winter months when the reservoir is filled naturally by rainfall and runoff. The project could be sized larger to draw the reservoir down in the summer as source of water for conjunctive use or ASR type projects (Kennedy/Jenks, 2018).

Project Objectives

A purified wastewater augmentation project at Loch Lomond would maximize the beneficial reuse of wastewater in summer months, and potentially provide more operational flexibility for reservoir operations. Instead of preserving storage to assure sufficient water supply for the City of Santa Cruz in the dry months, in all seasons Loch Lomond could be used as a climate independent resource for the region. If sized appropriately, the project could offset groundwater pumping by the City of Santa Cruz in the Santa Cruz Mid-County Basin, or if sold to SLVWD or SVWD offset pumping in the Santa Margarita Basin thereby raising groundwater levels in the locations where pumping is offset.

Circumstances for Implementation

The project provides an alternative means of utilizing drought resilient purified wastewater to augment Loch Lomond instead of for aquifer recharge and use as drought supply. Technical feasibility of the project is still largely unknown and further investigation is required. Several key factors that will determine feasibility are:

- There is a regulatory pathway for reservoir water augmentation projects, and though no projects are currently permitted in California, there are three projects in various stages of planning, design, and construction
- Requires meeting reservoir retention and dilution times
- Facility operation would be limited when the reservoir is full due to natural runoff
- Climate change and resiliency study by the City of Santa Cruz is in progress to understand true benefit of supply in dry years

- Project may require the City of Santa Cruz to operate Loch Lomond differently in the future
- Public perception related to perceived public health issues associated with using wastewater as a source supply for drinking water

4.5.2 Public Noticing

Public notice for all aspects of the project will be carried out by member agencies prior to the start of the project. Public noticing is anticipated to occur through compliance with CEQA for any facilities or plans associated with the project.

Projects will be approved through regular member agency public board or council meetings in which public discussions or comments will occur. Future notification of the public for any additional pilot testing or long-term implementation would be done prior to initiation of the project.

4.5.3 Overdraft Mitigation and Management Actions

The purified wastewater recharge projects presented within this section use outside purified wastewater sources to recharge the Lompico aquifer and increase groundwater levels in the Scotts Valley area, thereby eliminating overdraft conditions. Where recharge capacity of the project exceeds 710 AFY, recharge provides for drought supply through indirect potable reuse.

The purified wastewater augmentation at Loch Lomond project will only help address lowered groundwater levels in the Lompico aquifer if a portion of the water can be used by SLVWD and/or SVWD in lieu of pumping groundwater from the Lompico aquifer in the Scotts Valley area.

4.5.4 Permitting and Regulatory Process

The projects presented under this section will require an EIR to be developed in compliance with CEQA. Upon completion of the CEQA process, cooperating agencies' boards and/or councils shall take actions to certify the CEQA work and approve projects. No new water rights are being requested as part of any of the projects presented under this section.

4.5.5 Timetable for Implementation

The projects presented herein are only in the conceptual planning stages. Project scopes and benefits are subject to change based on further analysis. Key next steps are properly determining feasibility of the projects and defining key benefits.

4.5.6 Expected Benefits

While basin groundwater levels have stabilized in the last few decades, supplemental sources of water from outside the Basin may be needed to increase Lompico aquifer groundwater levels and meet Basin sustainability objectives. After recharging enough purified wastewater to increase groundwater levels to measurable objectives, any additional water stored in the aquifer may be used to augment groundwater or surface water providing a drought resilient supply that will increase the cooperating agencies’ water supply resiliency.

The groundwater model was used to simulate groundwater conditions in the Basin in response to injecting 710 AFY in the central and northern Scotts Valley area. The Basin groundwater budget and groundwater levels for the project simulation are compared against a baseline “no project” simulation. Both the project and baseline simulations account for projected climate change described in Appendix 2D. A project of greater capacity was not modeled.

Table 4-5 compares the Basin groundwater budgets for baseline conditions with injecting 710 AFY of purified wastewater into the Lompico aquifer. The project is simulated to have the following benefits to the Basin:

- 200 AFY more groundwater is left in storage
- 300 AFY more net groundwater discharge to creeks as baseflow

Compared to 540 AFY conjunctive use (Section 4.3.6, Table 4-1), the amount of groundwater discharge to creeks from 710 AFY purified wastewater recharge (Table 4-5) is very similar, but there is 75% more groundwater in storage because of direct injection into the Lompico aquifer.

Like the expanded conjunctive use with Loch Lomond project, groundwater storage losses for the 710 AFY purified wastewater injection simulation is mostly in the Santa Margarita aquifer due to reduced precipitation in the climate change projection used in the simulations (Table 4-6).

Table 4-5. Baseline and 710 AFY Purified Wastewater Recharge Project Groundwater Budget

Water Budget Components Average Total for Water Budget Period in parenthesis (AF)		Projected Baseline 2020-2072		710 AFY Injection 2020-2072	
		Annual Average (AF)	Percent of Total Inflow or Outflow	Annual Average (AF)	Percent of Total Inflow or Outflow
Inflows	Precipitation Recharge	12,100	56%	12,100	54%
	Subsurface Inflow	100	<1%	100	<1%
	Return flows (System Losses, Septic Systems, Quarry, Irrigation)	1,200	6%	1,100	5%
	Streambed Recharge	8,400	39%	8,400	37%
	Inflow Totals	***21,800***		***22,400***	
Outflows	Groundwater Pumping	2,800	12%	2,900	3%
	Subsurface Outflow	100	1%	100	1%
	Discharge to Creeks	19,400	87%	19,700	87%
	Outflow Totals	***22,300***		***22,700***	
Storage	Average Annual Change in Storage	-500	-	-300	-
	Cumulative Change in Storage	-24,000	-	-16,300	-

*Small discrepancies between total inflow and outflow may occur due to rounding

Table 4-6. 710 AFY Purified Wastewater Recharge Project Groundwater Budget by Aquifer

Water Budget Components Average Total for Water Budget Period in parenthesis (AF)		540 AFY Conjunctive Use 2020-2072			
		Santa Margarita Aquifer	Monterey Formation	Lompico Aquifer	Butano Aquifer
Inflows	**Precipitation Recharge**	5,700	1,300	900	3,600
	Subsurface Inflow	0	0	0	90
	Return flows (System Losses, Septic Systems, Quarry, Irrigation)	500	200	200	150
	Streambed Recharge	1,600	800	400	3,330
	Flow from Other Aquifers	3,300	600	2,300	1,160
	Inflow Totals	***7,800***	***2,500***	***2,800***	***7,800***
Outflows	**Groundwater Pumping**	900	100	1,400	520
	Subsurface Outflow	0	0	0	100
	Discharge to Creeks	6,100	2,100	1,500	6,920
	Flow to Other Aquifers	4,400	700	1,500	860
	Outflow Totals	***8,000***	***2,500***	***3,500***	***7,900***
Storage	**Average Annual Change in Storage**	-200	0	-700	-100
	Cumulative Change in Storage	-9,300	-1,600	-3,000	-3,400

*Small discrepancies between total inflow and outflow may occur due to rounding

The groundwater model is used to simulate benefits to groundwater levels from injection of 710 AFY of purified wastewater (green dashed line on Figure 4-2 through Figure 4-5, and Figure 4-6). In the Olympia wellfield area (Figure 4-2), there is no increase in groundwater levels because all injection takes place into the Lompico aquifer south of Bean Creek and there is no direct connection to the Santa Margarita aquifer north of Bean Creek. The most distant monitoring well from where injection takes place is SLVWD Pasatiempo MW-1. The hydrograph for this well shown on Figure 4-3 simulates around 20 feet of recovery which is a smaller groundwater level improvement than expanded conjunctive use. The difference in benefit is because resting the Pasatiempo wellfield through conjunctive use is more impactful than injection some 2 miles to the northeast. SVWD #10 (Figure 4-4), in the south Scotts Valley area, also has a smaller groundwater level increase than expanded conjunctive use because injection is about 1 mile away.

At a location close to injection, SVWD #11A (Figure 4-6), groundwater levels are simulated to increase up to 80 feet, well above those predicted for expanded conjunctive use at this location. SVWD #15 Monitor (Figure 4-5) is a monitoring well screened in the Lompico and Butano aquifers. It has a 50-foot groundwater level benefit, which is similar to the expanded conjunctive use but without the seasonal fluctuations that occur in the expanded conjunctive use simulation. Its resultant groundwater levels do not have seasonal fluctuations since injection occurs uniformly throughout the year.

The purified wastewater augmentation at Loch Lomond project has unknown benefits to the Basin at this early stage of the City of Santa Cruz's recycled water planning efforts.

4.5.7 Legal Authority

California state law gives water districts the authority to take actions necessary to supply sufficient water for present or future beneficial use. Land use jurisdictions have police powers to develop similar programs. The Sustainable Groundwater Management Act of 2014 grants SMGWA legal authority to pass regulations necessary to achieve sustainability. Water use efficiency projects make use of preserving existing sources already within each member agency's specific system to which each agency already has rights.

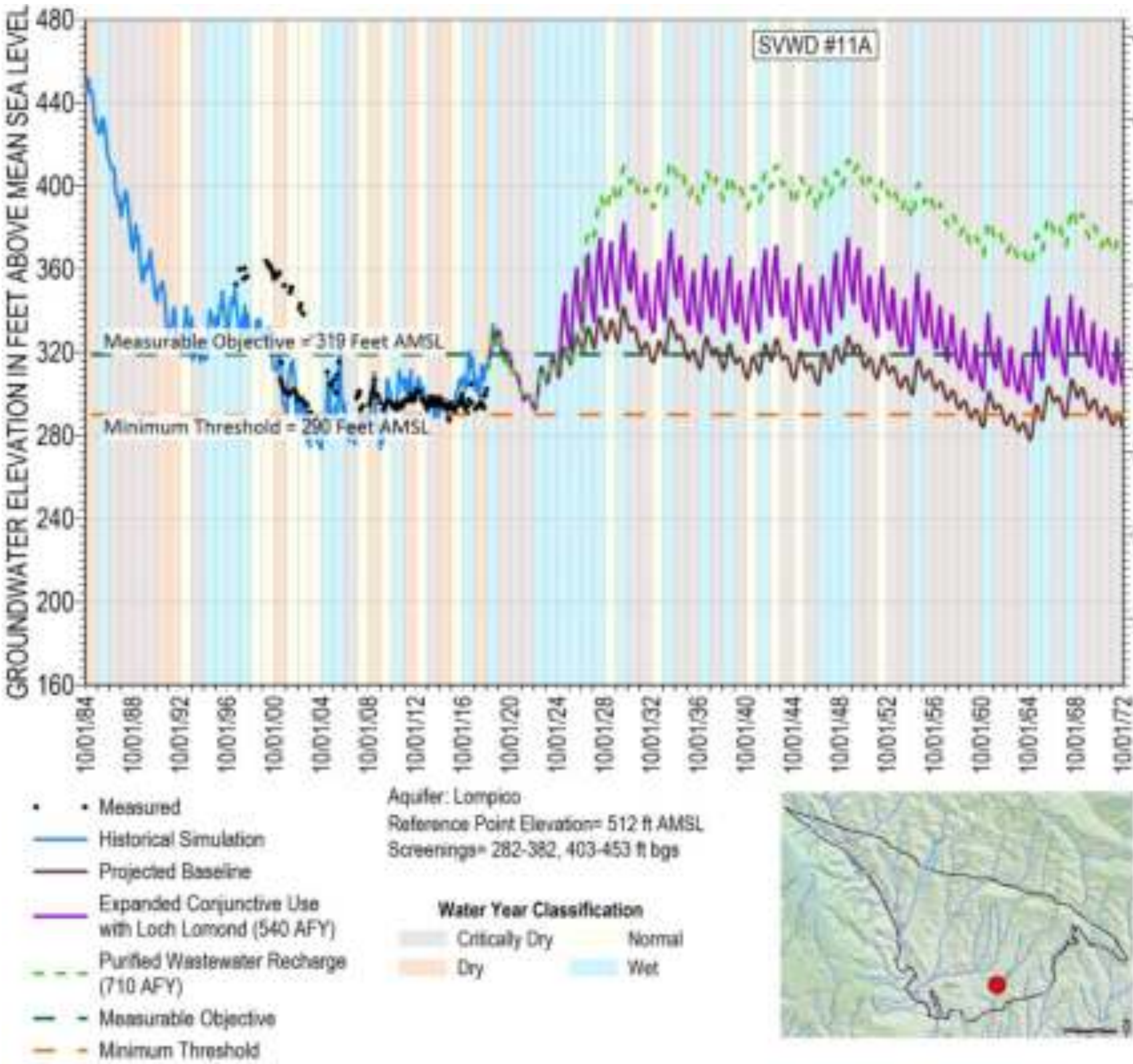

Figure 4-6. SVWD #11A Simulated Groundwater Levels (Lompico Aquifer)

4.5.8 Estimated Costs and Funding Plan

Projects included in this subsection require new infrastructure such as pipelines, interties, pump stations, injection wells, and new treatment facilities. Costs associated with the new infrastructure would be funded through a combination of increased operating revenue and outside funding sources. Potential outside funding sources could include IRWM Grant Programs, Sustainable Groundwater Management Grant Program, State Revolving Fund low interest loans, USDA grants and/or low interest loans, or USBR Drought Resiliency and/or Title XVI Recycled Water.

A summary of costs is presented in Table 4-7. Other project related costs presented below include engineering, permitting, land acquisition, environmental, special studies, legal, water use rights, and other in-direct costs. Cost estimates were prepared to AACE Estimate Class 5 intended for conceptual and planning level uses.

Table 4-7. Group 2, Tier 3 Estimated Project Costs

Project	Capital Construction Cost	Other Project Related Cost	Total Capital Cost	Annual O&M Costs
Purified Wastewater Recharge in Scotts Valley Area of the Basin (710 – 1,500 AFY Treated at an Existing Facility Outside of the Basin)[1]	$61.4 M	$46.1 M	$107.5 M	$2.6 M
Purified Wastewater Recharge in Scotts Valley Area of the Basin (3,500 AFY Treated at a New Facility inside the Basin)	$167.9 M	$126 M	$293.9 M	$5.9 M
Purified Wastewater Augmentation at Loch Lomond	$117.2 M	$76.1 M	$193.3 M	$7.5 M

[1] Costs are shown for the larger 1,500 AFY project. The smaller 710 AFY project is estimated at $97.9 million in total costs with $2.1 million in annual O&M.

4.5.9 Management of Groundwater Extractions and Recharge

All recharge water by injection wells will be metered and subject to reporting to the SWRCB as well as to the SMGWA to be included in the GSP's Annual Reports. Monitoring wells associated with the project proponent's permit requirements will monitor groundwater quality changes from the project. Some of the monitoring wells may be included as representative monitoring points (RMPs) in future updates to the GSP. Extractions to recover water stored for drought supply will be metered and accounted for separately from native groundwater extractions. Data collected as part of recharge operations will create a record of changes in groundwater levels and quality by the project and will be used to evaluate project impacts and its contribution to achieving sustainability.

4.6 Identified Projects and Management Actions Requiring Future Evaluation (Group 3)

If Group 2 projects are deemed infeasible or anticipated outcomes change, SMGWA may look to Group 3 projects to meet SMGWA sustainability goals. The level of detail provided for Group 3 is significantly less detailed than Groups 1 and 2 because the activities listed have not yet been seriously considered for implementation.

4.6.1 Public/Private Stormwater Recharge and Low Impact Development

This project includes, where feasible, installation of small to medium scale, 10 AFY to 1,000 AFY per site, facilities to capture stormwater to recharge the Santa Margarita aquifer through surface spreading and/or constructed dry wells. Preliminary siting of such facilities could be within the Lockhart Gulch area where stormwater runoff is currently diverted, near an existing detention basin on Marion Avenue, or one of several previously disturbed sites in public ownership or on property owned by the Santa Cruz Land Trust. Benefits would be location dependent but would likely locally increase groundwater levels around the recharge site and increase Santa Margarita aquifer baseflows to creeks. If stormwater recharge location can be found in the Camp Evers area where the Monterey Formation is absent, it will also benefit the Lompico aquifer underlying the Santa Margarita aquifer. While low-impact development projects do have positive impacts on basin recharge their individual flow contributions are typically small due to their limited footprints.

4.6.2 Enhanced Santa Margarita Aquifer Conjunctive Use

This conceptual conjunctive use operational strategy builds on Phase 1 and 2 Expanded Conjunctive use project described in Section 4.3.1.2. and 4.3.1.3. Its objective is to maximize the conjunctive use of the Santa Margarita and Lompico aquifers based on wet and dry years.

It is proposed that SLVWD extract from the Santa Margarita aquifer (Olympia and Quail Hollow wellfields) instead of its Pasatiempo wells extracting from the Lompico aquifer in years when the Santa Margarita aquifer has high groundwater levels. This allows the SLVWD Pasatiempo wellfield to provide for in-lieu recharge of the Lompico aquifer. In dry years, when Santa Margarita aquifer groundwater are lowered in response to reduced recharge from rainfall and impacting baseflows to creeks, SLVWD's Santa Margarita aquifer wells are rested by extracting instead Lompico aquifer groundwater recharged in the wet years.

The anticipated benefits of operating Santa Margarita and Lompico aquifer extractions in this way are that it maximizes the storage capacity of the Santa Margarita aquifer, operating it much like a surface reservoir. The expectation is that Santa Margarita aquifer groundwater will be available in the critical high water demand late summer and fall months when surface water is less available thereby maximizing conjunctive of the Lompico aquifer. By eliminating or reducing pumping from the SLVWD's Santa Margarita aquifer wellfields in drought years, groundwater that would have been pumped can remain in the aquifer to support creek baseflows. It also provides SLVWD with drought storage in the Lompico aquifer when groundwater levels in its Santa Margarita aquifer wells are too low to pump. There are also potential benefits to SVWD and the City of Santa Cruz.

Groundwater modeling of this operational concept will be needed to determine if it is feasible given climate change is expected to result in more dry years than wet years, and that the wet years will be wetter than historically experienced. Understanding potential impacts on the Santa Margarita aquifers contribution to creek baseflow and fate of the groundwater stored in the Lompico aquifer will also be important factors in determining its feasibility.

4.6.3 SLVWD Quail Hollow Pumping Redistribution

This project would add a new well within the SLVWD's system in order to redistribute pumping at the Quail Hollow area. SLVWD operates and maintains 2 active groundwater extraction wells in the Quail Hollow area which were constructed in the early 2000s. Prior to 1995, SLVWD operated wells at 3 additional locations in the Quail Hollow area. SLVWD plans to construct a third Quail Hollow extraction well to provide needed redundancy, additional capacity, and redistribute pumping in the area. Redistribution will help address drawdown impacts that may negatively affect some groundwater dependent ecosystems.

Wells sites in the vicinity of Quail Hollow Ranch are being considered to minimize potential interference with the two active Quail Hollow extraction wells with the intent of widening and reducing the depth of the pumping cone of depression caused by the existing wells.

4.6.4 Santa Margarita Aquifer Private Pumpers Connect to Public Water System

Public water systems operated by SMGWA member agencies could be expanded to incorporate parcels or developments dependent on private wells extracting from the Santa Margarita aquifer. A project of this nature would only be considered if it were found that private pumping was impacting surface water sources, if there was concern about shallower private wells going dry, or if there are climate change impacts not accounted for in current models. If this were the case, some parcels or developments could choose to be connected to the nearest public water system.

Preliminary analysis undertaken as part of GSP development using the groundwater model indicates that private pumping is not causing significant depletion of interconnected surface water and so this is not a necessary project. Additionally, connecting rural parcels to a water system will require significant additional infrastructure for minimal benefit given the size and relatively low population density of the region.

4.6.5 Direct Potable Reuse

Current California regulations do not allow direct potable reuse (DPR). DPR is the purposeful introduction of advanced treated wastewater into a drinking water supply, typically upstream of a drinking water treatment plant or directly into the potable water supply distribution system downstream of a water treatment plant. Unlike IPR projects, there is no environmental buffer that limits the capacity of a DPR project.

The report entitled "A Proposed Framework for Regulating Direct Potable Reuse in California" was released by the SWRCB in April 2018 and identifies key research areas to fill the identified knowledge gaps prior to the adoption of water recycling criteria for DPR through raw water augmentation by December 2023 (per AB 574). Given the outcome of the framework and interest in potable reuse statewide, raw water blending should continue to be tracked as a potential long-term strategy to maximize reuse and reduce ocean discharge. In general, future feasibility of the technology will be tied to overcoming the perception that there are public health issues associated with using wastewater as a source water for drinking water supplies.

4.6.6 Groundwater Use Restrictions

SGMA grants the SMGWA the authority to restrict pumping if the need or situation arises. At the time of submission of this GSP, pumping curtailment or restrictions are not currently being considered. However, should a future extreme scenario arise where the SMGWA fails to reach sustainability, the SWRCB will most likely enforce pumping restrictions as a management action to achieve sustainability.

For the purpose of the GSP, pumping restrictions are defined as reductions or limitations in the amount of water a current or future groundwater user can pump from the Basin. This would be applied in the case of a situation where implemented projects and management actions are insufficient to reach and/or maintain sustainability and one or more sustainability indicator is forecast to fall below minimum thresholds by 2042. Under such a curtailment scenario, the SMGWA would determine the amount of water that affected groundwater beneficial users could pump sustainably, and the pumpers would be required to reduce their groundwater extraction to that allocation. All pumpers subject to allocations and restriction would be required to be metered.

Should this dire option need to be considered at some point in the future, considerable technical work, discussion, and stakeholder input would be needed for the SMGWA to define the policies and procedures required to implement groundwater pumping restrictions.

4.6.7 Scotts Valley Non-Potable Reuse

Recycled water has been available for use in the City of Scotts Valley since 2002. Its availability increased steadily through expansion of the distribution system and the addition of service connections.

In 2021, the City of Scotts Valley is planning to conduct a study of potential upgrades or replacement projects for its existing Wastewater Recovery Facility. The full range of options has yet to be identified at the time of writing this GSP, however, it is anticipated to include looking at alternatives such as refurbishment of the existing treatment plant technology, upgrading to new technology such as membrane bioreactors, or other opportunities. Part of this study will be to review other reuse and system expansion opportunities for adjacent water agencies. Recycled water demand for irrigation primarily occurs in the summer months. SVWD provides recycled water for use by irrigation at parks, schools, homeowners associations, landscaped medians, and businesses. Recycled water use has tapered off in the last decade and has historically been climate dependent with higher usage during periods of reduced rainfall. While additional customers have been connected to the recycled water distribution system, overall demand has not increased significantly. Expansion of the system is currently limited by the economics of large capital costs required to connect a limited number of additional customers.

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SANTA MARGARITA
Groundwater Agency

Public Review Draft

Section 5. Groundwater Sustainability Plan Implementation

Santa Margarita Basin
Groundwater Sustainability Plan

July 23, 2021

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Acronyms & Abbreviations

AFY................acre-feet per year
DMS...............data management system
DWR..............California Department of Water Resources
GSP................Groundwater Sustainability Plan
JPA.................Joint Powers Agreement
MGA..............Santa Cruz Mid-County Groundwater Agency
MHA..............Mount Hermon Association
RMP...............representative monitoring point
SGMA...........Sustainable Groundwater Management Act
SLVWD.........San Lorenzo Valley Water District
SMC...............sustainable management criteria
SMGWA........Santa Margarita Groundwater Agency
SVWD............Scotts Valley Water District

5 GROUNDWATER SUSTAINABILITY PLAN IMPLEMENTATION

This section describes how the Santa Margarita Groundwater Agency (SMGWA) Groundwater Sustainability Plan (GSP) will be implemented. It serves as an initial roadmap for addressing GSP implementation activities between 2022 and 2042 but focuses on implementation activities to be completed between 2022 and 2026, prior to the GSP's first 5-year update. It also provides an estimate of the cost to implement the GSP over the next 5 years (Table 5-1) and how the SMGWA plans to meet those costs.

In Table 5-1 annual costs are multiplied by 5 to arrive at the 5-year cost that is included in the total. Annual costs are directly related to work that needs to be done consistently to meet the requirements of SGMA. Items listed as lump sum are one-time costs that are not multiplied and are carried forward to the total 5-year cost. Annualized costs over the 5-year period are also provided in Table 5-1. It is important to note that not all lump sum costs will be required in the first year of the 5-year implementation period, but for budgeting purposes, are anticipated before the first GSP 5-year update.

This implementation plan is based on the current understanding of Basin conditions described in Section 2, the monitoring networks summarized in Section 3, and potential projects and management actions for achieving groundwater sustainability described in Section 4. Understanding of groundwater conditions and the specific details of projects and management actions will evolve over time based on future data collection, model analysis, and stakeholder input. New understanding about the Basin and how it responds to implemented projects and management actions may change the course of SMGWA activities, which is the reason why this section focuses on the next 5 years.

Each of the line items in Table 5-1 correspond to the 8 GSP implementation activities described in the subsections that follow.

Table 5-1. Estimated Santa Margarita Groundwater Agency 5-Year Costs For GSP Implementation by Major Category

Activity	Budget Categories and Tasks	Annual Cost	Lump Sum Items	5-year Total	Annualized Cost (5 years)
1	**Agency Membership and Funding Structure Evaluation**	To be accomplished in Fiscal Year 2022 and included in Fiscal Year 2022 budget			
2	**Administrative and Business Operations**				
	Administrative and Planning Coordination	$100,000	$0	$500,000	$100,000
	Treasurer Services	$10,000	$0	$50,000	$10,000
	Legal Services	$12,000	$0	$60,000	$12,000
	Communication and Outreach	$20,000	$0	$100,000	$20,000
	Audit Services	$9,000	$0	$45,000	$9,000
	Software and Licenses	$2,500	$0	$12,500	$2,500
	Memberships	$2,100	$0	$10,500	$2,100
	Meetings and Travel	$5,000	$0	$25,000	$5,000
	Insurance	$1,200	$0	$6,000	$1,200
	Supplies and Equipment	$1,000	$0	$5,000	$1,000
3	**Technical Support and Consultation**				
	Groundwater Model Simulations and Updates	$15,000	$0	$75,000	$15,000
	Consultants As-Needed Technical Support	$15,000	$0	$75,000	$15,000
4	**Monitoring & Reporting**				
	Groundwater Level Monitoring	$8,000	$0	$40,000	$8,000
	Interconnected Surface Water Monitoring: Streamflow	$40,000	$0	$200,000	$40,000
	Interconnected Surface Water Monitoring: 5-Year Vegetation Vigor	$0	$5,000	$5,000	$1,000
	Interconnected Surface Water Monitoring: GDE Monitoring	$5,000	0	$25,000	$5,000
	Annual Reports	$45,000	$0	$225,000	$45,000
	GSP 5-year Update	$0	$100,000	$100,000	$20,000
5	**Non-De Minimis Metering Program**	$2,000	$5,000	$15,000	$3,000
6	**Address Hydrogeological Conceptual Model, Groundwater Conditions, and Monitoring Network Data Gaps**				
	Streamflow Gauge on Carbonera Creek	$0	$15,000	$15,000	$3,000
7	**Data Management System**	$40,000	$0	$200,000	$40,000
8	**Evaluate, Prioritize, and Refine Projects and Management Actions**	Funded by individual agencies sponsoring specific projects and management actions			
	Contingency (10%)	$33,280	$12,500	$178,900	$35,780
	TOTAL	**$366,080**	**$137,500**	**$1,967,900**	**$393,580**

5.1 Implementation Activity 1: Agency Membership and Funding Structure Evaluation

The SMGWA is organized as a Joint Powers Agency (JPA) by and between 3 public agencies: San Lorenzo Valley Water District (SLVWD), the Scotts Valley Water District (SVWD) and the County of Santa Cruz. The water districts are the Basin's principal water purveyors, while the County oversees the well permitting process and represents non-municipal pumpers. The SMGWA member agencies agreed to jointly develop this GSP and fund the required activities during the GSP development period. However, it is appropriate and prudent for the SMGWA to evaluate expanding the agency's membership and funding structure. This activity will determine the most effective and equitable approach going forward with GSP implementation starting after the GSP is submitted to DWR by January 31, 2022. No budget is included in Table 5-1 for staff costs related to evaluating changes to agency membership and funding structure because it is anticipated that the activity will be completed in Fiscal Year 2022 and funded under the approved Fiscal Year 2022 budget.

5.2 Implementation Activity 2: Administrative and Business Operations

This category includes various activities in support of the SMGWA, including administrative and planning coordination, Board support, legal and audit services, communication and outreach, and miscellaneous services and supplies. Estimated costs to cover these expenses are provided in Table 5-1.

This category broadly includes various management, planning and programmatic support tasks to the SMGWA for ongoing GSP and SGMA related requirements. The SMGWA has used a collaborative staffing model since it was formed in 2017 whereby cooperating agencies participating in Basin management through the SMGWA do so as part of their internal budgets and not that of the SMGWA. Staff from cooperating agencies provide leadership, management, and administrative and support services to the agency. For the SMGWA to fund agency staff time, the SMGWA bylaws would need to be revised.

Outside vendors and consultants are retained to perform specialized activities such as technical work, legal counsel, financial audit, facilitation, public outreach, and grant administration. As the SMGWA shifts from GSP development into implementation starting in 2022, administrative support needs will be evaluated to determine the appropriate level of service and structure. It is anticipated staffing needs will be assessed annually during the early years of GSP implementation as a better understanding of the agency's needs is developed.

The SLVWD Finance Manager has been appointed and continues to serve as SMGWA Treasurer and is responsible for the financial and accounting activities of the SMGWA. The SVWD has been providing administrative staff support to SMGWA with a half-time employee position designated for this purpose. Considering that in the future, the scope and frequency of activities for the agency will change notably, the appropriate level and method of providing administrative services will need to be assessed.

Community outreach activities will also transition from awareness building and education about SGMA, SMGWA, and the Basin, to providing more routine updates on the implementation efforts of the GSP and communication on Basin conditions. Some of the activities can be achieved under the administration function while others require subject matter expert services.

5.3 Implementation Activity 3: Technical Support and Consultation

This category includes activities by technical consultants in support of implementing the GSP. It includes ongoing improvements and use of the groundwater model to evaluate impacts from projects and management actions on groundwater conditions, and as needed-technical support not related to the groundwater model. Estimated costs to cover these tasks are presented in Table 5-1.

5.3.1 Groundwater Model Simulations and Updates

The Basin groundwater model helps inform development of projects and management activities, and ongoing performance assessment of the GSP's sustainable management criteria (SMC). Periodic updates to the groundwater model are required to continue to refine and improve its capabilities and maintain ongoing functionality. This includes incorporating new model tools and features, aquifer parameters, refining of climate change projections, and related work to support ongoing simulations of projects and management actions. The estimated cost of this task is provided in Table 5-1.

5.3.2 Consultants As-Needed Technical Support

It is anticipated the SMGWA will have a need for technical support to inform Basin management. The estimated $15,000 per year for this activity included in Table 5-1 covers general as-needed costs that are not project specific. Examples of as-needed support include assistance with the data management system (DMS), collate and upload seasonal high and low (at a minimum) groundwater elevation data to the online SGMA portal as required by the SGMA, periodic SMGWA requests for information, attending SMGWA Board meetings when requested, and providing ongoing updates on SGMA related activities by the DWR and others.

There may be times when a defined project requires consultant support. Specific needs beyond what is included in the 5-year budget provided in Table 5-1 are yet to be identified and are not included in the budget. Examples of technical consultant support for potential future projects are hydrogeologic technical support (not groundwater model specific), economic (e.g., cost-benefit analysis), programmatic assessment of funding mechanisms, supplemental studies to address data gaps, vulnerability assessments for climate change, and additional assessment of managed aquifer recharge opportunities.

5.4 Implementation Activity 4: Monitoring and Reporting

One of the primary ongoing functions of GSP implementation is data collection and its evaluation, comparison of data against SMC, and reporting of groundwater conditions. The SMGWA will either contract consultants, negotiate agreements with agencies, and/or hire staff to implement the GSP's monitoring and reporting tasks. Cooperating agencies will provide the monitoring data they collect from their existing monitoring networks as part of their ongoing operations. Costs for monitoring and reporting are included in Table 5-1.

5.4.1 Monitoring

The SMGWA's monitoring program is described in Section 3.3. Individual member agencies will continue to collect the same data from their monitoring networks as they have prior to the GSP to inform management and operation of their respective water supplies. It likely that costs resulting from improvements to or expansion of existing monitoring networks necessary to evaluate progress towards sustainability, or otherwise added at the request of the SMGWA, will be funded by the SMGWA.

Groundwater level, groundwater quality, extraction, streamflow, and rainfall data collected by cooperating agencies will be uploaded semi-annually to the DMS described in Section 5.7. Data stored in the DMS will be downloaded by the consultant or SMGWA staff preparing the annual report and summarized in the required tables and figures to demonstrate that progress is being made toward sustainability in the Basin, as defined in Section 3. Cooperating agency uploads to the DMS will be coordinated with the requirement under SGMA for SMGWA to upload, at a minimum, seasonal high and low groundwater elevation data to the SGMA portal by January 1 and July 1 of each year.

5.4.2 Reporting

SGMA regulations require that the SMGWA submit regular reports to DWR documenting Basin conditions and progress toward sustainability. The costs to prepare the required reports are included in Table 5-1 and described below.

- **Annual Reports.** In accordance with SGMA Regulation §356.2, annual reports will be submitted to DWR starting on April 1, 2022. The purpose of the report is to provide monitoring and total groundwater use data to DWR, compare monitoring data to sustainable management criteria, and adaptively implement actions and projects to achieve sustainability.

- **5-Year GSP Update Reports.** Five-year GSP update reports will be provided to DWR starting April 1, 2027. The SMGWA will evaluate the GSP at least every 5 years to assess whether it is achieving its sustainability goals. The evaluation will include a description of significant new information that has been made available since GSP adoption or amendment and whether the new information or understanding warrants changes to any aspect of the plan.
- **GSP Amendments.** Although not required by SGMA regulations, the SMGWA may prepare amendment(s) to the GSP as the monitoring networks are refined and understanding of basin conditions are improved over time. The amendment does not need to correspond to the GSP's 5-year update if there is an urgent need to make a change to the GSP.

5.5 Implementation Activity 5: Implement Groundwater Extraction Metering for Non-*De Minimis* Extractors

The SMGWA will initiate a well metering program to collect volumes of non-*de minimis* groundwater extraction. These data will be used to assess and refine the sustainable yield calculation, which is used to define undesirable results related to the reduction of groundwater in storage sustainability indicator. The metering program will apply to all non-*de minimis* private pumping extracting more than 2 AFY and will be led by the County of Santa Cruz. Under the SGMA, private well owners who extract less than 2 AFY for domestic purposes (also called *de minimis* users), including individual water systems serving fewer than 5 connections, may not be required to meter their wells by the SMGWA. The SMGWA has no current plans to regulate or to charge a fee on either *de minimis* or non-*de minimis* private users. The SMGWA may evaluate these options as funding mechanisms in the future, with any fees that may be proposed being commensurate to the benefit received by *de minimis* and non-*de minimis* private users. Private users shall be engaged in this process.

Costs to implement the metering program are summarized in Table 5-1. The costs include program development including timeline, guidance documents, and outreach; coordination of program set-up and implementation; participant tracking; and coordination of annual reporting by the participants. The SMGWA will initiate planning to develop the program in 2022 and aim to implement it within 2 years. It is anticipated the non-*de minimis* users will be responsible for all costs related to the purchase, installation, calibration, and operation of the meters as well as annual reporting to the SMGWA.

5.6 Implementation Activity 6: Address Hydrogeologic Conceptual Model, Groundwater Conditions, and Monitoring Network Data Gaps

5.6.1 Identified Data Gaps

Section 2 identifies several data gaps related to the hydrogeologic conceptual model and groundwater conditions. There are areas of the Basin with limited to no data available to develop the hydrogeologic conceptual model and calibrate the groundwater model. Data collection during GSP implementation will be used to refine the hydrogeologic conceptual model for better groundwater management in the following areas:

1. Communities where there are higher concentrations of private domestic *de minimis* wells pumping from either the Santa Margarita aquifer or Monterey Formation
2. The Butano aquifer where it is pumped at depths more than 1,000 feet by SVWD
3. Areas where shallow groundwater is connected to surface water and groundwater pumping may be causing depletion of surface water

In 2020, the SMGWA was awarded a Round 3 Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Sustainable Groundwater Planning Grant Program) grant, administered by the California Department of Water Resources. In July 2021, a project funded by this grant will commence to expand the Basin's monitoring network through the installation of 8 new monitoring wells to fill the data gaps described above and described in more detail in Section 3.3.4.1.

Collection of additional hydrogeologic data during well installation of the 8 new monitoring wells, as well as their ongoing monitoring during GSP implementation will help the SMGWA improve Basin characterization. During drilling activities, groundwater level and water chemistry data will be collected, and drill cuttings will be examined to determine depths to the top of various geologic formations and the presence of sandy layers most suitable for aquifers. Gathering more lithologic and hydrostratigraphic data will help map the lateral and vertical extent, and aquifer characteristics of the principal aquifers and other formations with greater resolution. New information will further inform understanding of groundwater levels in parts of the Basin where no historical data exist and can be used to improve model calibration in those areas.

Groundwater Level Spatial Data Gaps Near Groundwater Pumping: Spatial data gaps are identified in areas pumped exclusively by *de minimis* and small water systems that lack historical groundwater level monitoring and hydrogeologic data. These data gaps will be addressed by installation of 4 new monitoring wells screened in targeted aquifers to collect groundwater levels: 1 well in the Santa Margarita aquifer, 2 wells in the Monterey Formation, and 1 well in the deep Butano aquifer.

Groundwater Level Spatial Data Gaps Near Interconnected Creeks: Spatial data gaps are identified in areas that have interconnected surface waters supported by aquifers pumped by municipal and private extractors, and with limited aquifer-specific groundwater level monitoring. In order to address these data gaps, 4 new monitoring wells will be installed with screen intervals in the aquifers underlying interconnected creeks. These wells will supplement the 2 existing shallow monitoring wells near creeks that are included as representative monitoring points for the depletion of interconnected surface water SMC. The new monitoring wells will include 4 wells in the Santa Margarita aquifer and 1 well in the Lompico aquifer.

Localized Streamflow Monitoring Data Gaps: During GSP development, streamflow monitoring data gaps were identified. To address the data gaps, 3 streamflow gauges were upgraded, and 2 new gauges were installed and calibrated early in 2021. The gauges are being monitored by the SMGWA and where possible will be paired with new monitoring wells to be constructed in 2022. There is one streamflow monitoring data gap of lower priority identified near Carbonera Creek which is not as connected to groundwater as most other creeks in the Basin and is therefore a lower priority to be addressed as funding becomes available.

5.6.2 Implementation Plans for Addressing Data Gaps

5.6.2.1 Groundwater Level Monitoring Network

The planning and construction of 8 new groundwater level monitoring wells will commence in July 2021. Budget for the next 5 years is not included in Table 5-1 because the SMGWA has already been awarded DWR grant funding and has budgeted the required match. Given the need for landowner negotiations, and potential limitations on well construction during winter months, this project will be completed in 2022, after GSP adoption.

5.6.2.2 Groundwater Storage Monitoring Network

In 2022, the SMGWA plans to implement a non-*de minimis* groundwater extraction metering program as described in Section 5.5 above. The more accurate groundwater pumping volumes generated from this program will be used to compile groundwater extraction data needed to assess whether the 5-year moving average Basin extraction is less than the sustainable yield which is used to determine reduction of groundwater storage undesirable results.

5.6.2.3 Interconnected Surface Water Monitoring Network

Four new monitoring wells, as part of the 8 new wells described in Section 5.6.2.1, will be completed in 2022 to improve understanding of surface water and groundwater interactions, to improve the groundwater model simulations of and surface water interactions, and to become representative monitoring points (RMPs) for the depletion of interconnected surface water indicator. Budget is not included in Table 5-1 because the SMGWA has already been awarded DWR grant funding and has budgeted the required match. The first GSP 5-year update will include analyses on the new well groundwater level data recorded by data loggers adjacent to gauged streamflow, accretion studies, and GDE monitoring. Based on findings in that first GSP 5-year update, additional monitoring locations may be identified.

In addition, either a new stream gauge will be installed, or an old gauge will be reestablished on Carbonera Creek within the first 5 years of GSP implementation. The SMGWA's estimated costs to install, calibrate and maintain 1 streamflow gauge are presented in Table 5-1. This estimate includes one-time costs related to the initial establishment of the new station. The cost estimate includes planning, site selection, design specifications, and related pre-installation tasks. It includes the cost to install monitoring instrumentation, conduct surveys and related work to establish each monitoring site, develop rating curves to establish a stream stage-discharge relationship, routine data collection, and station maintenance. The assignment of roles and responsibilities (consultants and agency staff) will be evaluated as GSP implementation proceeds.

5.7 Implementation Activity 7: Data Management System

As described in Section 3.3.3, the SMGWA, Santa Cruz Mid-County Groundwater Agency (MGA), and County of Santa Cruz have established a regional DMS to upload, store, and review data collected by the GSP monitoring networks for the Santa Margarita and Santa Cruz Mid-County Basins. Having all groundwater related data in the DMS will streamline data collation while preparing GSP annual reports and 5-year updates. Ongoing costs to SMGWA, shared with the MGA, include fees for hosting, maintenance, and licensing of the WISKI DMS. Cooperating agencies that collect relevant data within the Basin will be responsible for semi-annual uploads to the DMS.

5.8 Implementation Activity 8: Evaluate, Prioritize, and Refine Projects and Management Actions

Table 5-1 does not include SMGWA costs for evaluating, prioritizing, and refining projects and management actions. This is because individual cooperating agencies will principally lead efforts on evaluating projects and management actions, but may and are encouraged to collaborate with each other on feasibility studies when practical. Project implementation will likely involve partnerships between interested parties and benefiting agencies.

Projects and management actions are needed to achieve the SMGWA's sustainability goals and improve individual agency water supply reliability. The Mount Hermon / South Scotts Valley subarea is targeted for projects that increase groundwater levels in the Lompico aquifer where lowered groundwater levels still occur. Historical groundwater level declines have been mitigated by water use efficiency programs and use of recycled water for non-potable uses, However, additional projects are needed to achieve the SMGWA's sustainability goals under a projected drier climate.

Before cooperating agencies can begin pilot studies and develop project designs, further study of project feasibility from a technical and operational perspective must be completed. Cooperating agencies will be examining several alternatives in parallel to ensure sufficient projects and actions to account for the level of uncertainty in the Basin's hydrogeologic conceptual model. Refinement of projects and management actions will occur simultaneously with refinement of the funding mechanism that supports them.

Activities that will take place during the first 5 years of implementation include:

- Reaching agreements between cooperating agencies to refine project descriptions
- Clarifying water rights for recharge opportunities and water transfers
- Using the groundwater model for evaluating how those projects improve groundwater conditions in relation to SMCs
- Identifying synergistic infrastructure that would allow different projects to complement each other, facilitating easier adaptive management of projects over time, if necessary
- Applying for change of diversion or change of timing on water rights, as necessary
- Refining capacities of proposed projects
- Refining costs of proposed projects based on evaluations discussed above
- Agreeing to preliminary cost share options based on refined costs
- If projects are adequately defined, producing preliminary design of projects
- Completing pilot testing of the top projects to confirm their feasibility for providing anticipated benefits without causing negative impacts to the Basin and its beneficial users
- Initiating environmental permitting for projects, as necessary

In general, the process to complete a project from inception to implementation can take 5 to 10 years. Figure 5-1 shows the steps that will be taken to complete projects found to be feasible. Projects that rely more on existing infrastructure will be completed closer to the 5-year time frame, but projects with many miles of pipeline, pump stations, and new treatment facilities will take closer to 10 years to complete.

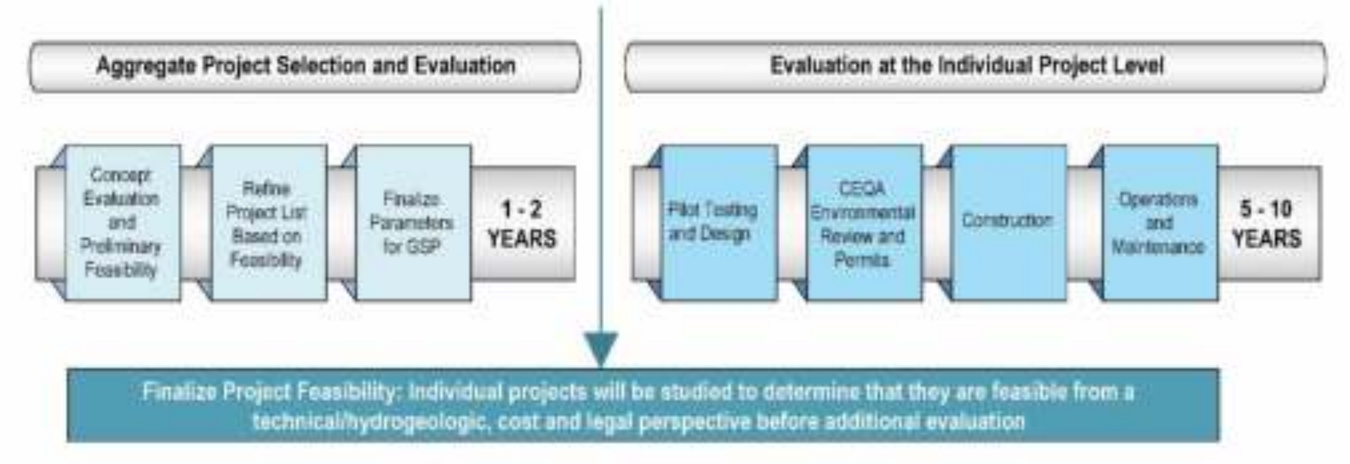

Figure 5-1. Project Development Process

5.9 Financial Reserves and Contingencies

Prudent financial management prescribes that the SMGWA carry a general reserve in order to manage cash flow and mitigate the risk of expense overruns due to unanticipated expenditures. General reserves have no restrictions and the ending balance in cash reserves becomes the beginning balance for the next fiscal year.

The SMGWA Treasurer, responsible for overseeing the financial health of the agency, will advise the Board on the appropriate reserves and requesting a contingency amount as part of the budget adoption process. An initial contingency of 10% of the annual budget is included in Table 5-1.

5.10 GSP Implementation Schedule

A general schedule showing the major GSP implementation activities and their estimated timelines during the first 5 years of GSP implementation is provided on Figure 5-2. Project and management actions summarized in Section 4 will have their own implementation timelines that would be determined after the project is deemed feasibility and funding is secured.

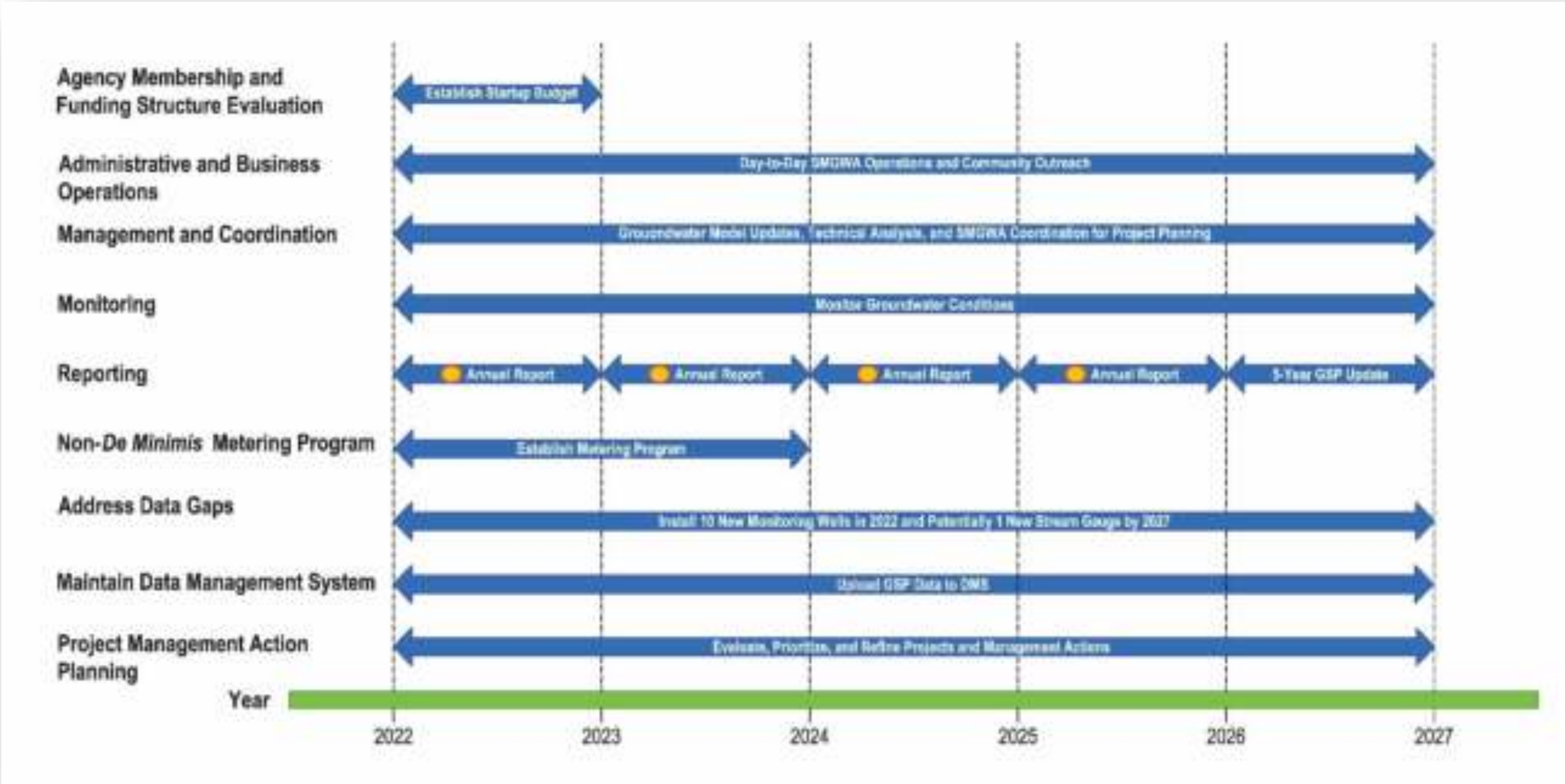

Figure 5-2. General Schedule of 5-year Implementation Plan